LINKED IN: THE SOFTWARE AND IT SERVICES SECTOR IN INDIA'S ECONOMIC DEVELOPMENT, 1980 to 2011

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Declaration for PhD thesis

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Abstract

Research on the use of information technology (IT) in production in the developed world demonstrates that its impact on both economic growth and productivity has been substantial. Despite this, literature on the potential for India's IT industry to bring about similar outcomes by selling IT within the country is resoundingly pessimistic.

The most important finding of the research described here is that this outlook is far too gloomy. A newly assembled time series of the IT sector's sales to Indian companies, or in other words the sector's forward linkages, shows that these have been substantial for some time. Since 2005-06 they have also been growing significantly faster. An original econometric investigation into the impact of this ongoing investment finds significant increases in both total factor productivity and output in the firms and sectors that make up the sector's domestic clients.

These findings beg a question: If published analyses imply a dismal future for the IT sector's forward linkages, why have domestic purchases from the sector, in fact, been growing so quickly? The research project included a programme of in-depth interviews undertaken in the field. This contributed another major finding. That is that IT has become appropriate for production in India as a result of a match between attributes of the technology and attributes of the country's society and markets.

The research described here was not limited to an investigation of the sector's forward linkages. It also included an extensive survey of backwards and other linkages from

the sector to the rest of the Indian economy. The thesis concludes that these too are now substantial and that the IT industry can therefore be described as a leading sector.

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Using this document

Indian Financial Years

In India a great deal of data is published in financial years which run from 1 April to 31 March. In what follows '2005-06' means the year starting on 1 April 2005 and ending on 31 March 2006, and this convention is adopted for all other years too.

Indian Numbering System

1 lakh = 100,000 = 100 thousand
1 crore = 10,000,000 = 10 million

Dollars and exchange rates

Monetary amounts are given both in Indian Rupees, abbreviated to Rs. and United States dollars, abbreviated to US$.

Reserve Bank of India (2011) provides Indian Rupee exchange rates for all relevant years and is used in all cases where a monetary amount is reported in both currencies.

Data Tables

Appendix 1 provides tables of the data behind many of the charts in what follows.

Acronyms and Abbreviations

BA: Bharti-Airtel

CII: Confederation of Indian Industry

CMIE: Centre for Monitoring the Indian Economy

CRM: Customer Relationship Management

GDP: Gross Domestic Product

GOI: Government of India

HW: Hardware

IBEF: India Brand Equity Foundation

ICT: Information and Communication Technologies

IT: Information Technology

ITES-BPO: IT Enabled Services and Business Process Outsourcing

MOSPI: Ministry of Statistics and Programme Implementation

NASSCOM: National Association of Software and Services Companies

RBI: Reserve Bank of India

STP: Software Technology Park

SWIS: Software and IT Services

SWIS-ITES-BPO:
Software and IT Services and IT Enabled Service and Business Process Outsourcing

TFP: Total Factor Productivity

US: United States

1. Introduction

1.1 Prologue: A parable about elves and shoes

> "As soon as it was midnight, there came in two little naked dwarfs; and they sat themselves upon the shoemaker's bench, took up all the work that was cut out, and began to ply with their little fingers, stitching and rapping and tapping away at such a rate, that the shoemaker was all wonder, and could not take his eyes off them. And on they went, till the job was quite done, and the shoes stood ready for use upon the table. This was long before daybreak; and then they bustled away as quick as lightning."
>
> Brothers Grimm, *The Elves and the Shoemaker*, (1912)

Within the last three decades India has become a major exporter of information technology (IT) and associated services to the United States and other developed countries. Producing these IT exports involves creating and maintaining programs which have been specifically tailored for particular overseas client companies. The work is labour intensive and complex and, because of the time difference, is often done during the developed countries' evening and midnight hours. Just like the elves in the story then, Indian software engineers use their specialised skills to produce bespoke products while their customers sleep. And just like the shoemaker's new and wonderfully made shoes, Indian-produced IT is used in lands far, far away from the home of its producers.

Until the end of the fairytale, when the shoemaker's wife makes clothes for them, the elves remain both naked and shoeless. Their exquisite production makes the shoemaker and his wife rich and puts beautifully finished shoes on the feet of many humans, but the elves and their kin receive no such boon. According to the accepted literature on the IT industry, this is also how it is in India. Throughout the already-published chapters of the industry's story, the finding is that India's wider economy has not benefited from the sector's existence. Indian IT firms have been equipping foreign firms with state-of-the-art technology while the majority of Indian firms have languished technologically. Some have attempted to arm themselves with IT, though without up-to-date technical advice or skilled personnel available in the IT industry, while others simply have not invested in IT at all. Apart from a relatively small group of IT workers and the companies that employ them, no one in India has become rich.

In the end, fairytales always have a 'happy ever after'. The research project described here finds that the same may be true in India. Indian firms are beginning to purchase IT from the country's own IT industry and this is enhancing both their productivity and output. On top of that, production of the industry's inputs is creating jobs and improving opportunities amongst low-skilled and disadvantaged workers. Together, these effects are having a noticeable impact on national-level output. In other words, IT in India no longer benefits only far-away firms in distant lands. It also now benefits the Indian economy and Indian people.

The next section is a brief outline of the theoretical concepts used to tell this emerging story.

1.2 The theory: Linkages, leading sectors, and development

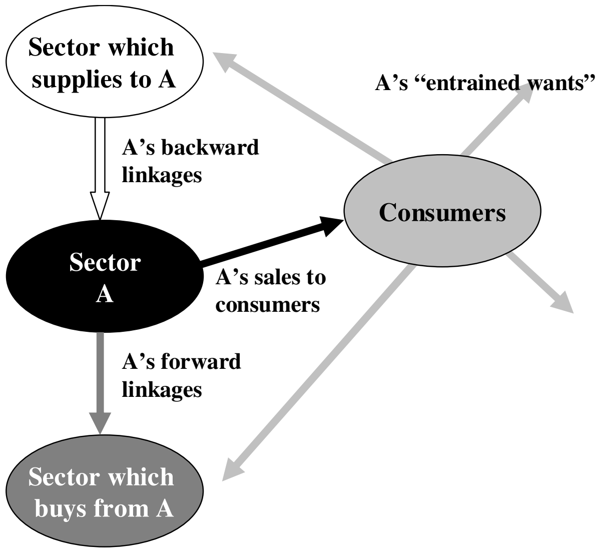
The idea that expansion in a particular sector could play a key role in a developing country's wider economic growth was first put forward in Albert Hirschman's (1958) *The Strategy of Economic Development*. He begins with a section entitled "The search for a Primum Mobile" (p. 1) which lays out the theory's foundations by arguing that, in a developing country, the most important step in creating or recreating a period of growth is to find "something" to start or restart it. Hirschman makes this case with a simple observation: As more and more empirical work and theorising is undertaken, the list of factors, conditions, obstacles, and prerequisites for growth gets longer (p. 1). It is an observation of his day that remains true today. In 1992, Levine and Renelt assembled and tested a dataset of variables found in the literature to have a significant effect on economic growth. Their dataset included more than 50 possible factors, though even this list was not complete, as they excluded variables identified in the literature that were not readily amenable to the methodology they used (Levine and Renelt, 1992: 945).

It is as fortunate now as it was in 1958 then, that the existence of this long list does not mean that every factor has to be available and in place before any output expansion can occur. Hirschman argues, 'the resources and circumstances whose presence has been shown to be needed for economic development… are not so scarce or so difficult to realise, *provided, however that economic development itself first raises its head*' (Hirschman, 1958: 5; italics in the original). Logically, there can be no demonstration of profits in any specific business or technology prior to its inception. This means it is difficult, if not impossible, for entrepreneurs to envision the profitable outcomes of investments in new ventures, so risky decisions involved in development are not undertaken (p. 10-14). Once a clear opportunity for profit can be demonstrated, though, entrepreneurs emerge and invest (p. 27). They then find that labour, capital, savings and all the other relevant items from the list are available in a latent form (p. 2–5).

The existence of all these potential resources presents opportunities. A new phase of development can be created by finding and using an 'inducement mechanism' that demonstrates profitable economic expansion is possible and brings specific and unambiguous opportunities for entrepreneurs (Hirschman, 1958: 6). 'The search for a primum mobile' is the search for such an inducement mechanism. It is the search for a sector of the economy where the beginning of output expansion creates clear opportunities for investment into other parts of the economy and, so, more growth. It is here that an important role for a particular 'leading' sector becomes clear. The ideal 'primum mobile', according to Hirschman's strategy for development, is a sector whose own growth induces growth in other sectors of the economy (p. 114–115, 202).

The transmission of growth is achieved through "linkages" which can be any mechanism which achieves the transmission of growth from one sector to another. Hirschman suggests and explains three particular types (see Figure 1.1). These are backward linkages, where output growth is transmitted from sector A to sectors supplying A's inputs; forward linkages where expansion is transmitted to other sectors which buy A's outputs; and "entrained wants" arising from use of sector A's products (p. 67, 100). Hirschman defines a "key sector" as one which has a "large" amount of backwards and forwards linkages, and which brings about entrained wants. Expansion in such a sector invites or suggests investments in other sectors. If the sectors which are linked to the first themselves have onward linkages to still more sectors, so much the better, because these indirect linkages can provide a further impetus for expansion and growth.

Figure 1.1: Hirschman's linkages



Source: Adapted from Hirschman (1958)

Hirschman's three linkages are not equally useful for bringing about economic growth. Backward linkages are the most reliable transmitters of growth because they occur in the context of shortage of a particular input to the 'primum mobile' sector. There are two different mechanisms by which expansion in the supplying sector can occur. The first is that the input becomes scarce, causing its price to increase and enticing entrepreneurs to invest in expanding its production. The second mechanism happens if this first mechanism fails. If entrepreneurs do not respond to increases in the input's price, the first, expanding, sector will feel an urgent need for more of the specific input. In that case it will be compelled to provide investment into expanded production for itself (Hirschman, 1958: 93). For forward linkages the same urgency is less likely. Sector A's firms may or may not feel the need to offer their product to a particular buying sector at a low price in order to continue to expand. Similarly, they may or may not invest into domestic sectors which could constitute new markets (p.

100). The crucial difference is that, for the 'primum mobile' sector, any sector which purchases its products, whether at home or abroad, is as good as any other, so there is no particular buying sector which is strictly necessary to A's continued expansion. Entrained wants are perhaps even less reliable. They arise in two ways, both of which are dependent on the vagaries of consumer preferences. The first is when the increased use of sector A's products leads to an increase in demand for products that are used in tandem with them, and the second is when the use of A's products proves desirable, leading to an increase in demand for products which are similar (p. 68).

Having laid out his definition of key sectors, Hirschman pauses to contrast them with an opposing type of sector which existed in many developing countries at his time of writing. These are the sectors which existed in the colonies solely to extract primary products and export them to the motherland. Hirschman argues that these were a source of hostility in developing countries because the extraction sectors had few, if any, linkages to the domestic economy, and so failed to improve outcomes for the colony (Hirschman, 1958: 110). Singer (1950: 33) clearly demonstrates the empirical fact that production of tea in Ceylon[1], oil in Iran, copper in Chile, and cocoa in Africa's Gold Coast[2] made very little, if any, contribution to the economic development of those countries. His explanation is that the extraction of primary products leads to expansion in other parts of the economy only if they are used as an input for manufacturing. Singer observes that in the examples he identified, processing and manufacturing were always done in Europe, after the raw materials had been imported. This meant that the original extraction industry prompted growth and investment in Europe, not in the colonies. Singer uses the word 'enclave' to describe colonial primary industries for export, because these sectors were incapable of

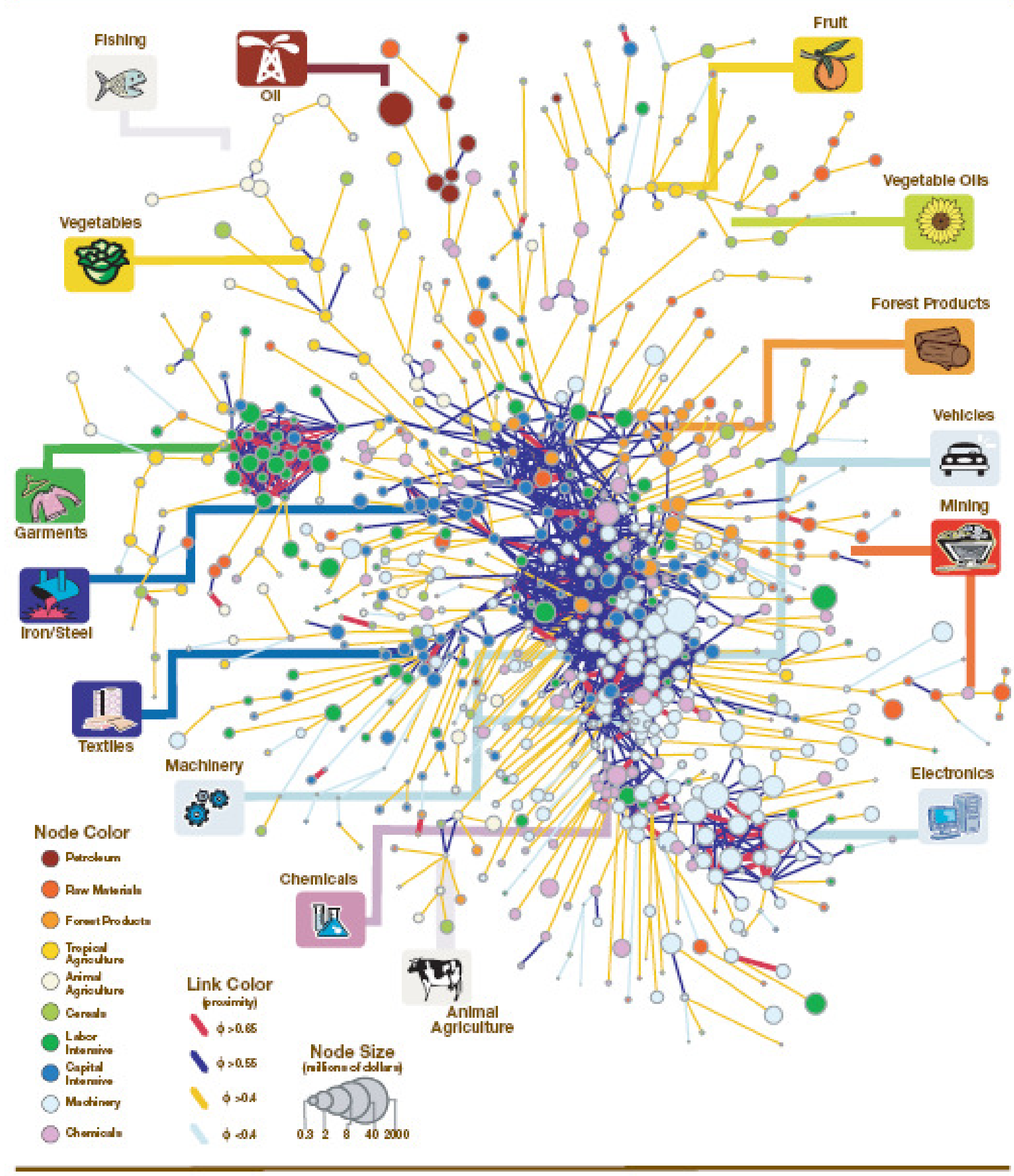
[1] Now Sri Lanka.
[2] Now Ghana.

initiating any wider processes of domestic industrialisation. The investment made by the colonists was really only a contribution to growth at home, and the industry might just as well be considered a part of the colonial master's home turf.

The idea that linkages and highly linked sectors are important in determining the path and extent of economic growth has been verified by a recent body of work, associated most prominently with Ricardo Hausmann (Hausmann and Klinger, 2006, 2007, 2007b, 2008; Hidalgo and Hausmann, 2008; Hausmann, Hwang, and Rodrik, 2006; Rodrik and Hausmann, 2006). Hausmann and Klinger, (2007: 11) analyse a mass of data on the products that different countries export, leading to the identification, for all pairs of products, of the probability that a country chosen at random will produce (and export) both[3]. This probability is a measure of the 'relatedness' of two products and can also be interpreted as a measure of the strength of linkages between sectors. Figure 1.2, which Hausmann, Hwang, and Rodrik, (2006) have titled the 'Product Space', maps this measure for all possible pairs of 1,006 products included in the project (p. 13). Each node represents a product and is proportional to the size of its world market. The nodes are linked in pairwise fashion, and both the length of the link-lines and their colour indicates their relatedness. Longer links (in light blue) join products which are much less likely to be produced by the same country than pairs of products which are joined by shorter links (red lines) (Hidalgo and Hausmann, 2008: 4).

[3] Hausmann and Klinger (2007:11) use exports rather than production so as to focus on both available data and on products that a country produces well enough to succeed in world markets.

Figure 1.2: The 'Product Space' for 1998-2000



Source: Hidalgo and Hausmann (2008:4)

To ascertain that their "relatedness", or linkages, measure is an important measure of how countries diversify from one product to another, Hausmann and Klinger (2007: 21) undertake an econometric analysis of changes in countries' production baskets. Their analysis shows that the "relatedness" of what a country already produces with a given new product has a strong and robust positive correlation with whether or not the new product will be produced in that country in the future (p. 22). Importantly, the empirical analysis demonstrates that this result is driven by specific, product-to-product linkages, and not by other theories which might produce similar diversification patterns (p. 22).

This is a very highly regarded piece of research which has spawned many additional contributions, including several which recommend a strategy for development very similar to Hirschman's. As of this writing, the first published paper on the subject, by Hausmann, Hwang, and Rodrik (2006), has been cited 500 times in only five years'[4]. Amongst these citations are two papers which use the product space to study anaemic economic growth in South Africa (Hausmann and Klinger 2006; Rodrik 2008). Both analyses note that South Africa's existing production capabilities are in products which are not strongly linked to other sectors. This is given as the reason for a failure to diversify into new areas and so at least one of the reasons for slow growth. In a clear echo of Hirschman's idea that bringing about expansion in a key sector with many linkages will promote growth, Hausmann and Klinger (2006) carry out an exercise to find one or more specific industries whose expansion might solve this problem. They look for sectors in dense parts of the "product space" or in other words sectors which have many linkages, and they conclude that the manufacture of machinery, equipment, and pharmaceuticals would be appropriate. Hausmann and Klinger then make a direct policy recommendation to the South African government that expansion in these industries would bring wider economic growth (Hausman and Klinger, 2006: 49). Hausmann and Klinger have performed similar analyses in Peru and Chile (Hausmann and Klinger ,2007b, 2008). Analysis again attributes periods of slow growth to the absence of strong and numerous linkages from existing production

[4]http://scholar.google.co.uk/scholar?hl=en&as_sdt=0,5&q=hausmann+hwang+ rodrik+2006, accessed 7 July 2011.

capabilities to new areas, and Hausmann and Klinger again advocate investment into particular highly linked sectors (Hausmann and Klinger, 2007b, 2008). Rodrik (2006), using Hausmann and colleagues work as a starting point, studies the evolution of China's production capabilities. Here, in analysing a success story, Rodrik argues that it has occurred because of expansion in a particular, highly linked, sector. He finds that government policies which deliberately targeted expertise in electronics have been crucial to China's wider success in production, exporting, and economic growth (Rodrik, 2006: 24).

The data that forms the basis of Hausmann and colleagues' and Rodrik's conclusions does not include software or IT services, so their bodies of work cannot be used to evaluate the Indian IT industry[5]. On the one hand, this is unfortunate because it means it is not possible to place the current case study in a literature of comparable studies. It also means that this research project begins without an understanding of linkages from software and IT services production in the rest of the world. On the other hand, however, the absence of software and IT services in Hausmann and his colleague's analysis presents an opportunity for a rich evaluation of the IT sector in India. Hausmann and Klinger's (2007) 'relatedness' measure is agnostic on the causes and processes behind sector-to-sector linkages. In the following chapters, the analysis is much more definite. Each type of linkage process is identified and then its actions in India evaluated. In this respect the research project remains faithful to Hirschman's original work. The concept of a "leading sector", which is used as a yardstick for Indian IT in this project, is close to Hirschman's original 'key sector'. Its basis is the strength and number of specific, explained linkage processes. A leading sector in this

[5] The Indian IT sector is composed of mainly software development and IT services. Hardware manufacture (which is included in the product space) makes up only a small proportion of the sectors total revenues. (See Chapter 3 for a detailed discussion.)

project must exhibit Hirschman's three linkages or similar, explainable linkages which transmit growth from one sector to another.

Another aspect of Hirschman's 'key sector' concept which is retained for the definition of a "leading sector" in this project is the requirement for a leading sector's linkages to be substantial relative to the size of its own output. Hirschman does not detail this condition directly, but he does advocate the use of a method for identifying key sectors (by Leontieff 1951) which is based on precisely that criterion (Hirschman, 1958:108). To this requirement on the size of linkages, the definition of a leading sector used in this project adds a second which also must be fulfilled. That is, a leading sector's impact on the economy through linkages must be substantial enough to impact macro-level output and growth. For the purposes of this project then, a leading sector is defined as 'A sector which has a disproportionately large impact on macro-level economic growth because its expansion leads to growth of other sectors' output through linkage effects'.

It is a definition which, in common with Hirschman and Hausmann and colleagues' work, recognises economic growth as an end in itself and pays no heed to qualitative aspects of that growth. This raises a concern because in developing countries not all processes of growth are of equal value. The ideal is for economic growth to benefit the poor, particularly those with many accumulated disadvantages. This ideal can be achieved in a leading sector strategy in two ways: through the type of sectors which expand because of linkages, and the types of sector-level growth process which linkages spark. In the best case scenario, the leading sector would be linked to secondary sectors which both offer employment to the poor and allow those workers a decent and continually improving quality of life. This latter criterion disqualifies the so-called 'low road' industries which achieve output gains by competing on the basis of low wages, cheap inputs, and small margins (Guiliani, Pietrobelli, and Rabelotti, 2005: 550). Industries that follow this path offer workers a meagre living where previously there was no employment, but they do not usually lead to long-term development. Firms are not only vulnerable to the entrance of new and cheaper competitors but possibly to declining terms of trade. There is also little chance of accumulation of cash for either workers or firms, leaving the economy with very little in the way of investment for sustainable growth. 'High road' industries, on the other hand, achieve growth through upgrading, investment, and productivity improvements (Guiliani, Pietrobelli, and Rabelotti, 2005: 550; Humphrey and Schmitz, 2000: 4). In these industries, an initial improvement of production techniques opens up the possibility of increased productivity and, hence, more profitable production. This can lead to firms possibly increasing workers wages and reinvesting profits for upgrading technology and equipment, meaning better outcomes for workers and a cycle of continuing upgrading, reinvesting, and profits for firms. These qualitative criteria for leading sectors are important in the following chapters because they are used as supplementary criteria for judging the Indian IT sector, along with the concepts of the leading sector, direct and indirect linkages, and the enclave.

The following section provides a guide to the remainder of the thesis and what it contains.

1.3 What comes next: Three major original contributions

The thesis makes three major original findings. Taken together, these demonstrate that the IT industry is a leading sector in India.

The first of the three findings is that the body of existing literature which deals with forwards and backwards linkages from the IT industry into the Indian economy is out-of-date and misleading. This literature is introduced and reviewed in Chapter 3, and is found to paint a dismal picture. Published works on India's IT industry find that there are very few backwards and forwards linkages and that the limited, identified benefits are vastly outweighed by negative implications. The prognosis from this existing literature is dire. Optimism for the future of any linkages is rare, and, in the case of forward linkages, two influential contributions outline reasons why there is little or no hope (Dahlman and Utz, 2005; D'Costa 2003). Balasubramanyam and Balasubramanyam, (1997), published in World Development, a highly ranked journal, even write that the IT industry in India behaves more like an enclave, not a leading sector. Chapter 5 provides empirical evidence that this view is far too gloom. It shows that 85% of the IT sector's substantial input needs are now purchased from Indian supplying sectors and that these sectors hire low skilled and disadvantaged workers. Once these backwards linkages are added to those arising from the purchases of IT workers, the resulting output has been estimated to be between 2% and 3% of India's GDP in 2005. Chapter 5 also demonstrates that forward linkages from the sector, measured by the value of software and IT services (SWIS) that the sector sold to Indian firms, began to grow significantly faster in the financial year 2005-06[6]. As of

[6] 2005-06 refers to the financial year from April 2005 to April 2006. This convention is adopted throughout the thesis.

2010-11, this trend has resulted in the SWIS domestic market amounting to nearly US$15bn. These forward linkages are to sectors which themselves sell in the domestic economy. An index of total forward linkages, benchmarking IT to other Indian industries, increased by 20% in only 3 years (2003–04 and 2006–07).

The second major finding from this research project, explained in Chapter 6, answers an important question: If influential published analyses on IT in India imply a dismal future for forward linkages, why have domestic purchases from the sector, in fact, been growing so quickly? What becomes clear in the chapter is that the existing literature misses the possibility that IT could be an appropriate technology for firms in India, and it doesn't foresee the possibility of there being significant demand in the domestic economy. In fact, IT is an appropriate technology for Indian firms because one characteristic of software, economies of scale, matches closely with Indian firms' consumer markets, which are large and in need of IT, but price sensitive. The match brings a virtuous circle. If prices of IT products can be kept low, there will be a large market amongst India's consumers for the final products that (potential) IT buyers make. These prices can remain low even after automation because whenever there is a large enough market, economies of scale built into software systems mean automation can be delivered for low per-unit costs. The IT sector has been instrumental in creating and activating this virtuous circle in several ways. The most important of these was an innovative deal between IT company IBM and mobile telecommunications provider, Bharti-Airtel in 2004. This introduced a new way of paying for SWIS outsourcing: the upfront costs of the IBM system were paid by IBM, and the customer, Bharti-Airtel, then only pays when they use it. It is a system that alleviates the need for firms to make the kind of risky investments that Hirschman identified as difficult for entrepreneurs in developing countries. It is also a system that allows both seller and buyer to make money. The IBM–Bharti-Airtel deal provided the first of many demonstrations that the virtuous circle in action could be profitable for both sides. In short, it was a clear proximate cause of the acceleration in SWIS use in India from 2005-06 through to today.

The third of the three major contributions is discussed in Chapter 7. The chapter describes an econometric model designed to establish the impact of forward linkages. Estimates arising from this work suggest that between 1.3 and 2.4 percentage points of India's GDP growth between 2005 and 2008 can be attributed to output effects of investment into SWIS from the sector. This means that the acceleration in forward linkages from the IT sector is a major cause of acceleration at the macro level; Indian GDP growth accelerated from an average of 6% per annum in the 10 years before 2004-05 to an average of 8.4% per annum in the seven years since then. But this is not the only important finding of Chapter 7. The econometric evidence also shows that output increases arising from forward linkages are not only the result of more inputs being fed into production, but that the introduction of outsourced SWIS from the IT sector increases total factor productivity in buying sectors. Buying sectors then have the opportunity to traverse the 'high road', rather than 'low road' to expansion, which in turn gives better opportunities to their workers. These findings on forward linkages are an important addition to the literature that details the impact of IT; this literature is reviewed in Chapter 2. For all the considerable effort expended in it, there has been no published empirical analysis of outsourced IT in any form. Even on related issues which have received a lot of attention, in particular the impact of non-IT outsourcing and in-house IT, there are few existing contributions which focus on developing countries. Of these few have as rich a quantitative dataset as that used here, and none includes, as this thesis does, complementary qualitative research.

In documenting these three major contributions, the remainder of the thesis follows the following layout. Chapter 2 provides the background to the research project, and is designed for the reader who is unfamiliar with the history and impact of IT adoption or with recent trends in the Indian economy. Chapter 3 reviews the current literature on the Indian IT sector. Chapter 4 describes the author's research methodology; Chapters 5, 6, and 7 highlight the findings from the new research; and Chapter 8 brings the thesis to its conclusion.

2. Background: A new technology and a new Indian economy

"The trouble with our times is that the future is not what it used to be."

Paul Valery (1977)

The research described in the following chapters takes place at the confluence of two major trends—the beginning and spread of IT use and faster economic growth in India—which began to unfold in the late 1970s and early 1980s. Both of these radically altered what was possible, and both led to the expectation that the future would be different in known and unknown ways. The first trend and perhaps the most widely felt of the two, began with the invention of the computer, and continued with a raft of changes in technology use and associated ways of working across the globe. The second was equally disruptive in its effects, albeit over a smaller geography. It began with a significant acceleration in Indian economic growth in 1980 and continued with a previously inconceivable performance of consistently rapid expansion.

Amongst a wide range of implications of these two game changing developments are several which are relevant to the research laid out in this thesis and these are the subject of this chapter. The intention here is neither to evaluate existing contributions on the issues surrounding the two trends, nor to come to any conclusions as to their causes, but merely to give an account of relevant background to the current work. Section 2.1 begins by covering the history and impact of IT adoption, focussing particularly on the type of IT produced in India—that which is sold to firms to be used in production. Section 2.2 outlines the recent history of India's economy. Section 2.3

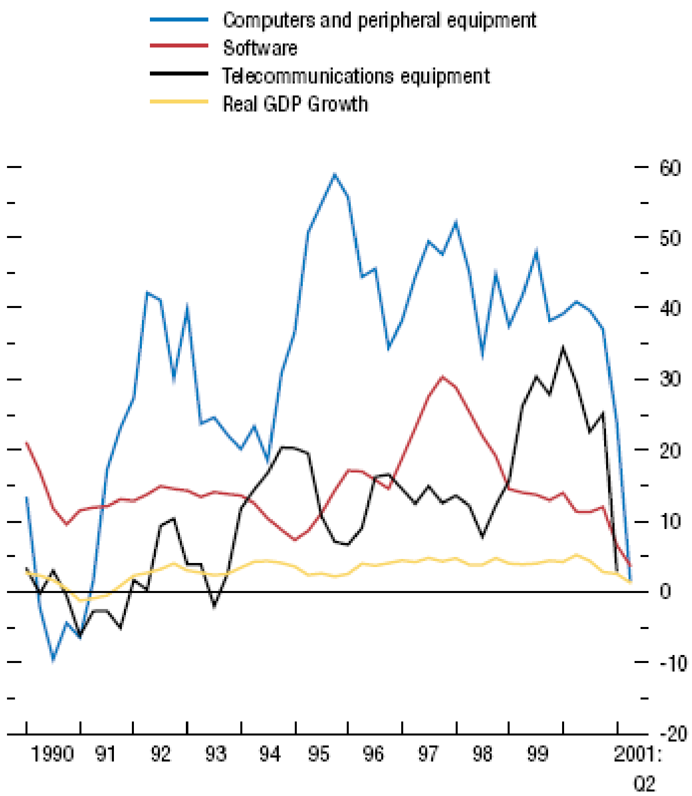
then wraps up this chapter and sets out how it fits in with what follows.

2.1 IT in production: A revolution in developed country firms

2.1.1 Rapid adoption of IT in the developed world

Figure 2.1 shows investment in IT in the United States during the 1990s. It reveals not only rates of investment growth for computer hardware in excess of 30% for the majority of the decade, but also rates in excess of 25% for software and telecommunications equipment towards the end of the decade.

Figure 2.1: Information Technology Investment in the United States, Annual Growth 1990–2001

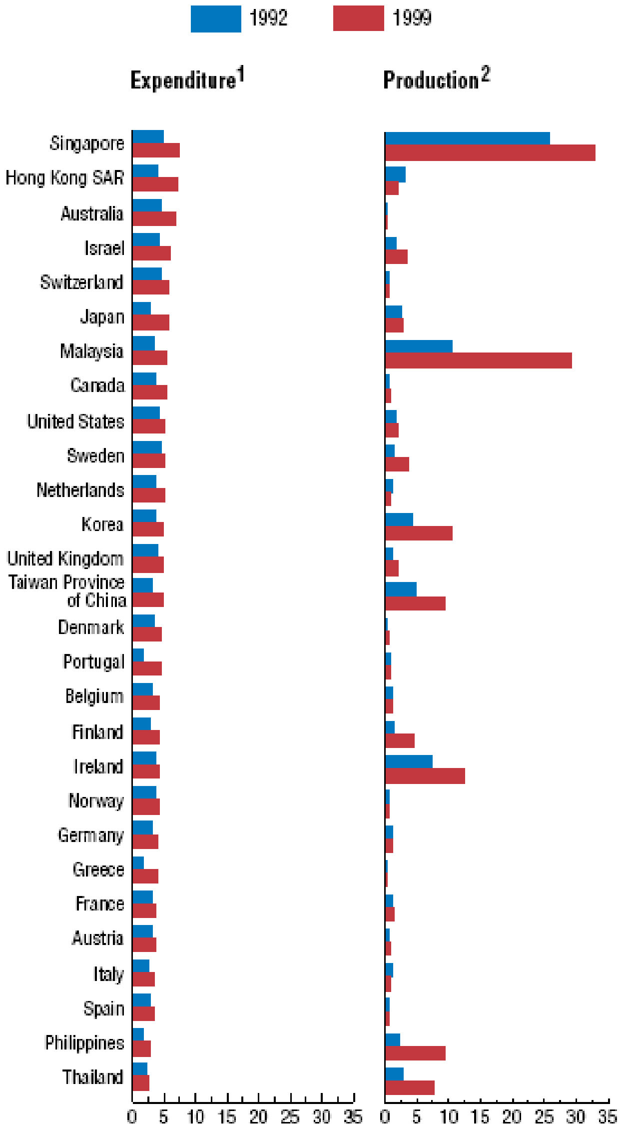


Source: International Monetary Fund (2001: 106).
Note: in percentages

This picture of rapid and prolonged investment into IT was reflected in both developed and newly industrialised economies during the 1990s. Figure 2.2 shows the per cent of gross domestic product (GDP) allocated to IT investment and production for 22 countries with developed economies and for 6 countries in emerging Asia. For the majority of these 28 countries, expenditure on IT was in the range 2.5% to 10% of

GDP in both 1992 and in 1999. The majority of countries' investment was also significantly higher in 1999 than in 1992.

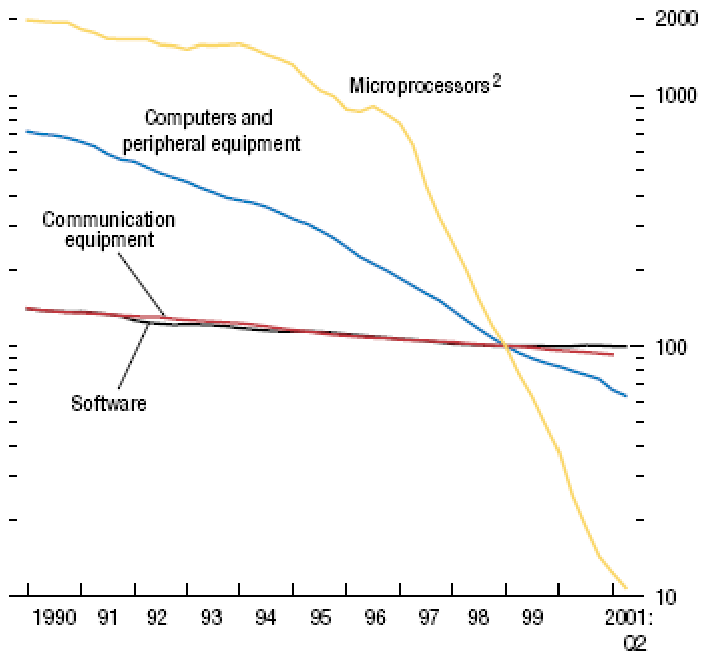
Figure 2.2: Information Technology (IT) Expenditure and Production, % of GDP



Source: International Monetary Fund (2001: 107).
Note: in percentage of GDP

The clearest proximate cause of these investment decisions is a combination of rapidly increasing quality, accompanied by rapidly declining prices for computers and other IT equipment. Production of these items is heavily dependent on the cost of producing semiconductor chips, a cost which has itself been falling rapidly because of technical progress (International Monetary Fund, 2001:105). Figure 2.3 shows price indexes for (1) microprocessors, computers, and peripherals; (2) software; and (3) communications equipment in the United States. In a trend that is consistent in other parts of the world (Bresnahan, Brynjolfsson and Hitt, 2002: 342), and earlier time periods[7] (Triplett, 1999: 324), all three sets of prices declined from 1990 to 2001, with microprocessors falling fastest, followed by computers and peripherals.

Figure 2.3: United States: Price Indices of Information Technology Goods



Source: International Monetary Fund (2001: 105).
Note: 1999:Q1=100; log scale.

This widespread experience of rapidly falling prices and, as a result, rapidly increasing investment into IT, has brought changes in both what firms produce and how they produce it. In fact, the changes have taken place in so many different sectors, and have transformed methods of production so dramatically, that authors have labelled them collectively as a "technological revolution" (e.g., Dasgupta and Singh, 2005: 3; David, 1990; International Monetary Fund, 2001; Nolan, 2001: 134; Perez, 1985), a distinct "stage of development" (Ozawa, 2005: 142), and even the

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[7] Triplett describes the evolution of microprocessors since 1978, including both their consistently improving performance and their consistently falling price.

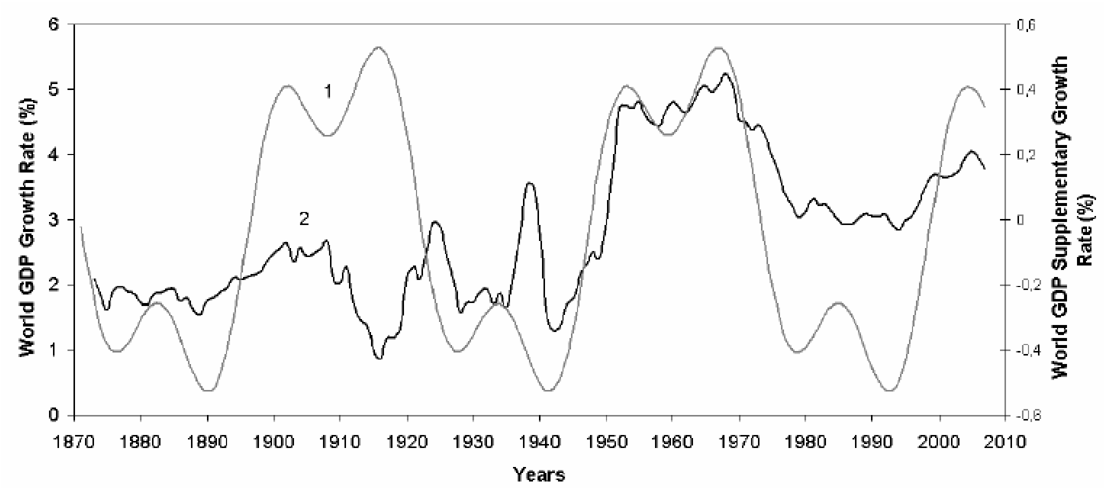
harbinger of a “new economy” (Kay, 2001: 56–57). In many of these contributions, the introduction of IT is argued to be so important that it is compared to the introductions of steam power, electricity, and oil (David, 1990; International Monetary Fund, 2001; Nolan, 2001: 134; Perez, 1985).

Those that are the most bullish on the socioeconomic importance of IT place it at the centre of a “long wave” of Schumpeterian creative destruction. They argue that a superior cluster of innovations around information, manipulated using IT, is replacing a previously dominant cluster of now-mature technologies that use inexpensive oil for mass production (David, 1990; Freeman, 1994; Perez 1985, 2001, 2005, 2008). This “techno-economic paradigm” shift is the cause of a worldwide move towards information and computer-intensive products and, in particular, services; it is also the reason why there is such huge demand for the technology (Perez, 1985: 9). The argument goes that as one pervasive cluster of innovations reaches maturity, the rate of innovation or improvement in technologies in the cluster slows down (Freeman, 1994; Schumpeter, 1939). This diminishes the competitive advantage and, hence, Schumpeterian profits available to a firm working with technologies from the mature cluster and gives entrepreneurs a reason to experiment with new and radically different technologies. When this process of experimentation begins to settle on a new, technically superior cluster of pervasive innovations, entrepreneurs realise the benefits of their experimentation by producing and implementing the new technology. This takes place not only in those sectors previously using the old technology, but also in sectors not previously in existence. For a period the pioneering entrepreneurs are able to earn monopoly profits (Schumpeterian rents) as they are the only firms with the new technology. After that, other entrepreneurs follow their lead. As second-level entrepreneurs compete with each other and with first-level innovators, prices of the new technologies fall, making widespread and fast adoption throughout the economy possible.

To support the importance of clusters of innovation, neo-Schunpeterians point to evidence such as that detailed in Figure 2.4. The figure illustrates a pattern which has been found in world GDP by many different authors in the years since it was first identified by Kondratiev in 1935. That is that GDP regularly switches between high and low growth in a wave pattern over 40 to 60 years (Hobsbawm, 1999: 87; Kondratiev, 1935; Korotayev and Tsirel, 2010). The neo-Schumpeterians argue that this occurs because of clusters of innovations. The high growth phase arises as a new cluster is adopted and its benefits realised, and the low growth phase takes over as the cluster reaches maturity. It is a claim which remains the subject of serious controversy (Freeman, 1994: 474; Kuznets, 1940: 267). However, if IT could indeed rightly be placed at the centre of a long wave of creative destruction, it would provide a clear explanation for the steep trajectory of investment into the technology in the developed and emerging countries[8]. It would also provide a dramatic context for the current case study. If the world economy is in the process of retooling in favour of information intensity and IT use, the industry which is the subject of the current case study produces a product which has strong prospects for sustained expansion over the coming decades (Perez, 1985: 15–16).

[8] Unfortunately verification of whether or not information and IT is at the centre of a neo-Schumpeterian long wave is outside the scope of this thesis. There is unlikely to be a definitive answer to this question for many years to come.

Figure 2.4: Patterns in World GDP growth, 1870–2010



Note: Curve 1 is Korotayev and Tsirel's estimated long wave; Curve 2 is an 11 year moving average of World GDP Growth.
Source: Korotayev and Tsirel (2010: 18)

Even for sceptics though, one thing is clear. The rapid fall in IT prices and the consequent expansion of IT use led to an equally rapid expansion in the need for IT workers with the skills to implement the new technology (Athreye, 2005: 20; Chandrasekhar, 2001: 18-19; Desai, 2003: 9; Heeks, 1996: 115; Joseph, 2002: 13; NASSCOM, 2007b: 10). In particular, because software is an essential complement to computer hardware, the rapid growth of investment into hardware in developed economies (exemplified by Figure 2.1) was accompanied by a necessarily fast-growing demand for software. Wherever a packaged software product was not already available, there was consequently a rapid increase in demand for technical personnel who could create new programs. During this period, the necessary experience was rare, so firms in developed countries were willing to accommodate learning on the job—albeit with a specialized workforce required to have advanced degrees in engineering, sciences, or maths (Perez, 1985: 29). With the years of advanced university education needed, the supply of these technical graduates in the United States and Europe could not expand quickly enough. In the 1980s and 1990s, engineering, technology, the sciences and maths were not popular courses (Nolan, 2001: 100). Even later, when it became clear that specialising in IT led to strong career options and high salaries, there was still a time lag involved in universities designing the necessary courses. In the intervening period, with demand outstripping supply and salaries ever-increasing, firms began to look abroad for the staff they needed (Heeks, 1996: 115).

2.1.2 Strong evidence that IT improves productivity

It was in this context of a shortage of qualified labour, learning on the job, and rapid technical progress that Western firms began to incorporate IT hardware and software into their working practices (Bresnahan, Brynjolfsson, and Hitt, 2002: 344–345; Brynjolfsson and Yang, 1996: 18; Miller, 2001: 12; Nolan, 2001: 100). Over time and through much experimentation, it became clear that the ideal way to incorporate IT into a company was to gather information from all departments into a piece of software which is visible to and useable for all staff (Perez, 1985: 9). This increases both the amount and quality of information available to workers, enabling decisions to be made independently, without managerial assistance (Bresnahan, Brynjolfsson, and Hitt, 2002: 342; Brynjolfsson and Yang, 1996: 11). If the system also stores information about such decisions, then workers can also be monitored using it, again with the need for fewer managers (Perez, 1985: 9) — yet saving employee and management time and cost is not the only benefit. Decentralised decision making also improves adaptability. The IT-enabled company is typically significantly more adaptable to changing circumstances both within and outside itself (Brynjolffson and Yang, 1996: 30). It uses fewer workers and managers (Bresnahan, Brynjolfsson, and Hitt, 2002: 344), and it can easily adapt to offering alternative versions of a product (Brynjollfson and Yang, 1996: 30). Additionally, a firm with appropriate computer systems can accumulate savings in “processing time”, “transaction costs”, “inventory costs”, and “material wastage” (Mody and Dahlman, 1992: 1708). IT can even ensure that the firm makes efficient use of its assets through computerised inventory control and bookkeeping systems (Kraemer and Dedrick, 1994: 9).

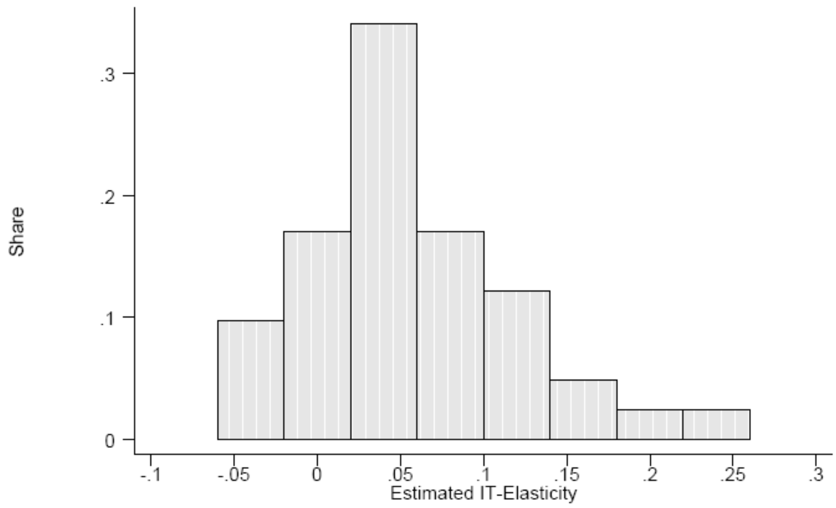
In hindsight, now knowing the uncertain nature of the early experiments using IT in the workplace, it is not surprising that the first attempts to quantify the impact on output and productivity yielded no measurable effects. At the time, however, these inconclusive findings were a massive shock to researchers. In reviewing literature which attempted to identify the impact of an expansion in IT capital (both hardware and software) in the United States, from a base of close to zero in 1975 to almost $80 billion by the late 1980s[9] to no avail, Robert Solow famously expressed the general frustration: “You can see the computer age everywhere but in the productivity statistics” (1987:36). What followed was a huge amount of effort in questioning the data and methods used to identify the impact of IT, which was collectively referred to as the “Productivity Paradox” literature. This effort continued without reaching any convincing conclusions about the validity of the tools or the sign and magnitude of any bias[10] until finally the “paradox” was resolved through publication of papers which found the expected effect — a positive impact of IT use on both productivity and output.

The first of these successful papers used econometrics on large companies in the United States using data from the late 1980s and early 1990s (Brynjolfsson and Hitt,

[9] Figures quoted in Brynjolfsson and Yang, 1999: 48.
[10] Triplett (1999) identified a *positive bias* on the impact of IT (but no magnitude was identified); Bayoumi and Hacker (2002), Brynjolfsson and Yang (1999), and International Monetary Fund (2001) identified a *negative bias* on the impact of IT (no magnitude identified); Brynjolfsson and Hitt (2003), Nordhaus (2002), and Stiroh (2001: 5) identified a *bias of unknown sign* on the impact of IT (no magnitude identified).

1993; Lichtenberg, 1993). These were followed by a long series of similar econometric analyses covering different geographies and timescales which have, in a majority of cases, also found a positive impact of IT. Figure 2.5 is taken from Stiroh (2002), and it provides a meta-analysis of these studies. Focussing on the output elasticity of IT capital (both hardware and software), it summarises the estimate from 40 econometric models that were published in 20 different studies on firms or industries in developed countries. In Figure 2.5, the median estimate suggests that doubling the stock of IT capital leads to a 5% increase in output; however, there is considerable variation, with estimates ranging from –6% to +24% output change for a 100% increase in IT capital.

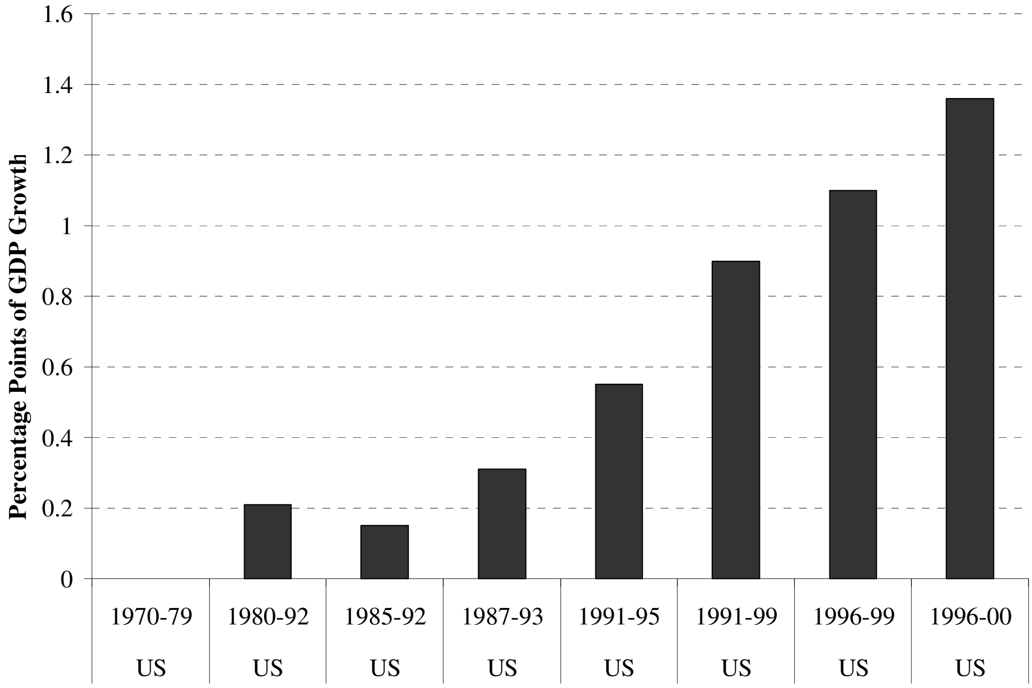
Figure 2.5: Histogram of Output Elasticities of IT from Firm or Industry-level Econometric Studies



Source: Stiroh (2002: 30).

As this literature using firm and industry-level data continued to build, a second set of analyses began to find evidence of output and productivity effects using macro-level national accounts data. This second literature examined the economy-wide impact of IT use on either economic growth or growth in aggregate labour productivity. Figure 2.6 shows the results of analyses which report the impact on GDP growth in the United States. It summarises the results of eight separate analyses which all used the same methodology but different time periods. The findings are arranged, from left to right, by the start date of the period under consideration, with each vertical bar showing the number of percentage points of GDP growth which are attributable to IT use. The chart shows that very little of US growth was attributable to IT in the 1970s and 1980s, with the three earliest studies finding that IT contributed less than 0.4 percentage points (between 0% and 7%) of GDP growth during the period under review. From the early 1990s onwards, however, IT started to have a greater impact, and by the 1996–2000 period, its contribution had reached 1.36 percentage points per annum (32% of GDP growth in that period).

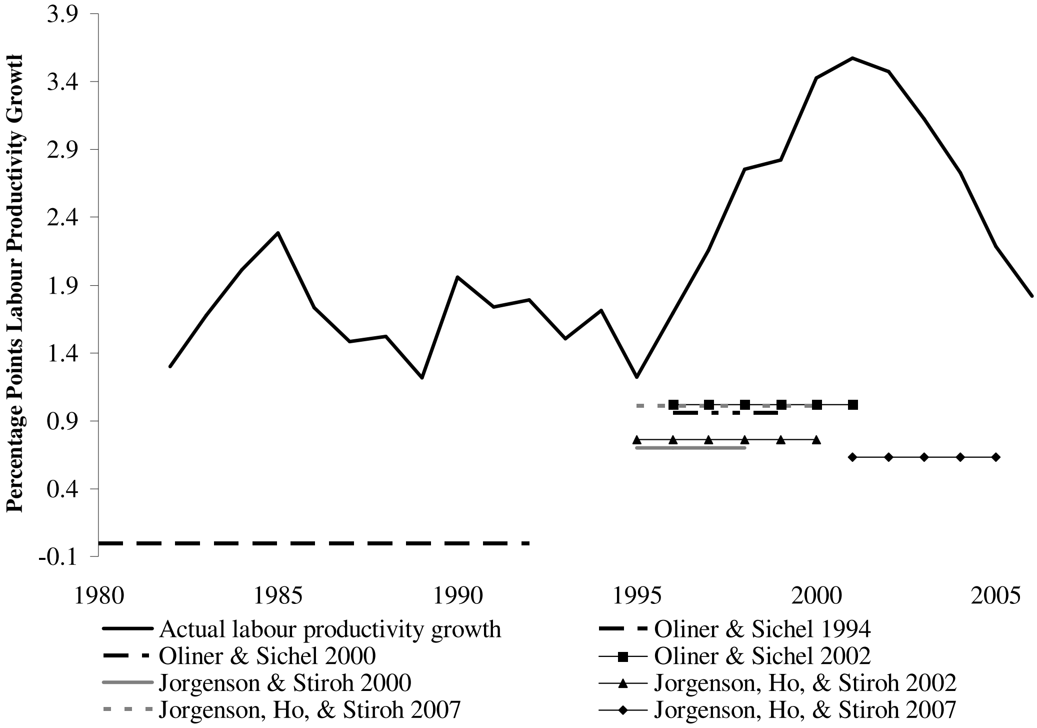
Figure 2.6: GDP Growth Per Annum Attributed to IT in the United States



Note: In percentage points. Adapted from Crafts (2001); Daveri (2001); International Monetary Fund (2001: 106,116); Jeong, Jeong, and Shin, (2002); Jorgenson, Ho, and Stiroh, (2007: 9); Jorgenson and Stiroh (1995); Oliner and Sichel (1994, 2000); Sichel (1997).

This pattern of an emerging IT impact throughout the 1990s in the United States is also reflected in the findings of macro-level labour productivity analyses, which are illustrated in Figure 2.7. Actual labour productivity growth is plotted along the solid line and the findings of studies in the literature which attempt to identify the impact of IT use in production are plotted on the other, horizontal, lines[11]. In the interests of clarity, only one of the many papers which found no impact in the early years is included, that of Oliner and Sichel (1994). To the right of this, the findings of six different studies which found that IT contributes between 0.6 and 1.1 percentage points of labour productivity growth in slightly different time periods in the mid- to late-1990s are also plotted.

Figure 2.7: The Effect of IT on US Labour Productivity Growth, Percentage Points



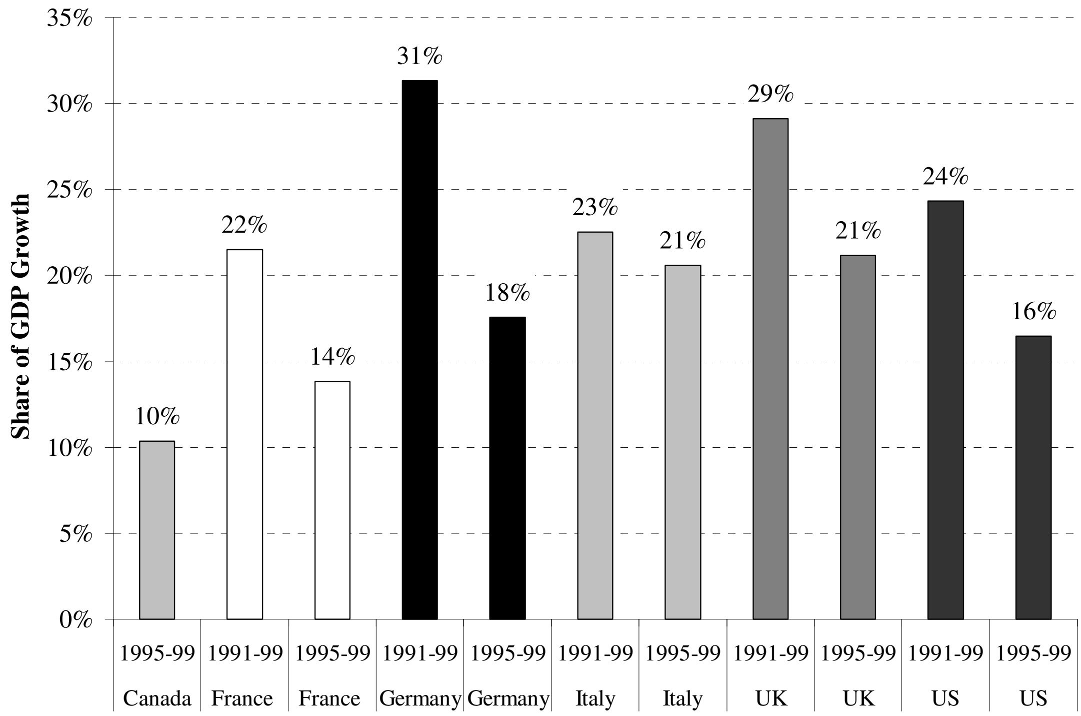
Notes: Adapted from Jorgenson and Stiroh (2000), Jorgenson, Ho and Stiroh (2002, 2007); and Oliner and Sichel (1994, 2000, 2002). Horizontal lines denote contribution to labour productivity growth from IT use as estimated by the authors identified.

Figure 2.8 compares the findings from the United States to the impact of IT found in other developed countries. It draws on the results of two studies published in 2001 which identified percentage points of GDP growth attributable to IT use between

[11] These studies all used the same methodology but different data, so the comparison in Figure 2.7 is valid.

1995 and 1999 and between 1991 and 1999 respectively (Colecchia, 2001; Daveri, 2001). To facilitate comparisons between the different countries, the impacts of IT identified by these authors have been expressed as a share of total GDP growth in each country.

Figure 2.8: Share of Total GDP Growth Attributed to IT Use in Developed Countries



Note: Adapted from Colecchia (2001); Daveri (2001); World Development Indicators (2010).

Taken together, these global findings show that as firms in developed countries experimented with the new technology and began to settle on appropriate ways of utilising it, IT did in fact begin to have significant returns. At the micro-level, estimates of the output effects of IT regularly put its marginal contribution to output as larger than its cost and, hence, its returns as super-normal (Sadun and Van Reenan, 2005: 4). At the macro-level, use of IT has been accepted as the cause of acceleration in both economic growth and labour productivity in the United States. In other developed countries, between 10% and 30% of economic growth in the 1990s has been attributed to the use of IT.

In developing countries there is so far very little evidence of a positive effect of IT, and as a result some authors remain unconvinced that the technology is or can be appropriate there (Miller, 2001; Mody and Dahlman, 1992). On evidence, use of national accounts or industry-level data is rare because it requires sophisticated data collection and handling which is often outside the capabilities or priorities for developing countries (International Money Fund, 2001: 109). On top of that, the majority of the existing econometric literature includes less wealthy countries only as part of an international sample with developed countries also included (Dewan and Kramer 2000; Kraemer and Dedrick 2002; Pohjola 2002). In the main, these cross-country studies find an overall effect of IT, but it disappears if attention is restricted to developing countries only, leading to the conclusion that developed counties are driving the estimated relationship. Some authors argue that the lack of measured effect in developing countries is simply because IT is not appropriate for such countries. Mody and Dahlman (1992) offer perhaps the clearest example of this argument, stating that IT is only needed at the "emerging" stage of development, a period during which wage increases threaten the country's comparative advantage in labour- intensive production. Miller (2001:12) also argues that because IT requires technically skilled workers, and that such workers are in short supply in developing countries, the technology will be much less useful there.

This position is beginning to be challenged within a young literature which uses econometrics on firm-level data, often with data from several different countries included (Basant et al., 2006; Motohashi 2008; World Bank, 2006a). Basant et al. (2006: 13) are perhaps the most convincing in that group. They use firm-level data from Brazil and India to identify the effect of IT in manufacturing between 1998 and 2003. Even after controlling for firm-specific effects and a wide range of variables suggested by theory, they find a positive effect of IT on productivity that is more than double Stiroh's (2002) median from developed countries[12]. Similar conclusions are made by World Bank (2006a) which used a much wider sample, including 20,000 firms from 26 different sectors in 56 developing countries, including India. That study shows that IT use, as measured by use of personal computers, email, and the Internet is positively correlated not only with labour and total factor productivity, but also with enterprise-level growth, profitability, and investment. Whilst these findings may be early indications of an emerging and strong impact of IT in some or all parts of the developing world, the weight of evidence remains light. So far there is no clear consensus as to whether less developed countries experience greater or lesser benefit from adopting IT than their counterparts in the West (Avgerou, 2003: 374; Miller, 2001: 5; Patibandla, 2002: 102).

2.1.3 New ways to organise production and new ways to compete

Meanwhile, back in the developed countries, firms who had installed IT began to find new ways to use it to compete. They came to realise that the uses of their new systems were not limited to co-ordination, monitoring, or planning within an individual firm. The same systems that decentralise decision making among working groups in one firm are equally useful for decentralising decision making among different companies that work together; even if the companies are based in different countries (Olsen, 2006: 5). It is a role for IT systems that has had far-reaching consequences since the 1980s, because it has allowed companies to easily take advantage of policy changes which occurred around the same time as these technologies became available (Nolan, 2001:101). Between the end of the 1970s and the late 1990s, trade and investment liberalisation in the form of reduced tariffs and free trade agreements (such as the General Agreement on Tariffs and Trade and others signed by members of the World

[12] Stiroh (2002) found a median elasticity of 5% more output for doubling the IT stock, whereas Basant et al. (2006) found 15.7% for Brazil and 11.5% for India.

Trade Organization) flourished throughout the developed and developing world. This stimulated the growth of international trade which, in turn, offered companies in the developed world two options previously denied to them (Nolan, 2001: 97–98). First, they were able to purchase materials and intermediate goods from a much wider array of potential suppliers from around the world, and, second, they were able to compete for a share of a much larger global market. It is in how businesses reacted to these two new opportunities that the external co-ordination abilities of the new IT systems came to have such a far-reaching effect. With their IT systems in place or under development, Western firms devised the strategy of competing in the new global market by "selling off 'non-core businesses'" and, instead, purchasing "non-core" intermediate inputs from the most cost- and quality- effective suppliers, wherever they happened to exist around the world (Nolan, 2001: 101; Olsen, 2006: 8). This practice is commonly referred to as outsourcing; if the supplier is in a different country, it is referred to as offshoring[13].

Outsourcing allows IT-enabled firms to develop their "core businesses" by focusing their research and development, mergers and acquisitions, and marketing strategies on achieving dominance in world markets for whichever parts of their business are the most profitable. This, in turn, allows firms to earn monopoly or oligopoly profits and so continue to invest in maintaining relative strength in their core activities. It is a strategy which has been ascendant, and successful, amongst large Western firms since liberalisation (Nolan, 2001: 101). However, outsourcing is not possible unless firms can rely completely on their supplying and buying partners. For this reason, the quality and extent of co-ordination between suppliers and buyers has become a much

[13] Offshoring can also refer to the practice of moving productive capacity to another country whilst keeping it within the same firm.

more important component of competitive advantage, and large Western firms have insisted that their suppliers both purchase IT systems and focus on core competencies themselves (Nolan, 2001: 103). In this new competitive regime then, both suppliers and buyers are finding new benefits from IT. The technology is not only delivering efficiencies internally, but also enabling new strategies for competition through facilitating outsourcing and offshoring of non-core businesses. Alongside the within-firm cost and co-ordination savings discussed above, a new set of savings has been added to the competitive edge IT is expected to bring: between-firm savings, such as "deeper and more effective interactions with suppliers and consumers", and "centralised global procurement" (Nolan, 2001: 102).

Since 2000 an empirical literature has emerged which evaluates how outsourcing contributes to output and productivity in the firms and industries which use it. These contributions hypothesise that the impact of outsourcing should be visible through increases in either total factor productivity (TFP) or labour productivity, because outsourcing is expected to facilitate the relocation of the least productive parts of a company's business, leaving better productivity in the core part of the business. This can occur simply because of the composition of tasks assigned to each company. However, it can also occur because the company concentrates its efforts on fewer remaining core tasks. Other routes by which outsourcing can impact on productivity come from accompanying organisational change which can trigger productivity-enhancing restructuring of processes, or efficiency gains as firms learn from their partners (Amiti and Wei, 2006: 7).

The literature predominantly uses studies of manufacturers who outsource either manufactured components or services. The latter group may include outsourcing of IT services (e.g., Amiti and Wei, 2004), but the studies do not examine IT outsourcing separately. The literature covers the United States (Amiti and Wei, 2004, 2006) and the European Union (Egger and Egger, 2001), as well as single-country studies of the United Kingdom (Criscuolo and Leaver, 2005; Girma and Görg, 2004); Republic of Ireland (Görg and Hanley, 2003, 2005; Görg, Hanley, and Strobl, 2004); and Austria (Egger, 2001). The only authors who provide evidence on outsourcing for India are Banga and Goldar (2004).

Figure 2.9: Empirical Evidence on Outsourcing and Productivity

Source	Country	Industry	Period	Type of outsourcing	Productivity Measure	Remarks	Productivity effects from outsourcing		
Aggregate level							**M**	**S**	**SC**
Egger & Egger (2001b)	EU12	Manufacturing	1992-1997	Offshore	Low-skill labour level	Short-run effect	-	n/a	n/a
						Long-run effect	+	n/a	n/a
Amity & Wei (2006)	United States	Manufacturing	1992-2000	Offshore	Labour growth	General	+	++	n/a
					TFP growth	General	+	++	n/a
Amity & Wei (2004b)	United States	Manufacturing	1992-2001	Offshore	Labour growth	General	0	+	n/a
Egger et *al.* (2001)	Austria	Manufacturing	1990-1998	Offshore	TFP growth	General	+	n/a	n/a
Plant level							**M**	**S**	**SC**
Görzig & Stephan (2002)	Germany	Manufacturing	1992-2000	Any	Return per employee	Short-run effect	++	-	+
						Long-run effect	++	+	+
Görg & Hanley (2003b)	R. of Ireland	Manufacturing & services	1990-1995	Offshore	Labour growth	Electronics sector	0	0	n/a
					Labour level		0	0	n/a
					Labour level & growth	Upstream firms	0	0	n/a
						Downstream firms	0	+	n/a
							M	**S**	**MS**
Görg & Hanley (2005)	R. of Ireland	Manufacturing & services	1990-1995	Offshore	TFP level	Electronics sector	n/a	n/a	+
							+	0	n/a
Görg et *al.* (2004)	R. of Ireland	Manufacturing	1990-1998	Offshore	Labour level	General	+	0	n/a
						Exporting firms	+	0	n/a
						Domestic firms	0	0	n/a
Criscuolo & Leaver (2005)	United Kingdom	Manufacturing & services	2000-2003	Offshore	TFP level	General	n/a	+	n/a
						Manufacturing	n/a	0	n/a
						Services	n/a	+	n/a
						Domestic	n/a	+	n/a
						Foreign	n/a	0	n/a
						MNEs	n/a	0	n/a
						Non MNEs	n/a	+	n/a
						Exporter	n/a	0	n/a
						Non exporter	n/a	+	n/a
							MS	**MS * FO**	
Girma & Görg (2004)	United Kingdom	Manufacturing (subsectors)	1980-1992	Any	Labour / TFP level	Chemicals	+ / +	+ / +	
						Engineering	++ / ++	++ / ++	
						Electronics	0 / 0	0 / 0	
					Labour / TFP growth	Chemicals	0 / 0	0 / 0	
						Engineering	0 / +	+ / +	
						Electronics	0 / 0	0 / 0	

Source: Olsen (2006: 24).
Notes: M = manufactures outsourcing, S = services outsourcing, MS = manufactures and services outsourcing, SC = services contracting, FO = foreign ownership. + indicates a positive significant effect. - indicates a negative significant effect. 0 indicates insignificant effects. Double signs indicate that effects are larger relative to single signs for the same study. Not all effects depicted here are necessarily robust over all model variations in the different studies.

Figure 2.9 reproduces a summary table of the findings of this literature from Olsen (2006). Although it is so far a small literature, Olsen (2006: 28) does identify some emerging generalisations. Under the column spanner titled “Productivity effects from outsourcing, the subcolumn labelled “M” (for manufactures outsourcing) is predominantly populated by small or insignificant effects. Olsen interprets this as evidence that there are diminishing returns to outsourcing of components manufacturing; as of the early 2000s, it was a much more established practice than services outsourcing. Olsen concludes that services outsourcing has a higher return, particularly if the outsourcing company is a services firm itself (Olsen 2006).

What is not shown in the table is the size or magnitude of the productivity effects of outsourcing. Figure 2.10 shows estimated elasticities in the author’s preferred specification for 2 groups of studies whose estimates are based on the same method and so are comparable (Amiti and Wei 2004 (US); Banga and Goldar, 2004 (India); Criscuolo and Leaver, 2005 (UK): Girma and Gorg, 2003 (UK); Gorzig and Stephan, 2002 (Germany); Egger and Egger, 2001 (EU). Banga and Goldar, Criscuolo and Leaver, and Gorzig and Stephan conducted firm-level studies where outsourcing is measured directly from firm-level data on expenditures, and Amiti and Wei, Girma and Gorg, and Egger and Egger conducted industry-level studies where outsourcing is measured by outsourcing intensity[14]. In the studies of developed countries, the elasticities are similar to one another, with two firm-level estimates (Gorzig and Stephan; Criscuolo and Leaver) arriving at the same exact elasticity figure; and the industry-level studies all estimating between 2% and 6% more productivity per 10% additional outsourcing intensity. The estimate for outsourcing in Indian manufacturing stands out for being somewhat larger than the developed-country estimates, at 13% more productivity for a doubling of outsourcing expenditure (Banga and Goldar).

[14] The proportion of total expenditure on inputs that is outsourced.

Figure 2.10: Estimates of the Elasticity of Productivity to Outsourcing

		What is outsourced?	Who is outsourcing it?	Firm Level Studies: % increase in productivity for 100% more outsourcing	Industry Level Studies: % increase in productivity for 10% more outsourcing intensity
Banga & Goldar (2004)	**India**	**S**	**M**	**13%**	
Gorzig and Stephan (2002)	**Germany**	**S**	**M**	**6.8%**	
Criscuolo and Leaver (2005)	**UK**	**S**	**S**	**6.8%**	
Egger and Egger (2001)	**EU**	**M**	**M**		**5.3%**
Amiti and Wei (2004)	**US**	**S**	**M**		**4.3-5.7%**
Girma and Gorg (2003)	**UK**	**Both**	**M**		**1.7-4.9%**

Note: M = materials/manufacturing, S = services. Adapted from sources cited in the table.

This higher response in Banga and Goldar's study is suggestive of a more important role for outsourcing in developing countries, but more research is needed. As with the literature on IT discussed above, there are few existing studies on developing country firms and industries which undertake to outsource. Unfortunately that means that, to date, the existing literature is inconclusive on whether developing countries can expect the same, more, or less in productivity gains when they outsource as their developed-country competitors achieve.

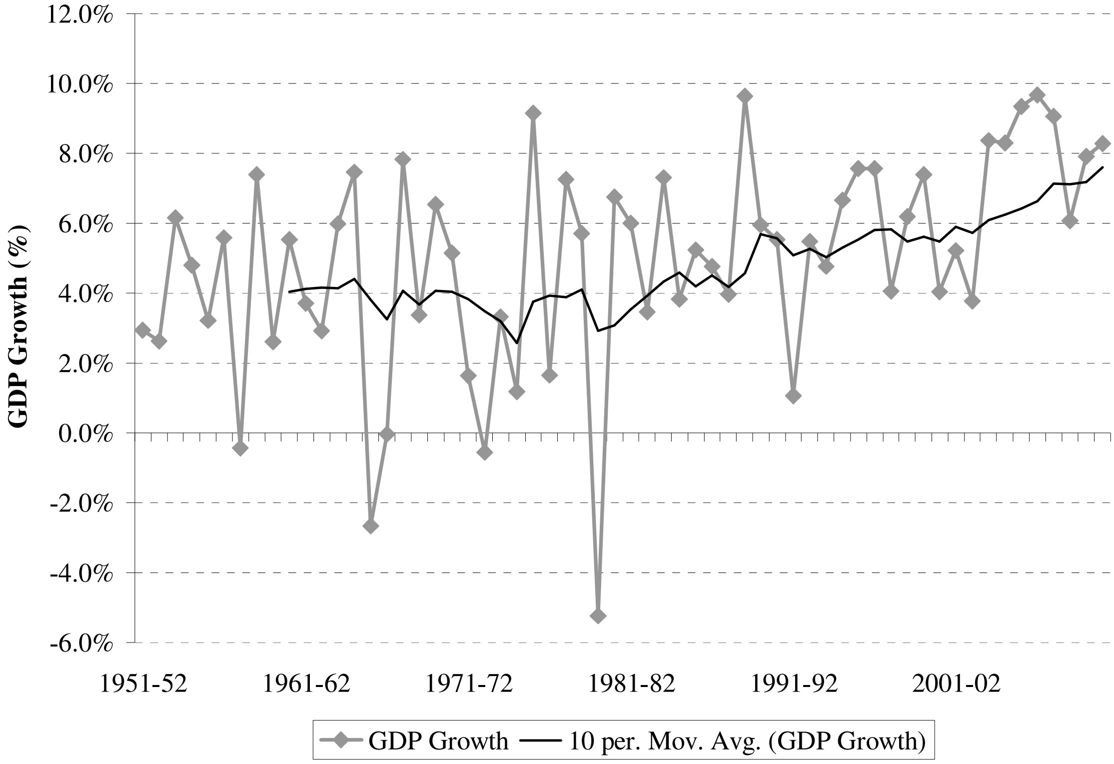
The next section details the second area of background to the thesis: India's pattern of growth since 1980.

2.2 Rapid growth in India's economy via service sectors and the middle class

Figure 2.11 plots India's real GDP growth for the period from shortly after its independence[15] to the present day. It illustrates clearly that economic growth in the country has accelerated since the late 1970s and early 1980s and is now proceeding at a rate far in excess of the norm in the period before that. Several rigorous statistical examinations have now converged on the conclusion that there was a statistically significant break point in the rate of economic growth between 1978 and 1980 (Balakrishnan and Parameswaran, 2007: 2917; Virmani, 2004a: 8; Wallack, 2003: 4312). Prior to 1980 (and after 1951-52) the average annual rate of growth was 3.6% whilst after it up to 2010–11(the coverage of this thesis), the same average was 6.2% (Ministry of Statistics and Programme Implementation, 2011). This section provides some explanations for the initial acceleration and identifies the character of growth in the later period, in particular it discusses the sectors of the economy which are driving the growth and the segments of society that are gaining the benefits from it.

[15] Independence was in 1947. This chart starts in 1951-52.

Figure 2.11: Real GDP Growth for India, 1951–52 to 2010–11 (in 1999–00 prices)



Source: Adapted from Ministry of Statistics and Programme Implementation (2011; 2010-1011 figures estimated as of 31 May 2011).
Notes: "10 per. Mov. Avg" shows a 10 year moving average of GDP growth

Despite some controversy in the literature as to the economic theories that might explain acceleration and sustained improved performance after 1980, there is widespread agreement that a particular sequence of government policies and actions were important. The first of these to have an impact on economic growth was a deficit funded fiscal expansion which began at the end of the 1970s (McCartney 2010:51-53). This large increase in public investment, from 5% of GDP in the 1970s to 9% in the 1980s, saw subsidisation of food grains in rural areas after the 1979 drought, as well as significant investment in agricultural infrastructure (Corbridge and Harris, 2000: 148; McCartney, 2010: 51; Rodrik and Subramanian, 2004: 8). These expansionary government expenditures are largely accepted to have been growth-enhancing and some were also designed specifically to help the poor, in line with then-prime minister Indira Ghandi's historical socialist agenda. However, not all of the expenditures that comprised this surge in public investment were in line with a socialist ideology. Public infrastructure spending was also directed towards projects that aimed to support the corporate sector in urban areas (Corbridge and Harris, 2000: 150).

This aspect of the deficit spending of the 1980s fits in very clearly with the idea that there was a change in Mrs Ghandi's agenda during the 1980s which left her government, and that of her successor and son Rajiv Ghandi, with a "pro-business orientation…aimed primarily at benefiting incumbents in the formal industrial and commercial sectors" (Kohli, 2006: 1253; Rodrik and Subramanian, 2004: 2, 14). Perhaps the most important steps in this direction were the retraction of industrial controls, devaluation of the exchange rate, and the relaxation of restrictions on import of intermediate goods (Panagariya, 2004: 14-15; Virmani, 2006: 22). In manufacturing and in certain other industries, these reforms afforded entrepreneurs the opportunity to freely import state-of-the-art technology and, in many cases, to use it without having to apply for a license or permit from the government. In accordance with the interests of incumbent business, protection from foreign competition was maintained so that there was no sudden entry of foreign producers who could undercut Indian firms (Rodrik and Subramanian, 2004: 2). However, during the 1980s, the government changed the form of protection in many industries, switching from quantity restrictions to charging import tariffs. The tariffs were high enough to eliminate competition from abroad, but according to Virmani (2006:35) Indian firms understood that the tariffs could, and probably would, be reduced at some point in the future. This set of policy measures offered not only a genuine opportunity for manufacturers to upgrade their technologies, but also gave them an imperative to do so because of the impending threat of competition from abroad. The evidence suggests that the private sector responded to this carrot-and-stick approach. Corporate investment increased from 1.1% of GDP in 1978–79 to 4.4% in 1982–83. There was also a rapid increase in the type of investment most strongly related to growth: Private investment in equipment grew from 4.5% of GDP between the 1950s and 1970s, to 5.8% between 1980 and 1984, and 7.1% between 1985 and 1989 (McCartney, 2010: 52).

It was in 1991, more than a decade after economic growth started to accelerate, that "pro-business" policy making was conjoined with "pro-market" policy making (Rodrik and Subramanian, 2004: 3). India enacted a package of reforms which, although having no discernable *impact* on the rate of economic growth (Wallack, 2003), have widely been credited with making the existing rate of growth *sustainable* (Acharya, 2002; Panagariya, 2004; Rodrik and Subramanain, 2004). In 1991 it became clear that the existing deficit-funded fiscal expansion was built on unstable short-term debts held abroad. When the Gulf War in 1990 raised the price of India's oil imports, without any corresponding improvement in exports, creditors started to doubt that India would be able to meet its foreign exchange requirements. When the debt to service ratio reached 26.3% in 1989, and the ratio of short-term debt to foreign exchange reserves hit 382% in 1991, India faced a balance of payment crisis (McCartney, 2010: 54). It was under these circumstances that a wide-ranging set of neo-liberal reforms were enacted, including a restructuring exercise which shifted India's debt towards more long-term agreements mediated by market exchange rates and remunerated at market interest rates. This offered a more readily tradable and so manageable set of borrowing for the government and opened the way for foreign investment into the country. Tariffs on Indian exports were removed, and the exchange rate was first devalued and then allowed to float. These actions were largely successful, and eventually were responsible for placing the government's finances on a more stable and, thus, sustainable footing[16] (McCartney, 2010: 55).

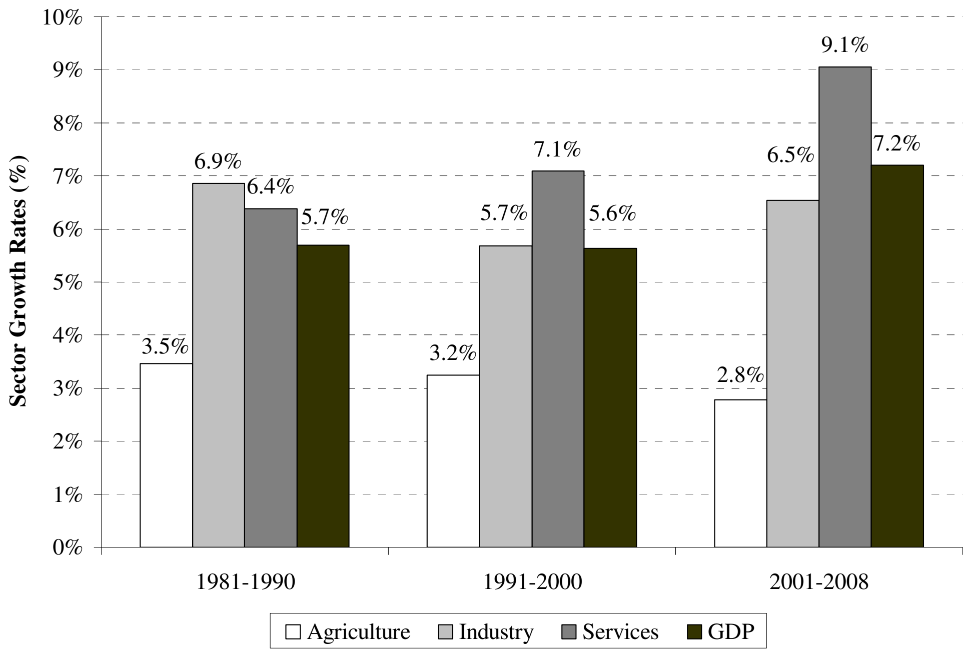
For the other partner in the government-business alliance during this period, corporate sector businesses, the outcome from the 1991 reforms was mixed. First, in a development that was mainly well-received by business owners, a great many of the remaining restrictions and regulations created during the earlier government-led planning were removed. The Statement of Industrial Policy of 1991 "did away with investment licensing" and removed "myriad entry restrictions" on firms (Panagariya, 2004: 23). It also restricted the sectors reserved for public-sector monopolies to only eight (Panagariya, 2004: 23). For manufacturing firms, however, there was another important implication of the reform package; protection in the form of tariffs on imported products was dramatically reduced and competition from imports began to be felt in India (Panagariya, 2004: 24). Wherever these imported goods were superior or more competitively priced than India's domestic manufactured items, Indian firms were presented with a decision: Either catch up quickly or lose part of their market share. It is a challenge that was spared many services firms in 1991 though. Not all services are tradable; it makes no sense to import a haircut. Of those services sectors that are tradable, many remained protected from foreign competition after 1991. Liberalisation was pursued gradually in the services sectors and the entry of foreign competition occurred much later. For example, in banking, controls and regulation on foreign involvement were maintained until only recently, with the state remaining the dominant player as late as 2004 (Panagariya, 2004: 24).

[16] Foreign exchange reserves and short-term debt returned to sustainable levels by the end of the twentieth century.

The differential treatment of services and manufacturing during the 1991 reforms, and the consequent impact of different levels of competition from imports, may well be contributory factors to the subsequent pattern of growth after that year[17]. Figure 2.12 plots GDP growth rates by sector for the period between 1980 and 2008. It shows that prior to 1991, industries and services were growing at a similar rate, but thereafter services began to accelerate whilst industrial growth remained fairly constant. Between 1991 and 2000 the rate of growth of services was an average 1.4% higher than that of manufacturing industry. Between 2001 and 2008 the growth differential between the two had widened to 2.5%.

[17] See Gordon and Gupta (2004: 11–15) for a review of other possible explanations.

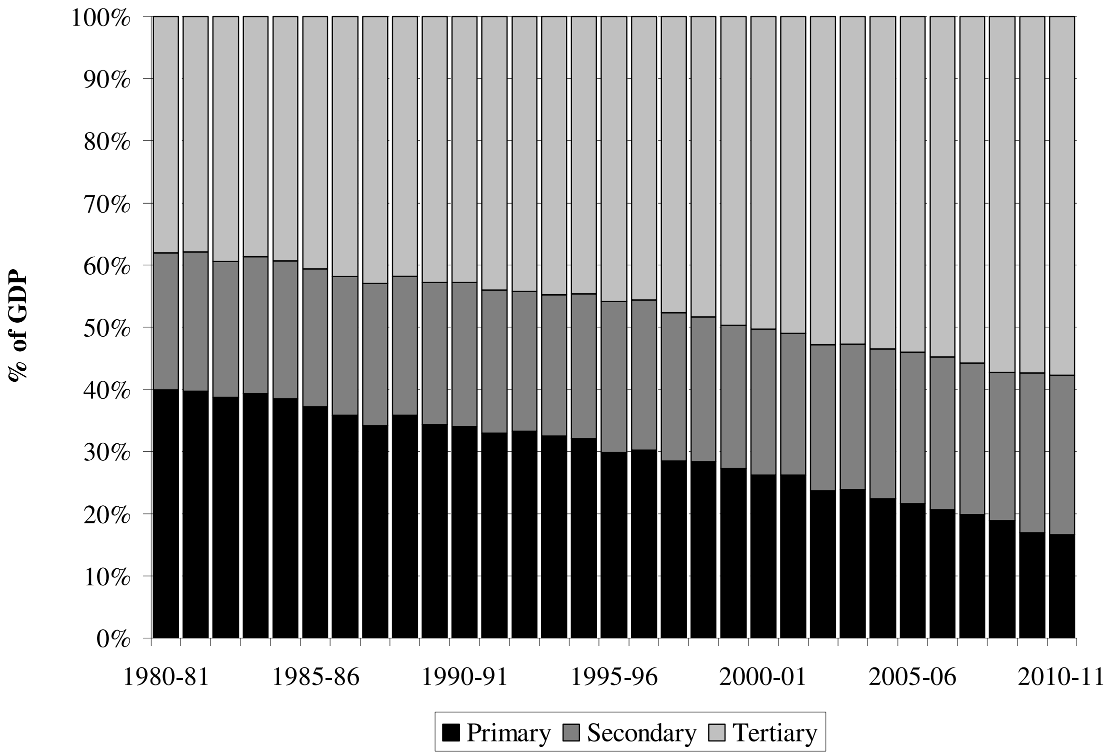
Figure 2.12: Indian GDP Growth Rates by Sector and Decade, 1981–2008



Source: Adapted from Reserve Bank of India (2009).

This differential growth pattern since 1991 has led to a restructuring of the Indian economy, as shown in Figure 2.13. As with many developing countries experiencing structural change, the share of agriculture in GDP has been falling and now comprises a much smaller per cent of total Indian GDP. What is different about India, though, is that services, rather than manufacturing, have filled the gap, and as of 2008–2009, services' share of GDP is approaching 60%.

Figure 2.13: Sector-wise Composition of Real GDP in India (1999–2000 prices)

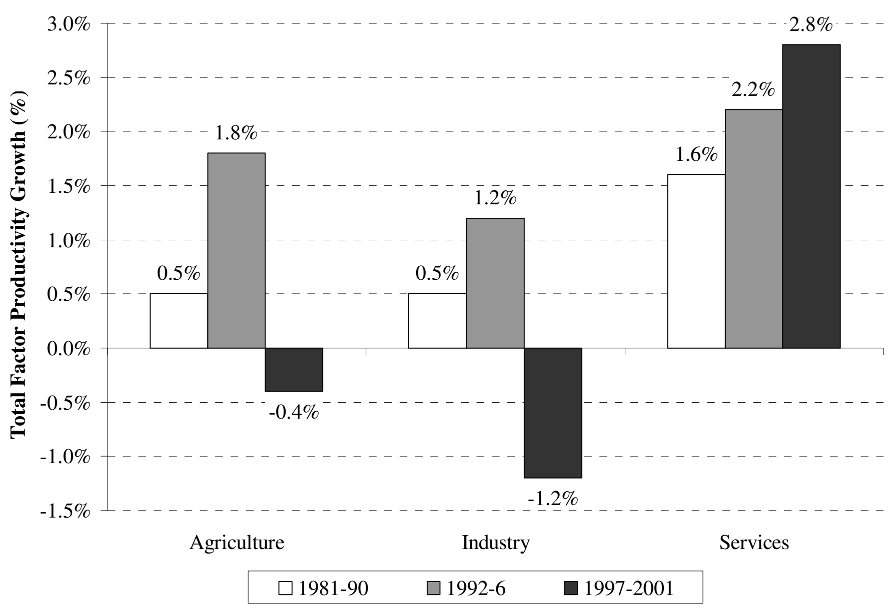


Source: Ministry of Statistics and Programme Implementation (2011; 2010-11 figures estimated as at 31 May 2011).
Notes: Primary refers to the conversion of natural resources into primary products, for example agriculture or mining. Secondary refers to manufacturing. Tertiary is services.

It is a development which stands out in stark contrast to both the economic history of the now-developed economies (Singh, 2006: 15) and to the theories of many of the most important thinkers in economics (as observed by McCartney, 2010: 107). Amongst these, analysis by three such scholars (Adam Smith, Karl Marx, Nicholas Kaldor) have the implication that the current structure of economic activity which India has developed will not be the best path for sustainable growth because productivity in the services sector is inherently low. Adam Smith (1776:127, 270) identified service sector workers as “unproductive labour” whilst Karl Marx treated services as a residual sector consisting of activities other than producing goods (Marx 1887). Economic expansion for these two authors meant moving resources away from the services sector and towards urban manufacturers (Smith) or capitalist agriculture or manufacturing (Marx). More recently, Kaldor's work states that manufacturing and agriculture have inherently higher productivity and productivity growth than services because of static and dynamic externalities, including increasing returns to scale perhaps through learning by doing, and linkage effects to different sectors (Singh, 2006: 25).

Empirical evidence on productivity in Indian services reveals a very different story to that which Smith, Marx and Kaldor might have expected, and in doing so, it presents a mystery: Total factor productivity data reproduced in Figure 2.14, shows that productivity growth in services has exceeded that in manufacturing since 1981. Going further, Dasgupta and Singh's (2005: 28) analysis of macro-level data concludes that there are indeed positive externalities of the kind envisaged by Kaldor from some service sectors in India to the rest of the economy. Hansda (2001) finds that at least some of these have arisen through linkages, just like those introduced in Chapter 1, between services and both agriculture and industry.

Figure 2.14: Total Factor Productivity Growth by Sector, India, 1981–2001



Source: Poddar and Yi (2007: 8)

For Dasgupta and Singh, this unusual productivity and growth-enhancing role of services is of central importance:

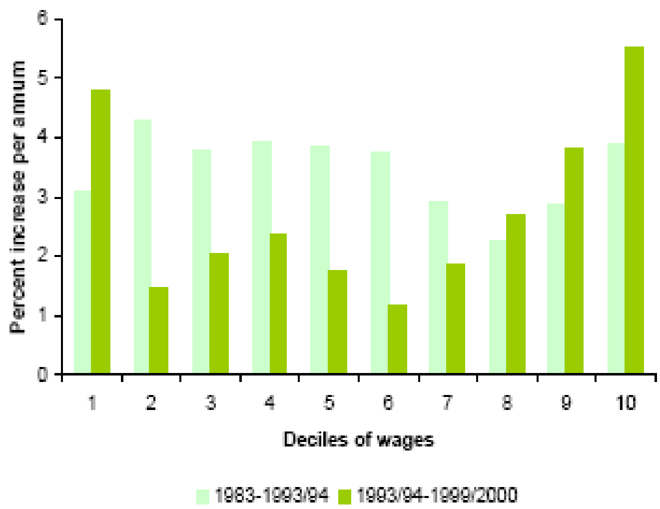
> "services in the future may replace industry as the engine of growth, even in developing countries. In that sense, India may be regarded as pioneering a new development path which gives primacy to services rather than to manufacturing as the leading sector." [Dasgupta and Singh, 2005: 3]

The idea that services can play such a central role is also supported by evidence from outside India. Services has been the "largest and fastest-growing sector of the world economy over the past two decades" (McCartney, 2010: 108), and the service industries "now account for nearly three-quarters of total employment in some industrial countries" (Freeman, 1994: 489). However, for now, there is no consensus in the literature on whether a new development path that avoids manufacturing can really exist.

For McCartney (2010: 114), productivity in services is just one criterion in a long list for sustainability of the current growth spurt, a list which he examines before concluding that India's prospects are good. In particular, he gives significant space and attention to an account of the sustainability of demand in the Indian economy (p. 84–85). This includes demand for savings and investment (p. 90) and demand for labour and consumption (p. 90–93). On the latter he notes that the period between 1980 and 2000 was characterised by a phenomenon known as "jobless growth", and many sectors of the Indian economy exhibited a declining trend in their growth–employment elasticity. The employment elasticity of GDP growth declined from 0.62% (between 1983 and 1994) to 0.16% (between 1994 and 2000) (Joshi, 2004).

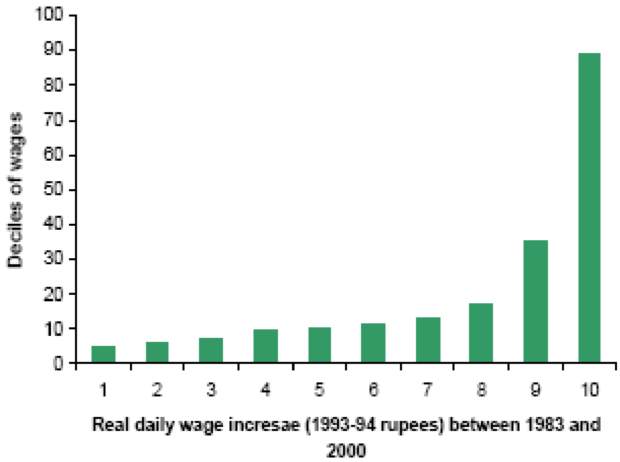
It is a situation which could have been a major problem for consumption demand in India if two other circumstances had not occurred that improved the spending power of those with reliable work. The first of these is a corollary of the fast growth in productivity in services already noted in Figure 2.14. Gordon and Gupta (2004: 8) suggest this occurred because of improvements in output per worker, as service industries experienced rapid technological progress. These industries already hired skilled, educated, workers and paid them well. As their output per hour increased further, these high wages increased further. The second reason is government efforts to redistribute incomes in favour of this already privileged group. According to Patnaik (1986) and Kurien (1989), government tax breaks have consistently favoured the middle class, and according to Sridharan (2004a), they have favoured employees in safe government jobs too.

Figure 2.15: Increase in Real Daily Wages, by Wages Decile 1983 to 2000



Source: World Bank (2006b: 30)

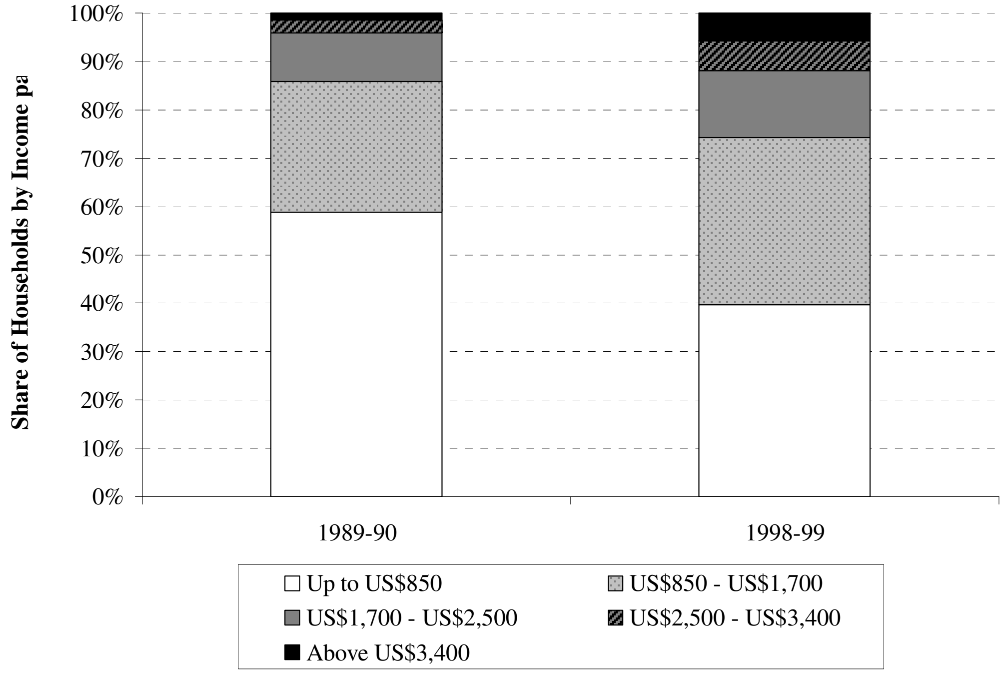
Figure 2.16: Increase in Real Daily Wages, by Wages Decile 1983 to 2000



Source: World Bank (2006b: 30)

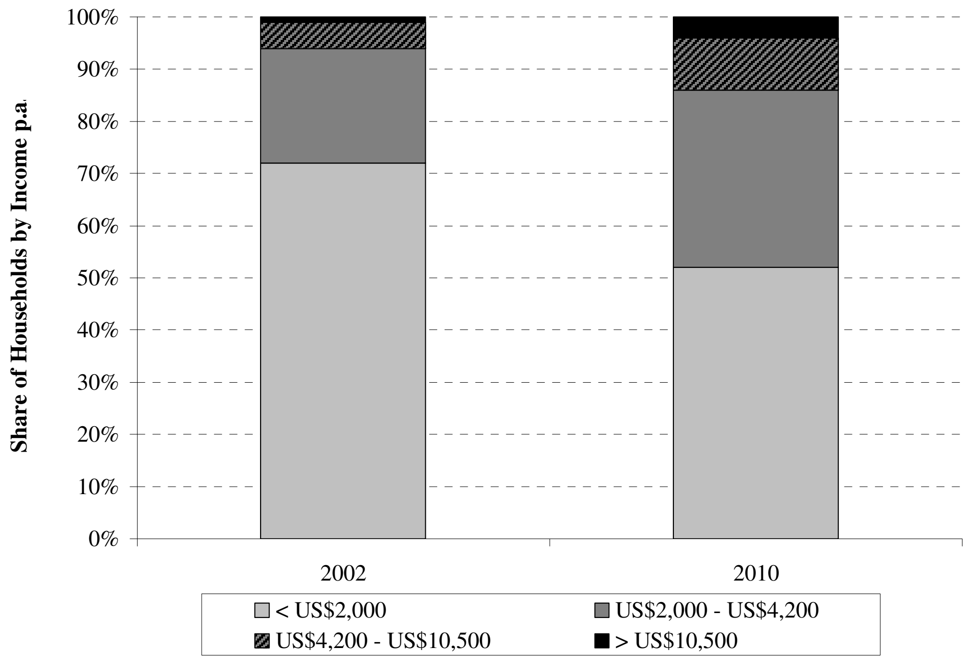
Figures 2.15 and 2.16 illustrates how these two circumstances–output per worker and tax breaks for the middle classes–have impacted wage increases in certain segments of society since the early 1980s. Both figures relate increases in wages to existing wage deciles, with Figure 2.15 showing percentage wage increases and Figure 2.16 the same data but in Rupees. Both figures show that wage increases have been concentrated in the higher wage deciles during the 1980s and 1990s.

Figure 2.17: Income distribution of Indian Households 1989–90 and 1998–99



Notes: Real income in 1998–1999 US dollars. Adapted from Sridharan (2004a: 413), with conversion from Sridharan's Indian rupees to US dollars using exchange rates from Reserve Bank of India (2011).

Figure 2.18: Income Distribution of Indian Households 2002 and 2010



Note: Nominal income given in current prices. Adapted from India Brand Equity Foundation (2011: 36)

Figure 2.17 and Figure 2.18 show how this pattern of wages growth has impacted India's income distribution at four different points in time. The two figures come from different surveys on incomes and use different income bands. Despite this, they clearly show that between the end of the 1980s and the present day a substantial stratum of Indian households has emerged whose income surpasses survival levels of consumption. Figure 2.17 illustrates this pattern for the nine-years between 1989–90 and 1998–99. It is based on a survey of 100,000–250,000 households (depending on the year) where the head of household was asked to report the family's annual income. During this period, 14% of the total number of households in 1998–99, arrived in the part of the income distribution that earned greater than US $1,700 per annum. The size of this group at the turn of the twenty-first century was nearly 25.8% of households (Sridharan, 2004a: 412). Figure 2.18 covers the period between 2002 and 2010; in 2002, 28% of Indian households earned more than US $2,000 per annum, and in 2010, this group grew to 48%.

Despite India's middle classes often being pointed to as an important source of domestic demand for all kinds of output (Asian Development Bank, 2010; Banerjee and Duflo, 2008; Deutsche Bank, 2010; India Brand Equity Foundation, 2011; McKinsey, 2007) and as a political force capable of influencing policy (Fernandes and Heller, 2006; Singh, 2006), there remains some debate in the literature on how to translate data on incomes into evidence on the size of this important group. The difficulty arises because what makes a person middle class is based on two criteria: a set of attitudes, backgrounds, and political orientations, and a level of income determined to fall somewhere between being poor and being rich (Banerjee and Duflo, 2008). Researchers usually adopt a definition of what is survival-level income, and then define the middle classes as those who earn more than this amount but less than some upper-level income above which a person would be classified as rich (Asian Development Bank, 2010: 5). Even with this simplified and pragmatic route to defining the middle class though, many choices need to be made, and income ranges that purport to define this class cover a wide range of values. Consequently, estimates of the size of the middle class cover a large range. In 2005, the lowest estimate of the middle class in India was 50 million people (McKinsey, 2007: 10) and the highest estimate was 274 million people (Asian Development Bank, 2010: 8). It is without doubt a wide range, but nevertheless a range that includes only very large numbers. Even at McKinsey's more modest estimate, the Indian middle class still number the same as the total population of England in the 2001 census (Office for National Statistics, 2011). The more bullish end of the estimates puts India's middle class as the second largest in the world, only after China (Asian Development Bank, 2010: 6). What is also true of India's middle classes is that as long as their definition mostly contains groups similarly defined to those shaded in dark grey in Figures 2.17 and 2.18, other researchers have come to the same conclusion as is so clear from the charts. India's middle class has been expanding at an impressive rate since the 1980s (Asian Development Bank, 2010: 8; Deutsche Bank, 2010: 2; India Brand Equity Foundation, 2011: 37; McKinsey, 2007: 13). These middle-class consumers, in tandem with the services-led pattern of growth outlined above, play an important role in providing the demand for income-elastic services and manufactured goods which in turn have played a central role in India's growth pattern (McCartney, 2010: 92). Not surprisingly, then, they have also played an important role in the part of India's growth pattern which was researched in the project and is analysed in the rest of the thesis.

The following section both provides a summary of this chapter and some comments on how its contents are relevant to the chapters which follow.

2.3 New research against the new backdrop: How this project fits in

The discussion in this chapter offers a summary of two major trends which together created a favourable environment for the IT sector. Section 2.1 presented data that showed a rapid uptake for information technologies in the developed world and outlined how it affected both economic growth and the nature of competition in developed countries. The analysis remains agnostic on the possibility that IT is at the centre of a neo-Schumpeterian long wave of technical change, but demonstrates that it certainly has been adopted quickly in industries in developed countries, leading to two important changes for the emergence of the IT sector in India. First, the rate of IT adoption was too fast to be matched by output of suitably qualified staff in developed countries, thus creating a shortage of skilled IT workers. Second, the installation of IT systems brought about vastly improved co-ordination and communication both within and between firms. This latter improvement in capabilities, in tandem with international trade liberalisation treaties and policies, enabled Western firms to begin to compete through outsourcing non-core businesses to the most cost and/or quality effective locations around the world. As IT was vitally important to many industries' growth, and because most firms had neither IT systems as their core competency nor the ability to easily and quickly recruit trained staff, many successful firms in developed countries turned to outsourcing to satisfy their IT needs. This sequence of events created a background of a demand for IT and an acceptance of offshoring as a means to deliver it, creating the circumstances for the Indian IT industry to grow, and for its study in the current project.

Section 2.1.2 covered both the uses and impact of IT since the 1980s, including a summary of both experimental and ideal uses of IT systems and a review of the literature on the impact of these uses. The evidence shows that adoption of IT has been an important driver of both GDP and productivity in developed countries since the late 1980s, and firm-level studies have recently begun to find IT also relevant for these outcomes in less-developed countries. It is a pattern of evidence on developing countries which is immediately reminiscent of that which appeared on developed countries just before the "productivity paradox" was resolved in the late 1980s and early 1990s. At that time there was no evidence based on macro-level data for a positive impact of IT on growth and productivity in the Western world. The first positive impacts were noticed in firm-level data similar to that which has recently yielded positive impacts in developing countries. This suggests that these first studies in developing countries may be a leading indicator of a much wider role for IT in improving productivity and output in those countries. In turn, it is suggestive of the possibility that IT use in India, including uses arising from the IT sector's forward linkages, might prove just as positive. The current state of the literature on the impact of IT highlights the need for more research in developing countries and, in particular, more of the kind of research that is included in the following chapters.

A similar situation prevails in the current state of the literature on outsourcing. Section 2.1.3 finds that evidence from the developed world shows that outsourcing does indeed have a positive impact on productivity in the firms and industries which use it. However, the literature review finds only one study of outsourcing in developing countries. This study, which covers outsourcing of services from manufacturers in India, found a stronger effect on productivity than is the norm amongst studies in developed countries (Banga and Goldar, 2004). This is consistent with the possibility that firms in developing countries gain more in terms of learning from outsourcing relationships because of the advice available from experienced partners in the developed world. However, with such a small amount of evidence, it is too early to conclude from the literature that this is indeed the case and, therefore, there is a need for more research. The literature review on the impact of outsourcing also reveals that there are no existing studies on the impact of IT outsourcing considered separately from other business services. This is an important omission if IT outsourcing does different and possibly more valuable jobs for the companies that buy it versus other types of outsourcing. In short, what the review of the literature on outsourcing finds is that there are now two important gaps: a need for more research on outsourcing from firms in developing countries, and a need for research on IT outsourcing considered separately from other services. The work in the following chapters occupies these gaps.

Section 2.3 moves from the emergence and role of IT to outline the recent history of India's economy. The section first outlines scholars' debates on the causes of its significant acceleration starting in 1980 and then highlights some of the drivers of rapid economic growth thereafter. Along with a large fiscal expansion, another important contributor to growth was a particular style and sequence of reforms which was undertaken in Indian manufacturing during the 1980s and 1990s. According to Virmani (2006), one of India's most senior government economists, first "pro-business" reform and then "pro-market" reform were enacted and this combination led to increased corporate sector investment and, thus, growth. The reforms gave Indian manufacturers a window of opportunity in the pro-business period to prepare for the pro-market reform that introduced competition from foreign companies. That these policies successfully brought investment and acceleration around 1980 is important to this project. The research described in the chapters that follow suggests that one of the investment opportunities which were taken up during this period was the purchase of IT hardware and software. This happened not only in manufacturing firms in the 1980s, but also later, when a similar scheme of reform was carried out in services. The importance of these later reforms is discussed in Chapter 6.

Section 2.3 covers which sectors of the Indian economy have grown the fastest in recent decades and which groups in society have most benefited from this growth. India's experience runs contrary to received wisdom on development, which usually predicts that industrialisation and manufacturing lead growth. In India, it is services industries that have been replacing agriculture, as development leads to structural change. Partly as a consequence of this unusual sector-wise composition of growth, and partly for other reasons, the major beneficiaries of India's economic growth in the past 30 years have been its middle class. Rather than lifting the most desperate out of poverty and into a sustainable level of consumption, India's recent pattern of economic growth has concentrated on those who started with some advantages. This now-sizeable group has, as a result, been able to continue to consume non-essential products and services in ever increasing quantities. The discussion here stopped short of examining how and why these features of India's economy are relevant for the current research. This omission is rectified in Chapter 6, where it is found that middle-class demand for income elastic goods and services is important to the emergence of substantial domestic forward linkages from the IT sector. It also turns out in Chapters 5 and 7 that in many cases it is the services sectors that both satisfy this middle class demand, and make up the domestic market for SWIS.

The next chapter, Chapter 3, provides a review of the literature which considers the Indian IT sector specifically, and analyses its role in India's economy.

3. The Literature: Incredulous about IT in India

> "And our nation, though it has no drinking water, electricity, sewage system, public transportation, sense of hygiene, discipline, courtesy, or punctuality, does have entrepreneurs. Thousands of them. Especially in the field of technology. And these entrepreneurs—we entrepreneurs—have set up all these outsourcing companies that virtually run America now."
>
> Aravind Adiga, *The White Tiger*, (2008:4)

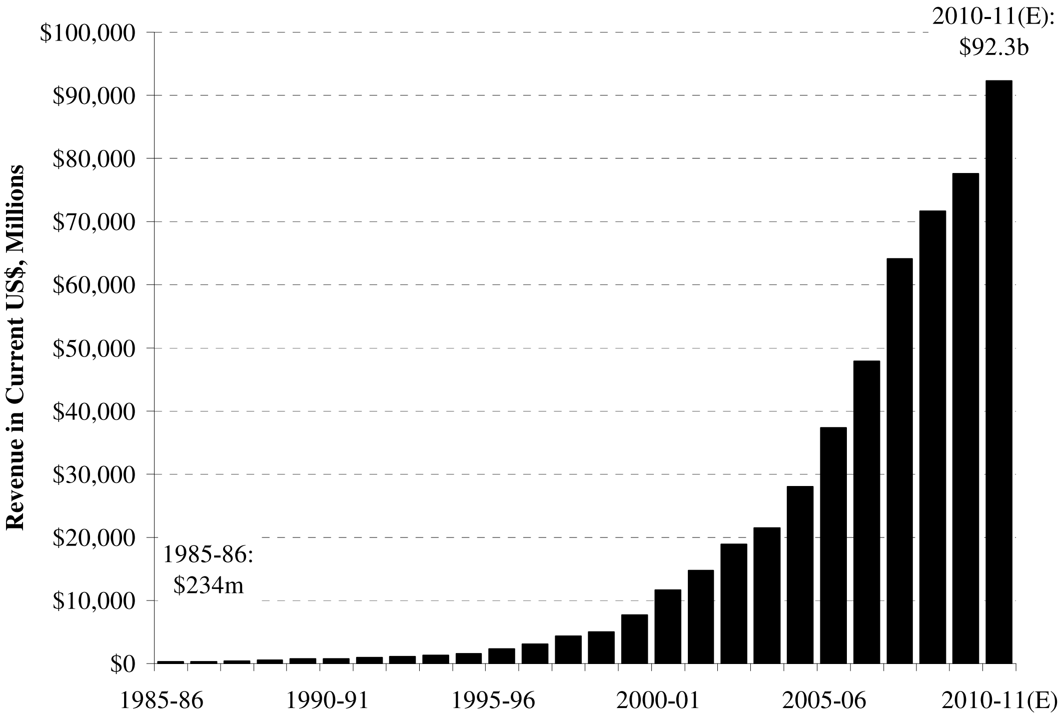
The literature on the IT sector in India has two major strands. The first documents and explains the sector's emergence and fast growth, and the second evaluates the role of the sector in the wider Indian economy. This chapter argues that both of these strands are permeated with a sense of surprise or disbelief similar to Aravind Adiga's. Economists don't make generalisations about India's sense of courtesy, punctuality or hygiene, but they frequently express surprise that a substantial IT exporting sector has arisen in the country. They often follow that by contributing a new explanation for the sector's unfathomable existence and success. It is on the hypothesis that the sector might play a wider role in the Indian economy that incredulity about IT in India really shows though. According to the literature, the IT sector has very few linkages of any kind in the domestic economy, and, forward linkages, in particular, have been woefully inadequate. Where it looks to the future, the literature is even less optimistic. It finds that, despite Indian firms having contributed to successful automation in America and Europe, it is unlikely in the short- to medium-term future that they will do the same at home. On the question of IT being or becoming a leading sector then, the literature answers resoundingly in the negative.

The remainder of this chapter reviews these two strands of literature. Section 3.1 describes the sector, its markets, and its size with current facts and statistics. Explanations for the sector's stellar growth trajectory are reviewed in Section 3.2, while Section 3.3 covers the literature written on the sector's wider role in the Indian economy. Section 3.4 concludes by stating the reasons for questioning the pessimism in the latter set of literature, in turn justifying the current research described in the chapters that follow.

3.1 Stellar Growth in the IT Sector

Figure 3.1 shows the size of the IT sector in India since 1985 in terms of its revenue earnings. Composed of Hardware (HW), Software & IT Services (SWIS) and IT Enabled Services/Business Process Outsourcing (ITES-BPO)[18], the sector's total revenues are now over 400 times higher than they were in 1985-86. This increase, from US$234m in the mid 1980s to over US$90bn in 2010-11, translates to a compound annual growth rate of around 26% per year over 25 years

Figure 3.1: Revenue of Indian IT Sector (HW, SWIS, ITES-BPO)



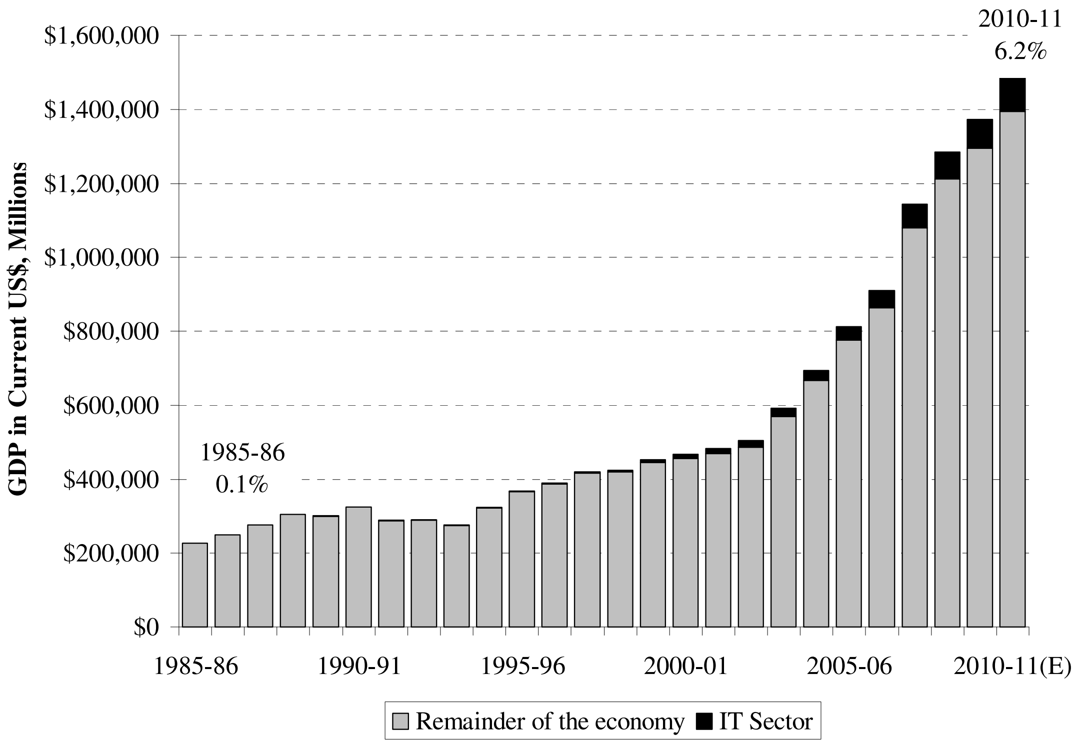
Sources: Athreye (2005: 34); eGov Reach & NASSCOM (2011: 1); Hanna (1994: 100); Heeks (1999b:2); Kenney and Dossani (2002: 237); Kumar and Joseph (2005: 94); NASSCOM (2008a: 1); NASSCOM (2009a: 6, 203); NASSCOM (2011: 1); Sridharan (2004b: 34, 37).
Note: (E) = estimate by NASSCOM (2011).

This impressive and consistent growth performance has not surprisingly begun to contribute to India's GDP. Figure 3.2 shows India's total GDP and the total output of the IT sector in current $US dollars. The IT sector's share of GDP has increased from

[18] These terms are defined in detail in Chapter 4.

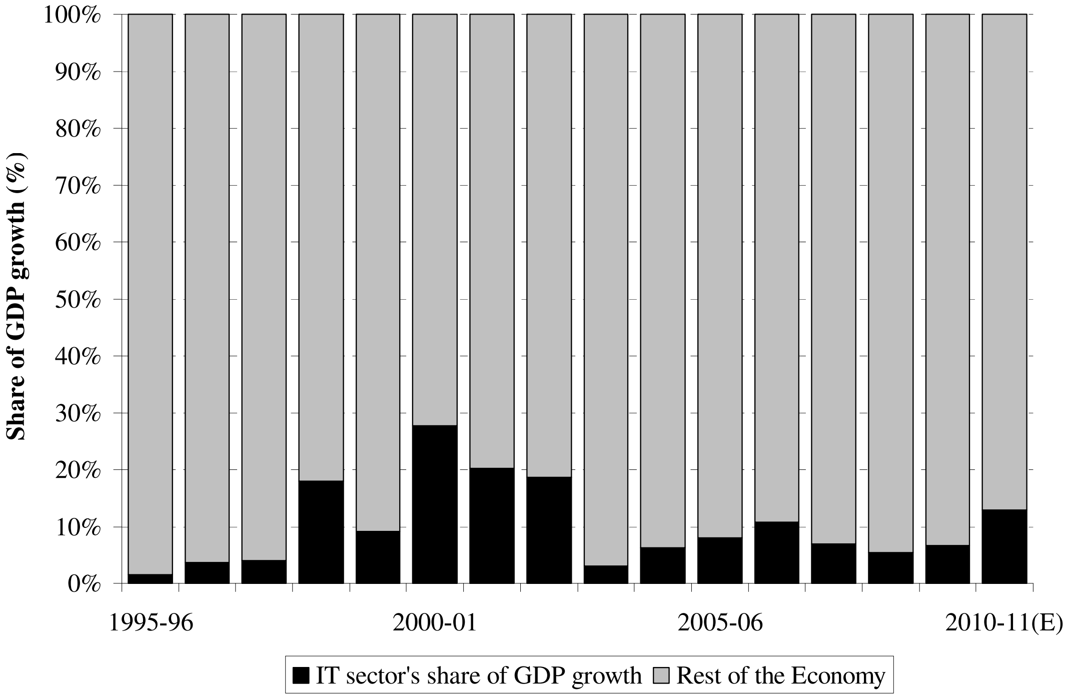
0.1% in 1985 to 6.2% in 2010-11. This is still only a small share of the overall output of the economy, but it is a share that has been growing quickly. This is reflected in Figure 3.3 which shows the share of total GDP growth in each of the last 15 years that has come directly from the IT sector and demonstrates that growing IT revenues have been a significant contributor to economic growth. During the period, the sector has contributed an average of close to 10% of GDP growth per year.

Figure 3.2: India's GDP with IT Sector Output



Source: Adapted from Ministry of Statistics and Programme Implementation (2011); Reserve Bank of India (2011).
Notes: IT output as per Figure 3.1.

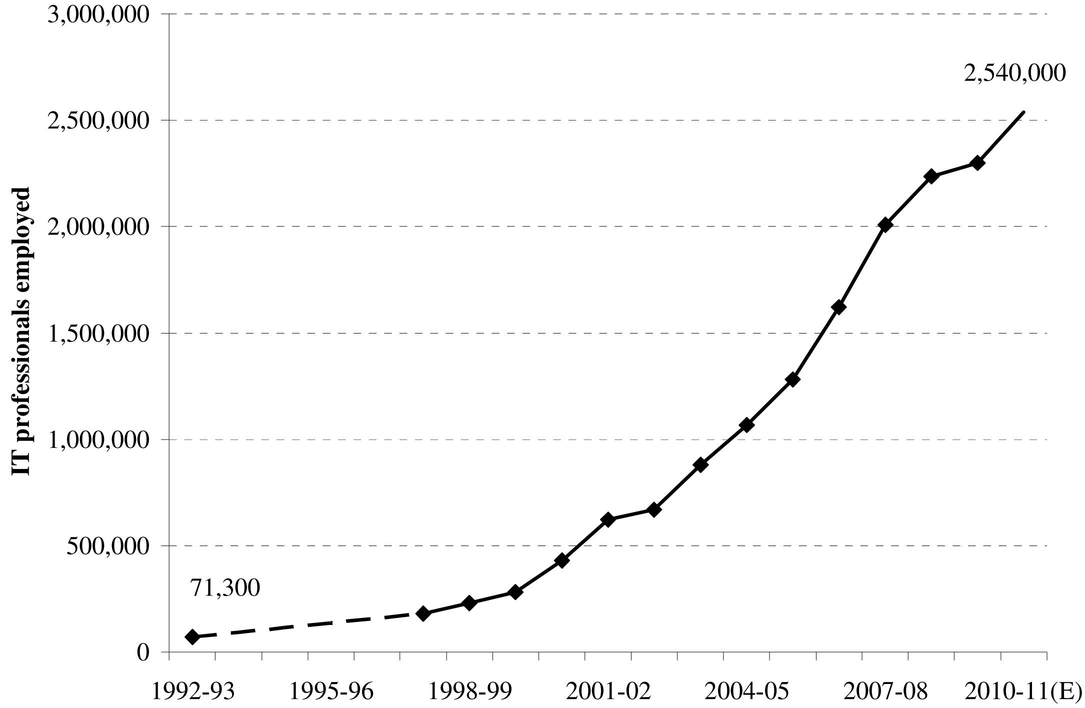
Figure 3.3: IT Sector's Contribution to GDP Growth



Source: Adapted from Ministry of Statistics and Programme Implementation (2011); Reserve Bank of India (2009, 2011)
Notes: IT output as per Figure 3.1.

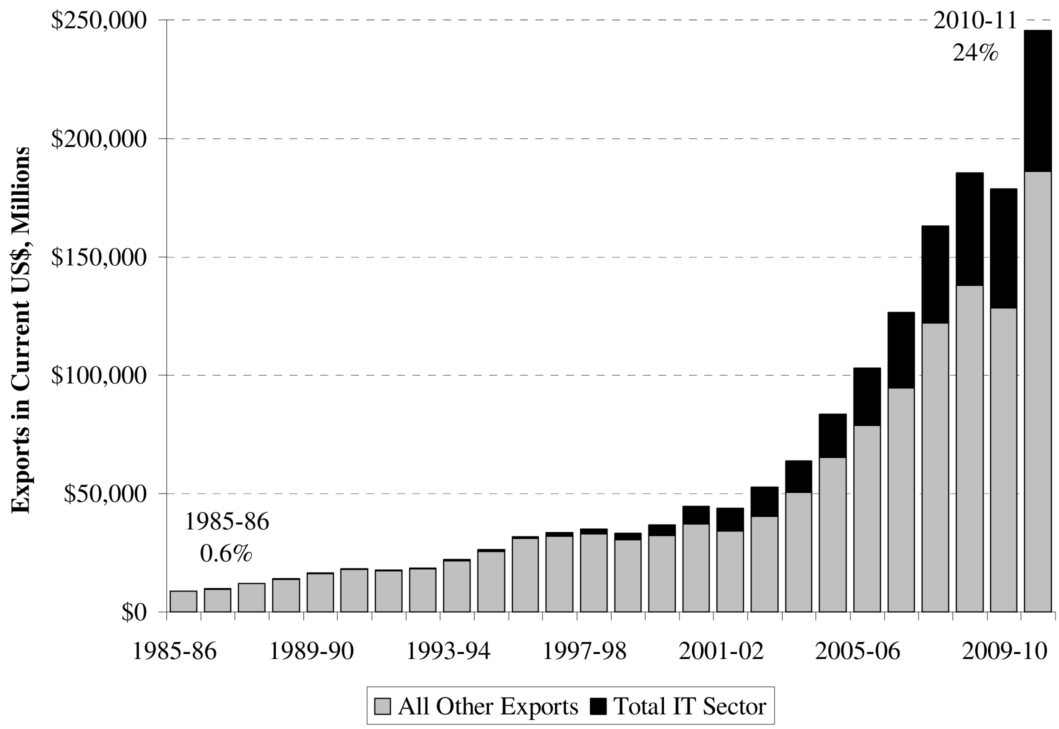
Figures 3.4 and 3.5 illustrate the sector's contribution to employment and export revenues, respectively. Employment in the sector has expanded rapidly, from 71,300 IT professionals in 1992-93 (the earliest year available) to 2.5 million in 2010-11. The IT sector also contributes a substantial, and increasing, proportion of India's exports. The IT sector's share in total gross exports from India reached 24% in 2010-11, up from 0.6% in 1985-86.

Figure 3.4: Employment of IT Professionals in the Sector



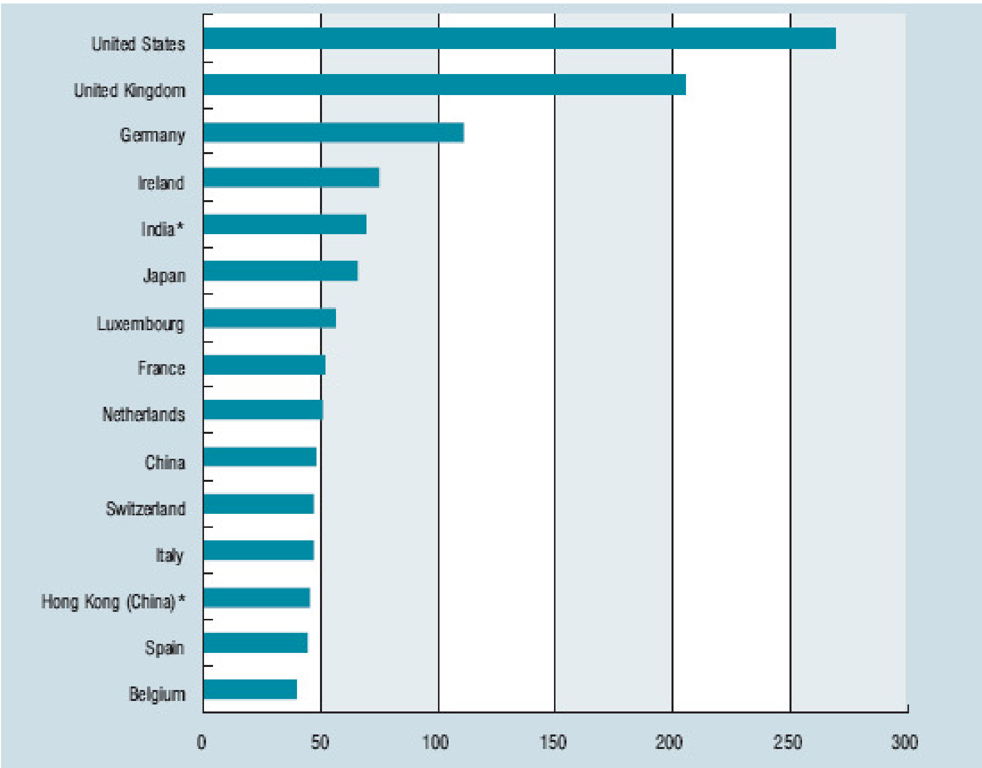
Sources: Hanna (1994: 49); NASSCOM (2007a; 2007b; 2009a: 1, 2011:1).
Note: The original source is NASSCOM in all years. Dashed line represents interpolation for missing data.

Figure 3.5: India's Exports with IT Sector Exports



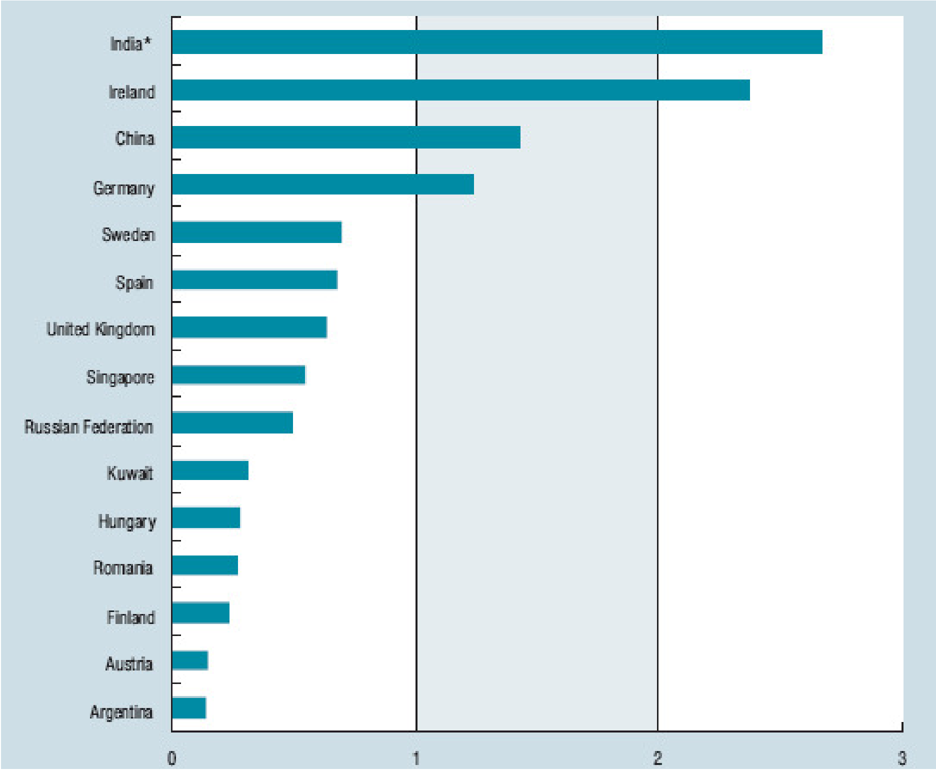
Sources: Athreye (2005: 34); eGov Reach & NASSCOM (2011: 1); Hanna (1994: 100); Heeks (1999b:2); Kenney and Dossani (2002: 237); Kumar and Joseph (2005: 94); NASSCOM (2008a: 1), NASSCOM (2009a: 6, 203), NASSCOM (2011:1); Sridharan (2004b: 34, 37). Directorate General of Commercial Intelligence and Statistics, (2011) These exports are not only significant within the Indian economy. Figure 3.6 places them in their international context by reporting exports of IT and ITES-BPO, excluding HW, in 2007 for the top 15 exporters worldwide. India comes fifth in this ranking, which is the highest position outside of Europe or the United States. Figure 3.7 provides the same ranking, but for export growth between 2000 and 2007. It shows that India's exports of IT are growing faster than any other country in the world.

Figure 3.6: Exports of IT and ITES-BPO in 2007 for Top 15 Countries (US$ billion)



Source: United Nations Conference on Trade and Development (2009: 77)

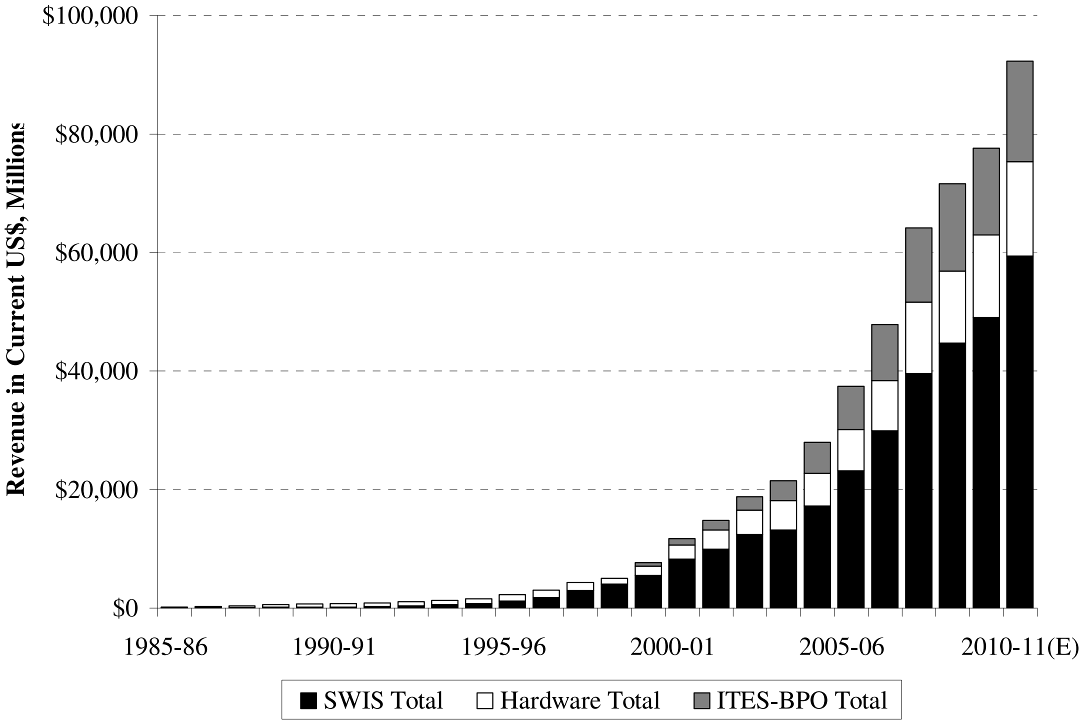
Figure 3.7: Growth in Exports of IT and ITES-BPO, 2000–2007 (%), for Top 15 Countries



Source: United Nations Conference on Trade and Development (2009: 78)

Figure 3.8 offers a breakdown of IT sector revenues by its component industries over the period from 1985-86 to the present. It shows that SWIS is not only by far the largest of the three industries in the sector, it was also the first to experience sustained and rapid growth (Kumar and Joseph, 2005: 94). Of the other two, HW makes up only a small proportion of the total revenues of the sector; although it predates SWIS, it never had the same success (Chandrasekhar, 2001: 16). ITES-BPO, on the other hand, has experienced fast growth since its arrival in India in the mid-late 1990s (Price Waterhouse Coopers 2005:15), and is an important part of the IT sector's success story. The dramatic growth in ITES-BPO came after and, according to many authors, as a result of SWIS (Arora and Gambardella, 2005: 292).

Figure 3.8: The Indian IT Sector by Its Component Industries (SWIS, HW, ITES-BPO)

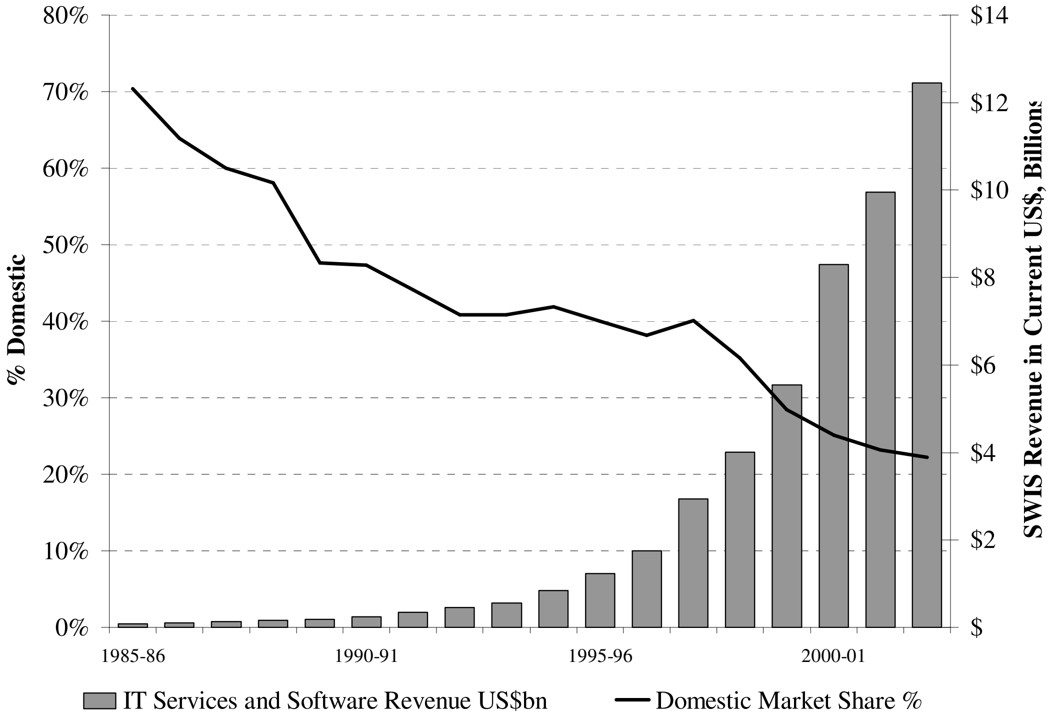


Sources: Athreye (2005: 34); eGov Reach & NASSCOM (2011: 1); Hanna (1994: 100); Heeks (1999b:2); Kenney and Dossani (2002: 237); Kumar and Joseph (2005: 94); NASSCOM (2008a: 1); NASSCOM (2009a: 6, 203); NASSCOM (2011: 1); Sridharan (2004b: 34, 37).
Notes: (E) = estimate by NASSCOM (2011).

Figure 3.9 drills down further, to examine SWIS revenues by its destination market in the period between 1985-86 and 2003-04[19]. It reveals that although the domestic market has been growing, the increase in SWIS revenues in the 1990s was accompanied by a falling share of output being sold to the Indian domestic market. In short, it reveals that the impressive growth trajectory illustrated above has been built predominantly on success in SWIS exports.

[19] This data is updated to 2010-11 in Chapter 5.

Figure 3.9: Software and IT Services Revenue, Domestic vs. Exports, 1985-86 to 2003-04



Sources: Athreye (2005: 34); eGov Reach & NASSCOM (2011: 1); Hanna (1994: 100); Heeks (1999b:2); Kenney and Dossani (2002: 237); Kumar and Joseph (2005: 94); NASSCOM (2008a: 1); NASSCOM (2009a: 6, 203); NASSCOM (2011: 1); Sridharan (2004b: 34, 37).
Notes: SWIS revenues plotted against RHS axis; domestic market share plotted against LHS-axis.

It is perhaps not surprising given the picture revealed by Figures 3.8 and 3.9 that the majority of the large body of literature that explains the growth of the IT sector in India focuses on the success of Indian SWIS in export markets. Section 3.2 is a review of this literature.

3.2 A simple cause hidden amongst an abundance of explanations

Surprise seems to be the most common initial reaction in the literature to the industry's success in exporting SWIS. Opening sections of contributions on the sector's early history have described it as "phenomenal" (Kumar, 2001: 4278), "striking" (Commander, 2005: 1), "unprecedented" (Joseph and Harilal, 2001: 3266), and both "extraordinary" and "remarkable" (Athreye, 2005: 7). Perhaps for this reason, there has been an inordinate amount of attention on the reasons for the sector's accomplishments. Interest has in fact been so consistent, that 20 years after the first articles and books were published on the subject[20], new explanations continue to emerge and literature continues to accumulate. This section reviews these contributions, and finds that, confusingly, both government intervention and, its opposite, free market-led development, are argued to be the most important. This review argues that the existence of this contradiction in the literature suggests that neither of these two opposing theories can, on its own, explain the sector's success. Instead, the chain of events and consequences that brought about such impressive growth rests on a simple story: the sector's early success was the result of the government and the private sector working, sometimes even intentionally, towards the same goal: to exploit a genuine opportunity for India which existed as a result of technological changes in the rest of the world. The remainder of this section teases this story out of the literature, beginning with a review of the debate on government intervention.

[20] Robert Schware published a paper on reasons for the IT sector's growth in 1992, Jyoti Saraswati published on the same subject in 2009. These may not have been the first or most recent publications on the subject, but they do illustrate nearly 20 years of attention.

The pro-intervention faction argues, in line with a heritage of literature dating back to List (1856), that infant industry policy on IT was the crucial reason for the industry's success. Saraswati (2008) is perhaps the clearest voice in this set of contributions[21]. According to Saraswati, the policy of providing protected domestic markets for HW in the 1970s was crucial. This policy led to IBM establishing a hardware manufacturing and maintenance operation in India rather than exporting there from a base abroad. Once the Indian government insisted that IBM either reduce its non-Indian equity ownership to 26% or close its operations, the conditions for the emergence of the SWIS industry were in place (p. 1142). At the time, IBM was the only major supplier of IT hardware, so when it decided to leave India, a government enterprise, Computer Maintenance Corporation, was established for the sole purpose of overseeing its operations. This state-owned enterprise then became the major player in HW maintenance (p. 1140), which is why SWIS skills emerged for the first time in India outside of a multinational company. After the Minicomputer Policy of 1971 was enacted and 40 HW import licences had been issued, a generation of SWIS firms was born and demand for skills in HW and SWIS grew (p. 1147). In Saraswati's analysis, two subsequent policies unlocked the substantial export success that these firms achieved; the New Computer Policy of 1984 and, from 1991 onwards, the Software Technology Parks (STP) scheme. The New Computer Policy reduced the customs duty on HW from 135% to 60% (p. 1147), and the STP scheme allowed the government to set up business parks in various cities. It also provided each business that relocated to a business park with satellite communications that enabled them to export via email and telephone and incentivised export work by offering tax exemptions on export revenues (p. 1149–50). Overall, Saraswati describes

[21] Heeks (1996); Joseph (2002); Joseph and Harilal (2001); and Kumar and Joseph (2005) are others in the same vein.

government intervention as "integral in promoting" the SWIS industry (p. 1139), and he has elsewhere pointed to this set of policies as the most significant example of a "developmental state" (Saraswati, 2009: 1), since that phrase was popularised by Amsden (1989) and Wade (1990) in their analyses of East Asian economies.

Ironically, the same set of infant-industry policies analysed by Saraswati have been interpreted by the other faction writing on the sector as a case study on the benefits of governments not interfering in market-led processes. Perhaps the clearest of these critiques is the observation that the policies just analysed failed to achieve their intended purpose: to build a substantial HW manufacturing industry. While government intervened extensively into the HW industry, the early stages of the SWIS industry was accompanied by little government attention and virtually no interventions and controls. As Singh (2002: 25) puts it: "there are over 400 central government statutes governing manufacturing, as well as numerous state laws…. [t]he software industry escaped these constraints partly by not being recognized by the government as an industry by itself."[22]Another critique on government intervention in Indian IT comes from Evans's (1992) look at policy in the 1980s, in which he argues that it benefited the SWIS sector by removing or relaxing previous government intervention. In particular, Evans argues that the policies which constrained the import of HW (so that Indian HW manufacturers could emerge in the presence of little competition) held the SWIS industry from growth. In his analysis, policy in the 1980s marked a clear change from these restrictive interventions and from state-owned production in the 1960s and 1970s (Evans, 1992: 1). It was this removal, he argues, that was responsible for the subsequent development in the SWIS sector. Ghemawat and Patibandla (1998: 1197) continue in the same vein by arguing that liberalising

[22] This point is also made by Kaushik and Singh (2004: 594) and Miller (2001: 31).

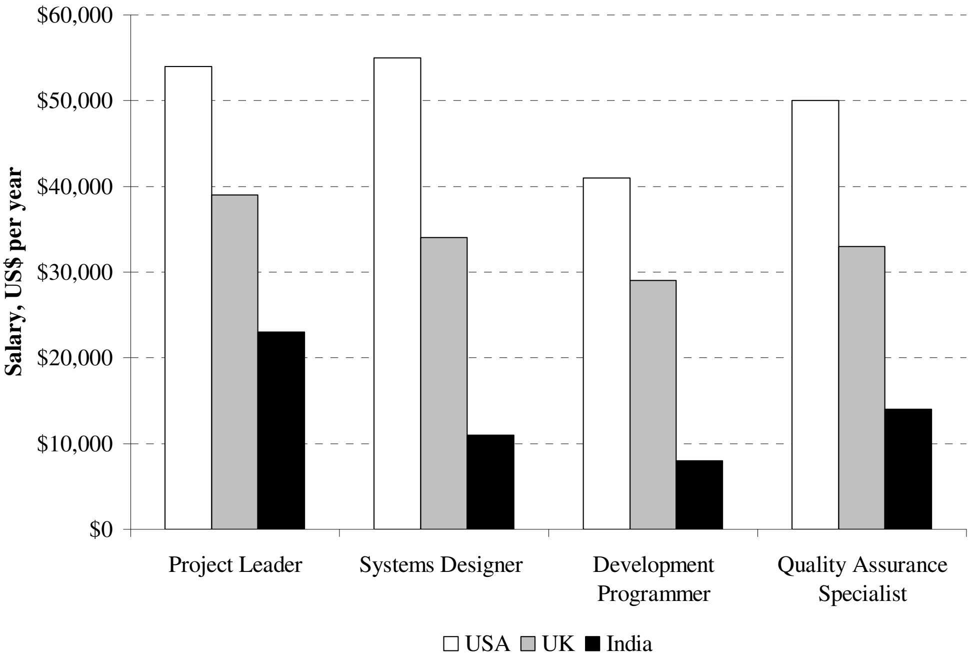
reforms in India in 1991, which removed various macroeconomic interventions[23], were responsible for increased sales in export markets and even lead to improved technical capacity in some SWIS firms.

The fact that contradictory conclusions can arise from analyses of the same set of policies reveals more about the analyses than about the policies themselves. In arguing that government policies at the beginning of the SWIS era were universally beneficial to the rise of SWIS exports, Saraswati (2008) twice misses that removal of restrictions on HW imports actually contributed to the emergence of SWIS firms; first in 1971, with the first issuance of HW import licences, and then in the mid-1980s when tariffs were reduced. However, Saraswati is not alone in being guilty of selective reportage of events. The authors seeking to argue that the removal of state-led development in the IT sector was mostly beneficial skate over the importance of the STP scheme and its undoubted beneficial impact on SWIS exports (Evans 1992, Ghemawat and Patibandla, 1998). Rectifying these omissions, however, yields a fairly mottled picture; some government policies were beneficial for SWIS exports, whilst others clearly hampered its growth. This implies that, taken together, government policies were neither the main reasons for the sector's success nor massive deterrents to it. Analysed in this light, the inconclusive evidence on government policy is suggestive of the need for an entirely different explanation of the sector's success.

[23] See Chapter 2 for more detail on these reforms.

Literature in the pro-market category identifies comparative advantage[24] as the key driver of a market-driven growth story for SWIS, providing one possible alternative narrative. These publications all point to data like that presented in Figure 3.10 which demonstrate that, as SWIS exports were becoming successful, India enjoyed an advantage in software arising from cheaper wages for IT staff (Athreye, 2005: 20; Chandrasekhar, 2001: 18–19; Desai, 2003: 9; Heeks, 1996: 115; Joesph 2002:13; NASSCOM, 2007b: 10).

Figure 3.10: Cost of IT Labour in India, the US and the UK in 1995



Source: Athreye 2005:20 (Table 8)

Whilst this absolute wage differential undoubtedly helped the SWIS industry export to developed country markets like the United States, it is not sufficient by itself to identify a comparative advantage as per Ricardo's theory (1817: Ch. 7). Arora and Athreye (2001: 6) address this by carrying out an application of the theory to this case

[24] The theory of comparative advantage says that two countries can both gain from trade if they have different relative costs for producing the same set of goods. Even if one country is more efficient (low cost) in the production of all goods, under particular circumstances it can still gain by purchasing particular goods from a less-efficient country. Gains are available as long as the less efficient country produces the goods being traded more efficiently than the other products it makes, and as long as the efficiency difference between the products in the selling country is bigger than the efficiency difference in the buying country (Ricardo, 1817).

study. They examine the ratio of Indian labour productivity in the SWIS industry to that in manufacturing, and then compare this ratio to that of other countries[25]. Figure 3.11 reproduces their analysis.

Figure 3.11: 1995 Productivity in Manufacturing and Software across Countries

($'000)	Manufacturing: Value Added per Employee (1)	Software: Revenue per Employee (2)	Index (2/1)
Israel	38.3	100	2.61
India	4.1	8.93	2.18
France	77.143	161.32	2.09
USA	98.2	126.02	1.28
Ireland	117.1	142.24	1.22
Finland	76.16	83.46	1.1

Source: Arora and Athreye (2001: 29)

Arora and Athreye (2001: 6) observe that India is more productive in software relative to manufacturing than all other countries, with the exception of Israel. In particular, India's productivity in software is more than twice its productivity in manufacturing. In the United States, which was the destination for 65% of India's software exports in 1997 and 1998 (Heeks 1999b: 5), the same ratio is lower at 1.28. This demonstrates that India does indeed have a comparative advantage in software, so it is no surprise that India exports software to the United States. With productivity in the two sectors in the two countries as shown these are exactly the kinds of transactions that free-market trade theory would predict. According to Ricardo's theory, once trade is possible, both countries will benefit.

Beneficial trade is of obvious relevance to the surge in India's SWIS exports, but it is also a rather unsatisfying answer to the question this section addresses. Discovering

[25] Arora and Athreye (2001: 6) use value-added as the index of labour productivity in manufacturing and revenue per employee as the index of labour productivity in software. This is because manufacturing depends on raw materials inputs, whilst software requires fewer material inputs but is relatively more labour- and worker- intensive.

that trade in software occurred because there was a benefit to both sides is helpful, but it does not explain why such a benefit existed. In other words, it does nothing to explain why the productivity figures in Figure 3.11 are what they are. To understand, it is necessary to put Figure 3.11 in context and to understand qualitative aspects of the history of both manufacturing and SWIS in India. On this issue, Arora and Athreye (2001: 24) offer that: "This comparative advantage in turn hinges on the availability of a large workforce that is English speaking and technically trained, and in the relative disadvantage that the economy has in manufacturing due to poor infrastructure investments in the past". It is a situation which does not exist in every developing country, and so may be a unique outcome of India's particular history. For example, the prevalence of the English language in India is undoubtedly a result of being a British colony. What is perhaps more transferable as a lesson on development though, is the impact that India's historical policy regime has had on its current productivity. Both India's pool of technically trained labour and its poor productivity performance in manufacturing can be linked to decisions taken during its period of centrally planned, state-led development in the 1950s, 1960s and 1970s. In that period, policies aimed at developing self-sufficiency in heavy industry led both to higher-level technical engineering training being offered in public education and to the implementation of many controls and interventions on the private sector's activities in manufacturing. These changes had direct effects on later productivity levels in software and manufacturing. The wide availability of technical education directly led to the existence of a trained workforce that was later required for high productivity in SWIS (Bhatnagar, 2006: 103; Kochar et al., 2006: 18), and the existence of controls and interventions eventually proved detrimental to manufacturing productivity (Ahluwalia, 1985: ch.7).

To summarise this review of the literature then, historical government policy, from the 1950s, 1960s and 1970s, provided the first link in the chain of events which led to the IT sector's success. This unintentionally created a comparative advantage for SWIS in India as a side effect of attempts to promote industrialisation. Then, from the 1980s onward, the private sector exploited this comparative advantage to great effect. At first this process took place in spite of generally unhelpful or neutral policy (like restrictions on the import of hardware) from governments that were more interested in hardware manufacturing. Later on though, supportive policies like the STP scheme and tax breaks on exports were much more helpful.

This narrative, however, cannot, by itself, explain the growth of SWIS exports. Having a supply of well-trained and relatively low-cost IT technicians would have been insufficient to cause the boom in Indian IT exports if there had not also been excess demand for these tasks to be completed in developed countries. As discussed in Chapter 2, this huge demand started the late 1980s and early 1990s, and despite scant attention on it in the literature on the Indian IT sector, its existence is really the most important cause of the sector's strong performance. The simple story which explains the emergence and strong performance of the sector is that because of technical change in western countries there was a shortage of IT workers. India, for the reasons discussed in this section, was in a position to step in to offer the required manpower. It is this simple story which explains why the sector's success is so surprising. In this case study, government and private sector activities intertwined to exploit an opportunity, and this was, with a few exceptions, successful. But without the inherent potential of the opportunity itself, even this joint effort would not have had "phenomenal" or "striking" results. It may well be rare to find both government and the private sector combining to bring a high-tech industry to a developing country. It is rarer still to find such an industry, where demand is so large and fast-growing that developed countries cannot meet their own needs for qualified workers. The reasons and circumstances which have been identified in this section combined to help India take advantage of such a rare and unique moment, and it was this which secured a “remarkable” event in India.

The next section evaluates the literature that analyses IT’s wider impact on India’s development.

3.3 Abject pessimism on the IT sector's wider impact

There is no doubt from the evidence presented in Section 3.1 that the growth of SWIS exports has made a contribution to India's economy through its impact on GDP growth, employment, and export revenues. However, the IT sector's overall large and ever-increasing size means that it is utilising a similarly large and ever-increasing number of resources to produce that contribution. This section reviews the literature on the benefits and costs through linkages of using those resources to produce IT[26]. It is a literature which is remarkably pessimistic. There are several contributions which argue strongly that the sector's activities are having negative implications for other Indian industries, and only a few contributions which identify positive linkage effects. On the other hand there are many accounts which lament a lack of these beneficial effects and argue that they are unlikely to arise in the future. In particular, many authors complain about a lack of forward linkages into India. They argue that the sector's "super" export orientation[27] means forward linkage benefits which should accrue to India are actually felt abroad. Taken together, these publications give the overwhelming impression that the IT sector is neither appropriate for India, nor can it help with its development needs. As in the epigraph that began this chapter, the picture painted is of an incongruous set of activities which exist within India's borders, but do not belong there.

[26] There are many possible implications of the IT sector's existence that fall outside the scope of the current work because they are effects that do not apply to other Indian industries. For example, social outcomes, such as quality of work (e.g., Ramesh, 2004: 492), workers' identity (e.g., D'Mello and Sahay, 2007), and gender equality (e.g., Ghosh, 2002:47), though of obvious importance to workers in the sector, are excluded from consideration here.

[27] Heeks 1996:18

The rest of this section reviews this pessimistic literature, and is laid out as follows: Section 3.3.1 discusses backwards linkages[28], or the possibility that purchases by IT sector firms and workers provide a stimulus to other sectors in the Indian economy by providing demand for their products. It also includes more general linkages. Section 3.3.2 discusses forward linkages, and Section 3.3.3 concludes with an overall summary of linkages in the literature and a discussion of whether or not these are extensive.

3.3.1 A dearth of backwards and other more general linkages

The literature identifies only one backwards linkage arising from India's IT sector: the emergence of a venture capital industry in India, as highlighted by Kenney and Dossani (2002). In providing a detailed description of that industry's arrival in India, the authors recognise the importance of government policies (p. 235), but they also argue that the IT industry's existence was necessary for the venture capital industry to get a foothold in India. Because the IT sector uses venture capital as an input to production, the sector has provided "a continuing flow of investment opportunities capable of growing sufficiently rapidly to the point at which they can be sold yielding a significant annual return on investment." (p. 236). Without these opportunities, they argue, venture capital would neither have emerged in India, nor had the success it has, in fact, experienced.

It is one bright spot amongst a dearth of positive views. According to Heeks (1996: 19), the IT sector has no other backwards linkages within the country. Apart from venture capital, all of the IT sector's other inputs are purchased from firms abroad. This benefits other countries by providing demand for their products rather than

[28] Different types of linkages were introduced in Chapter 1. They are defined fully in Chapter 4.

benefiting India by providing demand for the produce of other Indian industries. IT hardware is generally imported, and because exports have been the major driver of growth in the sector, travel and other marketing expenses have predominantly been incurred in the US or Europe (p. 75–76). This means that the IT sector cannot provide an impetus to growth in industries that supply these products within India. It also undermines the impact of one of the direct benefits to the Indian economy laid out in Section 3.1: the contribution to the Indian economy made by foreign exchange earnings arising from the sector's exports. Recall from Figure 3.5 that the IT sector's contribution to India's exports exceeded 10% in 1999-00, and has continued to grow, contributing approximately 24% of India's total exports in 2010-11. Taking into account use of foreign exchange for purchases made by the SWIS sector's backward linkages abroad, however, reveals that these figures are an overstatement of the net inflow of foreign currency[29]. Heeks (p. 75–76) redresses this omission by providing a careful consideration of the patchy macro-level data on imports by the sector. His estimates suggest that correcting for these expenses would have left net export earnings at approximately 55% of gross earnings in 1994-95. Joseph and Harilal (2001: 3267) conduct a similar analysis at the micro-level, using a sample of IT firms. Their findings verify Heeks's estimates, finding an import intensity of exports between 50% and 60% in all years between 1993 and 1997. Heeks goes on to say that these estimates may still under-state the true net foreign exchange earnings for India from the sector. They do not take into account the extent to which multinational SWIS firms based in India repatriate their profits, a phenomenon which might, according to him, account for a further 20% of SWIS gross export income (p. 76).

[29] Inflow of foreign currency has a macro-stability benefit, particularly in the context of avoiding another balance of payments crisis like that experienced by India in 1991 (outlined in Chapter 2).

What then, about backwards linkages from purchases by the sector's workers? Could these provide demand for the products of other Indian industries? Figure 3.4 noted that the IT sector employed 670,000 people in 2002-03. It is a figure which, according to D'Costa, writing in that year, is somewhat misleading. D'Costa (2003: 219) does not question the numbers, but he does point to the composition of the IT workforce, noting that employment has not spread beyond the most educated in India's workforce, who also live in the wealthiest parts of the country. Joshi (2004: 4176) adds further weight to this claim with a survey of the labour market in India. Her work confirms that the English language and technical skill requirements of export workers in the IT sector means that only the most privileged of the country's workforce are able to consider the sector as a relevant career option. As D'Costa (2003) points out, what this means for India's ongoing economic and human development is that the urgent need for employment amongst the poorest and uneducated masses is unlikely to be met by continued expansion of exports of IT. What it may also mean is that the IT sector's educated workers are those who would have had reasonable salaries, even if the IT industry did not exist. If this is the case, then the existence of the sector does not create an additional demand for non-IT products in any substantial way. Perhaps even more deleterious to the possibility of backward linkages is the so-called brain drain. Heeks (1996: 94-95) estimates that India loses around 10-15% of its SWIS export workers every year to developed countries. Living abroad, their consumption requirements are filled by their host country, removing their demand for products produced in other Indian sectors.

According to the literature, a lack of backward linkages is the least of the adverse effects arising from IT sector employment on export projects. There are two possible negative linkages from the IT sector to other Indian sectors. The first is a kind of

"Dutch Disease"[30] arising from the "windfall boom" of export income accruing to the IT sector (Joseph and Harilal, 2001: 3268): The windfall boom means that talented and well educated workers earn very good salaries in the IT sector. Other sectors which might otherwise have offered these workers employment must match this salary or manage without the skilled labour they would otherwise have had. According to Joseph and Harilal (2001: 3268), this has led to contractions in output in these other sectors. Perhaps even worse, though, is an outcome which has not yet been occurred, but which D'Costa (2003: 212) argues could well happen in the future. By paying higher salaries to those that are already privileged, the IT sector is breeding inequalities which may one day lead to social unrest or conflicts, particularly because the benefits of working in the sector are very visible to those without privilege or access to education.

The same gloom is reflected with consideration of a much wider possible set of "other" linkages which could be relevant, but do not fall neatly into Hirschman's schema[31]. The current literature identifies very few incidences of any of this wide range of possible positive effects arising from the IT sector. In particular, Balasubramanyam and Balasubramanyam (1998: 293) bemoan an almost complete lack of learning spillovers from the IT sector to other Indian industries, and a wide reading of the literature finds that other authors agree with this assessment. Throughout the publications reviewed for this research project, only one example of other industries learning from the IT sector is available to refute this claim. Arora and

[30] "Dutch Disease" is a phrase used to describe negative effects elsewhere in the economy arising from an export boom, usually based on natural resources reserves. It is named after the experience of the Netherlands in the 1960s, when it witnessed a boom in natural gas and, consequently, experienced weaknesses in its manufacturing sector. The phrase first appeared in *The Economist*. ('Dutch Disease', 1977:82-83).

[31] They are neither backward linkages (where the transmission of growth occurs through the IT sector's purchases) nor forward linkages (where the transmission of growth occurs through the IT sector's sales) nor entrained wants.

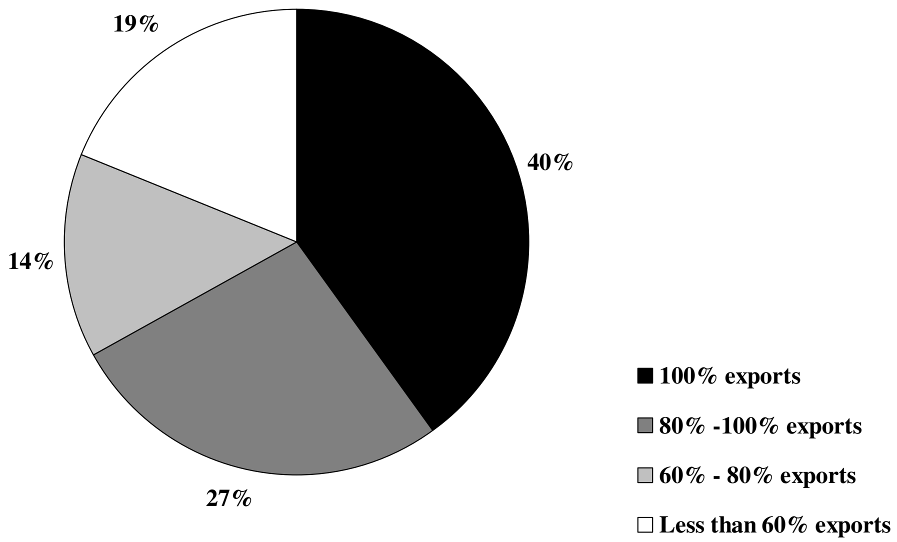
Athreye (2001) point to the role of IT firms in leading India's wider industrial sector to adopt modern business practices. According to these authors, practices such as good corporate governance (as required by international financial markets) and equity-based reward systems for senior staff have been widely adopted in IT firms, and then copied by the rest of the old economy. Unfortunately, Arora and Athreye fail to present convincing evidence that these changes were, in fact, learnt from the SWIS sector and not from other industries' own dealings with the Western world. They are similarly unable to identify any concrete positive impacts of these changes on productivity or output in the general Indian economy.

In summary then, the literature on backwards and general linkages from the IT sector to other sectors in the Indian economy paints a rather bleak picture. One definite positive backward linkage into venture capital and two possible learning spillovers of corporate governance and equity-based reward schemes are the only favourable effects identified. Instead, the majority of backwards linkages are abroad, and a fair proportion of foreign exchange earnings go straight out of India to pay for expenses. On employment, the fact that a significant number of educated export workers take jobs abroad means that these workers also do not contribute to backwards linkages. What is perhaps worse is that, far from contributing to positive outcomes in other sectors by providing a demand for their products, IT is simply absorbing workers. In doing so, the IT sector is starving other domestic sectors of the skilled workforce they need, and in the process bidding up the salaries they must pay.

3.3.2 No forward linkages, and no hope for them arising in the future

This section covers the literature on the linkage that is most important for the research in the remainder of the thesis - that which is concerned with the extent and consequences of the sector selling its output to Indian firms; in other words, forward linkages. In the main, contributions in the literature start by analysing or commenting on the relative size of domestic versus export revenues[32] , or on the export versus domestic orientation of a sample of IT firms (see Figure 3.12). This data is almost universally interpreted as showing insufficient amounts of domestic sales. Authors argue that the sector pays "inadequate attention" to the domestic market (Kumar and Joseph, 2005: 99); that it is preoccupied with exports (Kohli, 1991); or even that the domestic market has been "neglected" (Heeks, 1996: 72) or "eclipsed" by exports (Schware, 1992: 150).

Figure 3.12: Export Orientation by Share of Revenue for a Sample of IT Firms in 2002



Source: D'Costa 2006: 9
Note: D'Costa's statistics are from a survey of 102 NASSCOM members in Bangalore.

Heeks (1999a) explains why a small domestic market is a problem for India's wider development. He argues that: "Putting your brightest software stars to work on applications that boost the growth of foreign firms and foreign economies incurs a large opportunity cost when applications to meet the many pressing domestic needs are consequently sidelined" (p. 6). IT professionals engaged in export work make "no

[32] For SWIS, this is charted in Figure 3.9.

skill input into the domestic market" (Heeks, 1996: 149), and because export work offers perks like travel abroad and exposure to Western technologies, talented workers involved in the domestic sector are often lured into export work (p. 131).

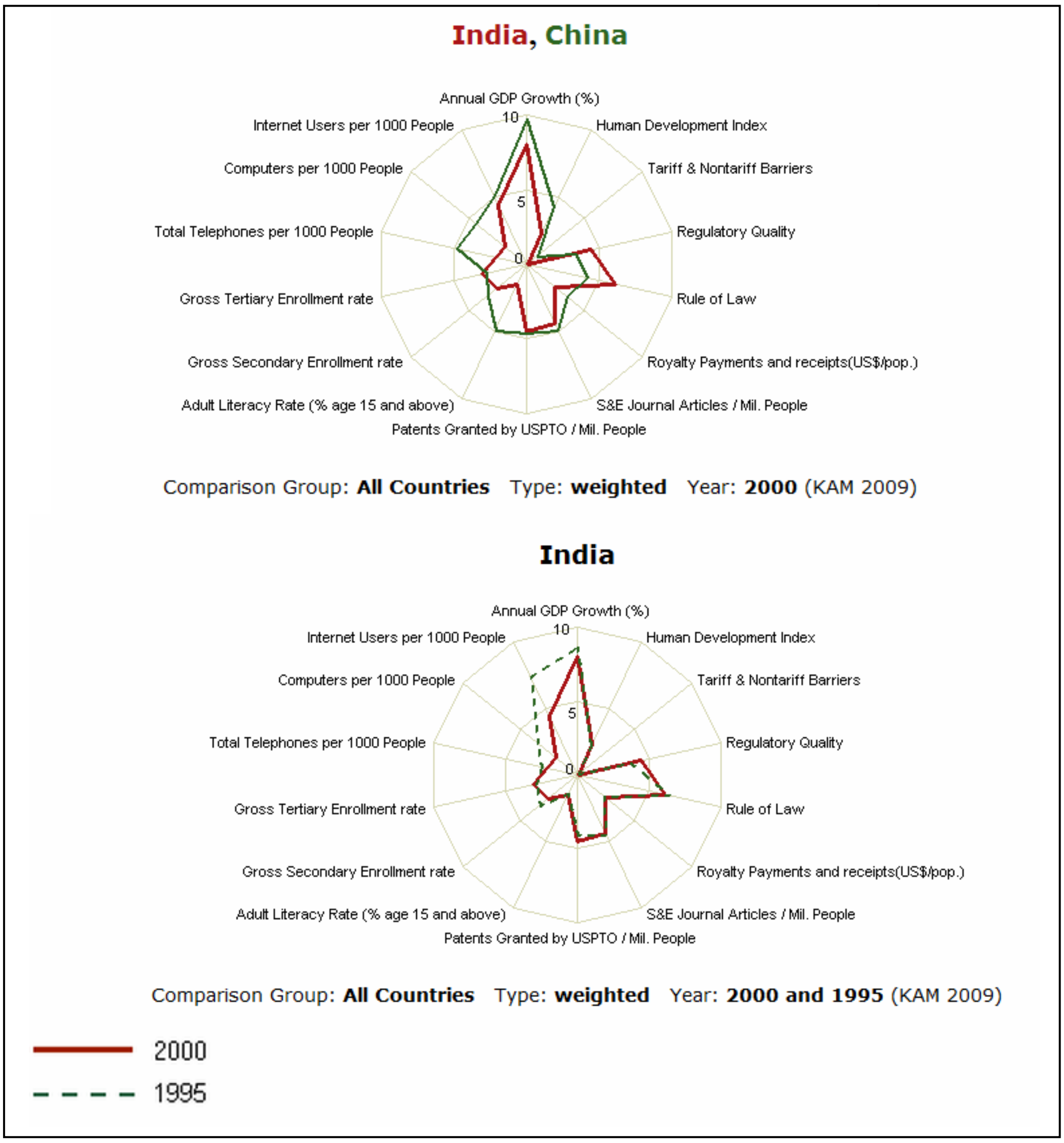
It is a lamentable situation not only for Heeks, but also for a wide range of authors from across the ideological spectrum who argue that the rise of a domestic market for outsourced IT would be beneficial for India's development. This position is so widespread, that amongst the many voices who argue for it (Chandrasekhar 2001: 1; Heeks,1999a: 9: Joseph, 2002: 2; Kumar and Joseph, 2005: 99; McCartney, 2006: 10 Singh, 2002: 34), there is even a rare consensus between economists from the neo-liberal orthodoxy (Dahlman and Utz 2005: xxix; International Monetary Fund 2001:108) and Marxist-oriented heterodoxy (D'Costa, 2006: 25; Saraswati, 2009: 1). Agreement also comes from representatives of the directly affected parties. The trade body which represents the IT sector in India, the National Association of Software and Services Companies (NASSCOM), has a "domestic market initiative" which actively promotes members working with India's non-IT sector (NASSCOM, 2008b: 1). Representing the other directly affected party, non-IT firms in India, the Confederation of Indian Industry (CII) goes even further, arguing in a joint paper with its hired consultants, that the IT sector's involvement in private sector activity is not only desirable, but is "critical" for enabling economic growth (CII and Accenture, 2007: 25). The discussion in Chapter 2, which analysed the literature on the impact of IT and of outsourcing elsewhere in the world, has already provided some justification for these calls. The results in Chapter 7 provide significantly more. For now though, the remainder of this section discusses the second set of findings in the literature on forward linkages—those that deal with the explanations of existing extent of forward linkages and their prognosis for the future.

On these issues, two well-known contributions offer in-depth analyses. Both start from the same position as the authors identified above, that the extent of forward linkages is small. Both also find, albeit for very different reasons, that the sector's pattern of export-led growth may actually preclude the possibility of forward linkages emerging in the short- to medium-term. Perhaps the most popular of these two contributions is, according to Volynets (2007), the "bestselling" World Bank report penned by Dahlman and Utz in 2005. Theirs is an analysis that identifies market forces as the reason for export focus in the Indian IT industry. They argue that foreign firms can afford to pay more for Information and Communication Technologies (ICT), and so Indian IT firms cater to them first:

> On the one hand, India is reaping tremendous revenues from continuing to expand provision of distance services globally; on the other hand, the high fees garnered from providing foreign IT services pre-empt Indian companies from developing ICT applications to meet domestic needs. [Dahlman and Utz, 2005: 114]

Dahlman and Utz do not outline any specific solutions to this "major" (2005:114) issue, preferring to focus on the bigger picture: the transition to a "Knowledge Economy". This broad concept is defined as encompassing "how any economy harnesses and uses new and existing knowledge to improve the productivity of agriculture, industry and services and increase overall welfare" (p. xvii). It clearly includes the types of activities that would occur if domestic firms used the IT industry to install new systems, but it also includes reams of other ways India's firms and populace might utilise IT to improve productivity or welfare. The authors use macro-level, cross-country score-cards, similar to those in Figure 3.13, as indicators of whether this transition is likely and how long it might take. The diagrams show scores on knowledge-specific endowments and market-friendliness. The data is normalised so that for a country to perform better over time on a particular score, it must not only improve in absolute terms, but it also must improve faster than the rest of the comparator group of 140 countries.

Figure 3.13: India KAM Basic Scorecard in 1995 and 2000, and Comparison with China in 2000



Source: World Bank (2009).

Whilst they do not explicitly say so, their choice of this methodology reveals a preoccupation with comparative advantage as the main determinant of where knowledge-intensive industries locate. The theory predicts that in the absence of restrictions on trade, industries that use IT intensively will emerge wherever the endowments for this type of industry are relatively advantageous. It is only in these locations that they will be profitable enough to be able to pay the world price for IT, including for the types of outsourced IT sold by the Indian sector. According to this thinking, two things must happen before India's firms will find it profitable to upgrade their information technology using the sector's services. First, faster improvement in knowledge endowments, relative to endowments for other types of production and relative to other countries, must occur. India must overtake both developed countries and other developing countries in the ratio of knowledge endowments to endowments applicable for other types of production. Second, a policy and institutional environment that supports free trade must be in place so that India's firms are able to participate and be competitive in global markets for knowledge-intensive products. Only then will India's firms find it profitable to pay the high fees required by the Indian IT services sector. Dahlman and Utz do not acknowledge it, but their own data shows this eventuality may well be a long way off. The top pane of Figure 3.13 shows India's position on knowledge endowments and free-trade friendliness relative to China. On all but one of the measures, China's normalised score is significantly higher than India's. The bottom pane shows India's position in 1995 and in 2000; on some knowledge endowments, India has actually lost ground compared to other countries. On all the other measures, there has been very little change.

In 2005, when Dahlman and Utz wrote their book, the comparative-advantage model for development was very much in the mainstream, so it is perhaps no surprise that this was the economic model underpinning the World Bank's thinking on the place of

IT in the Indian economy. However, authors outside of the mainstream argue vigorously that it is not the most appropriate model. Heterodox authors concentrate on the circumstances under which developing countries can enter into new economic activities, not by changing what they have (their endowments) but by changing what they learn. Anthony D'Costa is one such author. Starting from the premise that most of the technology in the IT sector is tailored for developed countries, and therefore inappropriate for India, his influential 2003 publication uses Marxist analysis to see if social and productive relations in the sector are conducive to learning which might allow for the emergence of forward linkages. Finding the answer to this question to be no, he classifies the Indian IT sector as a exhibiting a negative version of "uneven and combined development"[33].

This pattern of development occurs when, in search of cheaper labour, a modern global industry establishes production within the borders of a less-developed country whose main economic activity is subsistence agriculture. The output of the new industry is too technologically advanced to be appropriate for the developing country to use, and its inputs are, apart from cheap labour, too advanced for the developing country to provide. This means that the presence of the industry does little for the development of the country; a proletariat emerges in the new industry, but traditional sectors do not respond and continue to develop slowly, without the newer technology. This unevenness is self-reinforcing. Locating in a less-developed country keeps global firms in a dominant position: they can produce using both the best technology and the cheapest labour. This offers them the ability to out-compete any new entrants and to invest in innovation which maintains their technological lead. In turn, this continued

[33] Trotsky's original concept of uneven and combined development encompassed both positive and negative implications of developing countries existing alongside and trading with more developed countries (Trotsky, 1977: 23–27). D'Costa's analysis of the IT industry in India diagnoses a negative version.

dominance raises barriers to entry for developing country firms in the modern sector, and thus raises the relative return for them to remain as subordinate suppliers of cheap labour for multinational companies. In the absence of independent industrialisation, the technology in the new sector *never* becomes appropriate for the general population of consumers and firms, and the unevenness of development continues unabated (Patnaik, 1997: 185).

D'Costa argues that the particular version of uneven and combined development which applies to the Indian IT industry rests on two major issues. First, with so many people engaged in subsistence agriculture, the Indian economy is structurally unable to support wide-scale education to university level. Although there are large enough pockets of educated engineers sufficient to entice IT capitalism to India, the majority of the populace is, and will remain, insufficiently educated to participate (D'Costa, 2003: 215). This has led to uneven development, with rapid growth of incomes amongst educated people working in the sector primarily in southern cities, and slow growth amongst the more numerous uneducated population, particularly in the west (p. 215–216). Second, global capitalists are so far ahead of Indian firms, that barriers to entrance in the industries that use IT are insurmountable. This means that the majority of Indian firms are not technically advanced enough to demand software or IT services (p. 222). The lack of domestic demand means that Indian IT firms can only fulfil the contracts offered by foreign companies, and these, in accordance with global firms' interests in preventing catch-up in India, are low-value with very little learning. It is a self-reinforcing trap of underdevelopment. The dominance of global capital in IT sectors and in sectors using IT closes down any possibility of SWIS firms learning from non-IT firms in India, or vice versa, because neither is able to catch-up and learn for itself. In the end, according to D'Costa, a system is created in which “fibre optic lines [are] running parallel with bullock carts” (cited in Reuters, 2002: 1), and where, in the absence of “[p]olicies that deal explicitly with structural contradictions unleashed by uneven and combined development”, there is little to no hope for Indian firms to begin to utilise the industry’s services (D’Costa, 2003: 222).

Figure 3.14: Bangalore: Uneven & Combined development?

Source: Chen and Devnani (2006: 1).

Of the two publications just reviewed— Dahlman and Utz (2005) and D’Costa (2003)—the prognosis for forward linkages from the IT sector is perhaps the most discouraging in D’Costa’s model. In his analysis, the focus on exports has trapped Indian SWIS firms into producing low-value, low-skilled services, directly preventing a domestic market for outsourcing from *ever* coming about. The situation is only marginally better in Dahlman and Utz because although they do at least offer some routes through which forward linkages might emerge in future, these are unlikely in the short term. In their analysis, there is potential for India to evolve its endowments to be better suited to IT-intensive production and this might lead to the emergence of forward linkages. However, for this to occur, endowments must accelerate past those of other countries; so that India becomes a *relatively* advantageous place to locate industries using IT, and this over-taking is exceedingly difficult to attain. In both cases, then, the prognosis for forward linkages into a domestic market is not particularly positive. If either of these two analyses is correct, there is little chance of observing the growth of a significant domestic market in India in the early decades of the twenty-first century.

3.3.3 Conclusion: IT is the opposite of a leading sector; it is an enclave

The preceding sections reviewed the existing literature on the looming question that this thesis addresses. They analysed viewpoints on whether the IT sector has significant linkages, allowing it to be a leading sector in the Indian economy. Section 3.3.1 argued that the literature on backwards and other linkages was very pessimistic, save for one backward linkage (venture capital) and two possible learning linkages (corporate governance and equity reward schemes). Authors found that the majority of backwards linkages led to foreign industries located abroad because many of the IT sector's purchased inputs were not produced in India. On employment, a lack of favourable backwards linkages was joined by a negative effect arising from the windfall boom of export income. Skilled IT workers' wages are high, which increases costs for other industries in India, who must compete with higher salaries to lure skilled workers. The discussion in Section 3.3.2 was perhaps even more negative. The literature review identified a large group of authors who found that forward linkages were woefully small. Despite their ideological differences, these authors were agreed that there could be substantial benefits to the Indian economy if this situation is rectified. Unfortunately two influential theoretical publications on this possibility were consistent in their implication: the prognosis is bleak. Neither predicted the emergence of substantial forward linkages in the short- to medium-term future.

On the question of IT being a leading sector, or a sector with many linkages able to contribute to wider economic growth, the literature in these two sub-sections, taken together, constitute a resounding no. In fact authors find the industry to be far more akin to the opposite of a leading sector identified in Chapter 1. Balasubramanyam and Balasubramanyam (1998) make this case very clearly. They draw a parallel between the modern IT industry in India and Singer's colonial "enclaves" (1950). At first, it sounds like a far-fetched comparison. Singer's enclaves produced basic primary commodities—a type of product far removed from software development or IT services. IT is neither basic, nor primary, nor a commodity. A deeper analysis, though, provides some parallels. Although software and IT services are not primary products, they, like Singer's primary commodities, only become involved in other industries in the economy when used as intermediate goods to produce some final product. The Singer comparison is pertinent because, as with colonial enclaves, IT is exported and then used for the production of final goods in developed countries. This means that any output improvement or productivity gain brought about by use of Indian IT happens outside of India's borders. More disappointing still is that these productivity gains may only be a first-round benefit for the destination countries. If use of IT leads to new or improved economic activity which embodies learning, it is the developed countries which import Indian IT that will enjoy these economic opportunities and not India.

In Balasubramanyam and Balasubramanyam's analysis, the IT industry in India behaves like the old extraction enclaves, offering no impetus for Indian firms to develop new capabilities.

> There are no obvious linkages between the sector and the rest of the economy, the engineers communicate with the clients or more specifically the computers in the clients' firms abroad via the satellite link, flock together in the bars and

> eating establishments in Bangalore during their leisure hours conversing in the *lingua* of bytes and ROMs of the trade. [Balasubramanyam and Balasubramanyam, 1998: 293]

In short, according to the literature, because the sector has no significant domestic market, backwards linkages or other learning spillovers, it is a modern-day version of Singer's enclaves. It is an industry in India which provides a highly lucrative investment for its owners, but whose benefits in terms of wider growth and development only occur abroad.

3.4 Tentative evidence that scepticism on linkages could be wrong.

The three sections in this chapter reviewed the literature on the role of the IT sector in India's economy. This analysis contributes two new arguments about the current literature's pervading point of view. The first is that opinions on the sector are permeated with incredulity about the success so far and prospects for the future of IT in India. This manifests in the literature as a sense of surprise at India's success in the IT industry. It is carried through into the literature on the sector's impact on the wider economy where authors express both a lack of belief in existing linkages and a prediction that linkages will not occur in the future. Section 3.2 contributed the second new observation about the literature which is that there is, in fact, good reason to be surprised about the emergence and marked growth of the sector. Its success was the result of India being ready with the right kind of workforce and with entrepreneurial vigour during a unique moment in the history of IT as a budding technology. Opportunities when demand for a new technology is growing so quickly that the labour market in developed countries cannot keep up are rare. Times where government and private sectors have, intentionally or not, worked in the same direction to meet that need are rarer still.

This final section makes a third new argument about the literature, one which is developed over the coming chapters: the incredulity in the literature on the sector's wider role is misplaced. It is based on incorrect and out-of date-perceptions of what the sector does for India, and it is too pessimistic. Figure 3.15 shows the beginning evidence uncovered during the early stages of this research project, evidence that suggests this new argument is accurate. It illustrates four headlines which appeared in the news in India and abroad after 2005. Each of these headlines reads that the IT sector is targeting or completing work in India. In other words, they all report the existence or emergence of forward linkages from the IT sector into India's economy.

Figure 3.15: Headlines from the Financial Newspapers in India and Abroad

Source: *The Economic Times* (2008); Kurmanath (2008); Menon (2008); Merchant (2005).

The journalists interviewed Indian IT industry executives, who expressed enthusiasm about the domestic market and a desire to complete projects there (Menon, 2008). The executives were optimistic about the size of the domestic market and its expected growth in coming years (Kurmanath, 2008); and they detailed particular strategies that their companies were planning to use to ensure that they are well-suited for completing domestic projects (Kurmanath, 2008; Merchant, 2005).

These reports suggest an alternative hypothesis to the pessimism outlined in Section 3.3, and indicate that, contrary to accounts in the reviewed literature, Indian firms are purchasing IT from the sector. When they do engage, Indian firms find IT companies that are interested in creating working relationships and have thought about their needs; in short, they find an IT partner that is willing and able to help. It is this alternative hypothesis that provides the impetus for the research laid out in the remainder of the thesis. Admittedly, the evidence found in newspapers is not rigorous, and it provides only snapshots of the IT sector's situation in India. It does, however, suggest that the literature might be missing the true extent of forward linkages. If this is true, the literature might also be incorrect in its assessment of other linkages. To put it bluntly, there is a need for new research which re-evaluates the findings on linkages.

Chapter 4 translates this assessment into clear research questions and articulates a strategy to answer them.

4. The Research: Broad scope and extensive methods

This chapter marks a dividing line. From here on, the thesis contains only original work initiated, researched, and analysed by this author on the Indian software and IT services (SWIS) sector. This new part of the thesis begins in this chapter with a discussion of the research and a description of the process. Section 4.1 is a review of the aims of the project and a discussion of the research questions. The goals are ambitious, leading to numerous and wide-ranging research questions and consequently to comprehensive research and findings. Section 4.2 sets out the systematic procedure that was followed to answer the research questions. The project involved a programme of qualitative research in the field; one substantial econometric model and one smaller one; an input–output analysis; and a tertiary study of existing private sector and government research. Each of these different methods was chosen to address a particular aspect of the research questions and great consideration was given to ensure that the methods were appropriate for the questions. Section 4.3 concludes that the research project uses a vast array of data and techniques, and in doing so provides a strong demonstration of diverse and relevant research skills.

4.1 Ambitious aims and research questions

The overarching aim of the new research is to validate or refute the hypothesis that the Indian software and IT Services (SWIS) sector is a leading sector as defined in Chapter 1. In other words, the aim of the project is to assess the current extent of all the SWIS sector's direct and indirect linkages and to identify their impact on both linked sectors and macroeconomic outcomes. Forward linkages are of particular interest for two reasons. First, early evidence included at the end of Chapter 3 points to the existence of more forward linkages than were identified or predicted by the literature. This suggests that there are important questions to be addressed as to why the analyses in the literature appear incorrect. Second, there is the question regarding whether forward linkages have the potential to transform production processes. Chapter 2 found that in the developed world, use of IT in production has led to productivity gains large enough to impact GDP growth at the macro level. At its peak in the 1990s, this contributed 1.4 percentage points in the United States, and between 10% and 30% of total GDP growth in other developed countries. If similar effects can be identified in India as a result of forward linkages from the sector, it would be a very important result. It was argued in Chapter 1 that productivity improvements not only lead to increases in output, but also to a desirable type of "high road" growth which has the potential to enable sustainable expansion based on reinvestments of profits, wages that guarantee a decent quality of life to workers, or both.

Clearly, the need to assess all possible linkages with all possible industries in India that might be linked to SWIS necessitates a very wide empirical focus. This is compounded by the necessity of both identifying linkages and quantifying their size. For forward linkages two more areas to investigate are also included. That is to identify what explains their current extent and growth and to quantify their impact on output and productivity. The remainder of this section explains how these wide-ranging questions were approached. The first step was to convert them into several manageable and specific research questions; the second step made the research questions operational through clear definitions of words and phrases in them.

Figure 4.1: Research Questions

Overarching Research Question: Is SWIS a leading sector in India?

1. **What is the current extent of direct and indirect linkages from SWIS and ITES-BPO?**
   a. **What is the current extent of direct backwards, forwards and other linkages?**
   b. **What is the current extent of indirect backwards and forwards linkages and how fast are they growing?**

2. **What explains the size and growth trajectory of direct forward linkages from the SWIS sector?**
   a. **Are the arguments of D'Costa (2003) and/or Dahlman & Utz (2005) valid?**
   b. **Are there other explanations in the literature which have not yet been applied to this context but which are helpful?**
   c. **Is there another explanation not previously identified in any literature?**

3. **What is the nature and size of the contribution that forward linkages from the SWIS sector make to outcomes in other parts of the Indian economy?**
   a. **What is the impact on firms that buy SWIS?**
   b. **What is the impact in different SWIS-buying industries?**
   c. **What is the impact on India's economy overall?**
   d. **What is the process by which these contributions come about?**

Figure 4.1 diagrams the questions addressed in the research. It includes the overarching question which corresponds to the thesis' overall conclusion and the three primary research questions (hereafter referred to as RQ1, RQ2, and RQ3). Each of the primary questions has several secondary research questions needed to clarify the issues involved; for example, the secondary questions for RQ1 clarify the different types of linkages assessed to answer RQ1.

The research questions rely on terms that were introduced in Chapter 1, such as leading sector and backward, forward, direct, and indirect linkages. Full definitions of these terms, alongside the definitions of the different IT-related sectors are given in Figure 4.2. The definitions of the IT sectors (HW, SWIS and ITES-BPO) are the same as consistently used by the Indian IT industry's trade body, the National Association of Software and Services Companies (NASSCOM). This is a pragmatic choice, as NASSCOM is the major source of available data on the size and activities of these sub-sectors (Desai, 2003: 2). In working with these definitions, the research is comparable with other work on the sector, including NASSCOM's own research and that of government, private sector, and academic researchers.

Figure 4.2: Definition of Terms in the Research Questions

SWIS Sector: The *Software and IT Services* sector is the industry in India which offers a full range of IT and software-related business-to-business services. These include custom application development, network consulting and integration, software testing, application management, IT outsourcing, software deployment and support, hardware deployment and support, IT training, IT consulting and systems integration, managed services, hosting services and support/maintenance, as well as sale and installation of packaged software in client businesses.

ITES-BPO Sector: This is the industry in India that produces *IT enabled service/Business Process Outsourcing,* such as call centres, preparation of company accounts, and processing of bank account queries.

SWIS–ITES-BPO: Together these two sectors make up the services part of the IT industry in India. *Hardware,* such as PCs, printers, and other peripherals, is excluded.

Leading Sector: A sector which has a disproportionately large impact on macro-level economic growth because its expansion leads to growth of other sectors' output through linkage effects

Backward Linkage: Any process by which increased production in one sector prompts increased production in another sector which supplies inputs to the first.

Forward Linkage: Any process by which increased production in one sector prompts increased production in another sector which buys inputs from the first.

Other Linkages: Any other process by which increased production in one sector prompts increased production in another.

Indirect Backward (or Forward) Linkages: In the presence of a backward or forward linkage, this is an increase in production arising from other backward or forward linkages from the second industry into all other sectors.

Source: NASSCOM (2009a: 251), Hirschman (1958)

The research project focuses on the SWIS sector rather than the whole of the IT industry introduced and documented in Chapter 3. There are important reasons for this. The time and costs involved in assessing linkages from all parts of the IT sector were prohibitive in a project of the size envisaged. Additionally, the three IT-related sectors (HW, SWIS, and ITES-BPO) fall into different groups according to classifications which are important to the research. Perhaps the most important of these distinctions is that only two of the three sub-sectors actually produce IT. IT-enabled services/Business process outsourcing (ITES-BPO), as its name suggests, uses IT to produce business services such as back office operations or call centres; it does not, however, produce IT. Another relevant distinction between the different industries is that SWIS and ITES-BPO belong in the services or tertiary sector, whilst the HW industry is composed of manufacturing firms. The three sub-sectors also have very different policy histories, and have experienced very different patterns of growth (Chandrasekhar, 2001). For all these reasons, the research was necessarily restricted to one of the three sub-sectors of the IT sector. SWIS was chosen for several reasons. The most important of these is that the early evidence from newspapers, identified at the end of Chapter 3, indicates fast growth in domestic SWIS deals. As discussed in Chapter 3, SWIS is also the largest of the three sub-sectors and has had more success than HW, and a much longer history than ITES-BPO (Kumar and Joseph, 2005: 94).

The only exception to the research questions' focus on SWIS comes in RQ1 which looks at the total extent and growth rate of direct and indirect linkages. Here the scope of enquiry is widened to include ITES-BPO. This decision was made partially because the most useful data source available to address this question reports SWIS and ITES-BPO together. However, the decision was deemed fit because it is accepted in the literature that ITES-BPO has actually arisen because of the existence of SWIS in India. Expansion into ITES-BPO occurred because Indian firms were already acting as SWIS outsourcers (Arora and Gambardella, 2005: 292). These firms had access to IT and communication technologies that enabled ITES-BPO outsourcing, and they also had the capability and reputation of being able to successfully provide outsourced services. In other words, ITES-BPO came about because it was possible to purchase IT through forward linkages from SWIS and because other linkages from SWIS had led to learning that was relevant for ITES-BPO. What this means for RQ1 is that direct linkage effects from ITES-BPO into other sectors in India can be interpreted as indirect linkage effects from SWIS. For the purposes of an investigation into the extent of linkages, aggregating the two sub-sectors does not diminish the coherence of the findings.

RQ2 addresses the reasons for changes in the size of the Indian domestic market for SWIS, or, in other words, the factors that determine the extent of direct forward linkages. The secondary research questions for RQ2 suggest an approach to the question which is rooted in the literature. RQ2a prompts a re-evaluation of the publications by Dahlman and Utz (2005) and D'Costa (2003) (covered in Section 3.3.2) which implied that a significant domestic market was unlikely in the short- to medium-term. The other two secondary research questions look for alternative explanations, recognising that these may already exist in the more general literature on economics and development. RQ3 prompts an investigation of the contribution that the use of IT from the SWIS sector makes to other sectors in India, and into the overall economy. The secondary questions attached to RQ3 identify the levels of aggregation at which this contribution might be expected to be visible. They require a consideration of the impact of purchasing IT on output and/or productivity in the buying firm, the buying sector, and in India. RQ3d completes the set of research questions by asking a broader and more open question about the process by which domestic market deals contribute to improved productivity or output.

RQ3 is the first of the research questions to introduce "SWIS-buying industries" as an object of investigation. This term refers to the industries that purchase SWIS from the IT sector. These industries were unknown at the beginning of the research project, and were later identified by reference to secondary data. This is detailed in chapter 5, where two different data-sources are used to identify SWIS-buying industries and is verified in chapter 7, where a third data-source also quantifies expenditure on SWIS in a sample of Indian non-IT firms. It is worth noting here that there are some industries where production is inherently more amenable to the use of IT, including SWIS (Baily and Lawrence, 2001: 309; Mann, 2003: 4; Stiroh, 2001: 19; Triplett, 1999: 318). This means that there are some industries which have a stronger potential to be purchasers of SWIS from the sector than others. In the chapters which follow the term “potential SWIS-buying industries” or “potential client industries” are used to indicate these relatively more likely sectors, although the inclusion of these terms is not intended to excuse the research project from identifying which sectors actually purchase outsourced SWIS in India.

The research questions and definitions given in this section are intended to split the research goals into manageable and operational questions which can be addressed with particular research methods. Section 4.2 below describes which methods were used for each question.

4.2 A substantial programme of research

This section covers the methods employed to arrive at answers to the research questions. They are many and varied. This author first undertook a programme of qualitative research in the field, and then collected and analysed several sources of secondary data. The analyses included one sizeable econometric model based on approximately 33,000 firm-level observations, one smaller econometric model, and an input-output analysis. A re-evaluation of existing private-sector and government research was also conducted. This number and mix of methods was necessary because the research questions have such a wide scope.

Figure 4.3: Research Questions and Methods Employed to Answer Them

	1: Use of Tertiary Data	2: In Depth Interviews	3: Analysis of Secondary Data
1. What is the current extent of direct and indirect linkages from SWIS and ITES-BPO?			
a. What is the current extent of direct backwards, forwards and other linkages?	X		X
b. What is the current extent of indirect backwards and forwards linkages and how fast are they growing?			X
2. What explains the size and growth trajectory of direct forward linkages from the SWIS sector?			
a. Are the arguments of D'Costa (2003) and/or Dahlman & Utz (2005) valid?		X	
b. Are there other explanations in the literature which have not yet been applied to this context but which are helpful?		X	
c. Is there another explanation not previously identified in any literature?		X	
3. What is the nature and size of the contribution that forward linkages from the SWIS sector make to outcomes in other parts of the Indian economy?			
a. What is the impact on firms that buy SWIS?			X
b. What is the impact in different SWIS-buying industries?			X
c. What is the impact on India's economy overall?			X
d. What is the process by which these contributions come about?		X	

In assessing the extent of the different linkages, RQ1a requires a wide range of data on the IT sector, as well as on many other different sectors. It asks a measurable question about the size of specific quantities yet has a very wide scope of enquiry.

The method chosen for this question was use of tertiary data and analysis of certain secondary data. RQ3a–c on the impact of forward linkages and RQ1b on the extent of indirect forward and backward linkages similarly ask well-defined and quantifiable questions, but they each have a smaller scope. All these questions were addressed using analysis of secondary data. Finally, RQ2 and RQ3d require collection of explanations, or, rather, chains of causal events. RQ2, which asks to explain the size and growth of forward linkages from SWIS, and RQ3d, which asks how those forward linkages impact economic outcomes, require answers that may be different in different contexts and that are shaped by interactions between particular actors. For these reasons, the method used to understand their answers is in-depth interviewing. This mapping of chosen methods to questions is summarised in Figure 4.3.

During the research, the different methods frequently provided additional information relevant to other questions, and so stepped outside the plan laid out in Figure 4.3. In other cases, the data collected for one question verified the data collected for another. However, the intention was to address each of the three groups of questions with a research method designed specifically for it. The remainder of this section lays out the different methods involved and the reasons why each method was chosen for the particular research question. The methods are discussed in the order they were undertaken during the research project.

4.2.1 Use of tertiary data for an up to date assessment on linkages

This section outlines the method used primarily to collect data on RQ1a; that is, it sets out how the current evidence on linkages from SWIS and ITES-BPO was collected. Answering RQ1a required the collection of data on a wide array of potential and actual linkage mechanisms between SWIS-ITES-BPO and all of the other sectors in the Indian economy. For each of these potential linkage mechanisms, the question required an investigation of both what the linkage was and to what extent it was important. In short, RQ1a is an oversized question with a wide remit. Answering it by collecting primary data would require its own large research project. Similarly, amassing sufficient secondary data to provide a new analysis of all possible linkages could easily make it impossible to address any further research questions. It is for these practical reasons that the majority of the answers to RQ1a (presented in Chapter 5) are established by reference to the analyses of other authors. While the work on RQ1a uses analyses of other authors, in many cases new explanations based on reinterpretations of their evidence, re-evaluations of their conclusions, or new applications of their empirical findings are put forward.

This reanalysis for RQ1a shares many characteristics with the task of reviewing the literature on a subject. However, there is an important difference between a literature review and the majority of the work which follows in the discussion of RQ1a. Unlike the literature review in Chapter 3, a great deal of the evidence which is marshalled under the first method has not been published in peer reviewed academic journals. It includes summaries, categorisations, and other analyses of data which have been carried out by private researchers, government agencies, industry associations, and other interested parties. These "other" researchers undoubtedly did not have the same aims or research questions as those that are of interest here. Their findings may have been based on assumptions or prejudices which are not easy to identify from their publications and which could be inconsistent with the current work or simply incorrect. In short, control of the steps involved in moving from primary data to the results has remained in the hands of researchers whose work has not been reviewed by experts (Blaikie, 2000: 184). These concerns are particularly important in seeking to provide the most current analysis possible on the SWIS sector's linkages in India. The research on these issues is often published first by those actually involved in the activities concerned. Not surprisingly, these are exactly the groups and actors who have the most to gain or lose by publicising one thing and ignoring another.

This is especially true for one source of tertiary data which was used very regularly the work under method 1, the IT industry's trade body, NASSCOM. NASSCOM is by far the most comprehensive and widely accepted source for the Indian IT industry (Desai 2003:2). However, its primary function is not to provide researchers with an unbiased account of the IT industry's activities. Instead, all of the eight objectives listed on NASSCOM's website (http://www.nasscom.in), and reproduced in Figure 4.4 below, are concerned with helping NASSCOM's members to achieve various goals. These range from influencing policies at home and abroad to supporting success in export markets, co-operation within the industry, and upgrading of production to "world-class" level. Objective 2 specifically states that NASSCOM's data collection and dissemination activities are designed for use by "software developers and interested companies overseas".

Figure 4.4: NASSCOM's Stated Objectives

Aims and Objectives:

NASSCOM aims to drive the overall growth of the global offshoring market and maintain India's leadership position, by taking up the role of a strategic advisor to the industry. NASSCOM's varied strengths include advocacy on public policy, international trade development, research and market intelligence services, and access to an international network through linkages with 40 industry associations across the globe. This enables NASSCOM to advise members—both established and emerging companies to further their growth.

Other goals include accelerating trade development efforts, improving talent supply, strengthening local infrastructure, building partnerships and driving operational excellence. It also boosts the process of Innovation; IT workforce development and enhanced cyber security.

Objectives:

1. Maintaining close interaction with the Government of India in formulating National IT policies with specific focus on IT software and services
2. Maintaining a state of the art information database of IT software and services related activities for use of both the software developers as well as interested companies overseas.
3. Encourage members to provide world-class quality products, services and solutions in India and overseas and help build brand equity for the Indian IT software and services industry.
4. Taking effective steps to campaign against software piracy.
5. Provide an ideal forum for overseas and domestic companies to explore the vast potential available for Joint Ventures, Strategic Alliances, Marketing Alliances, Joint Product Development, etc., by organising Business Meets with delegations of various countries.
6. Work actively with Overseas Governments, Embassies to make the Visa and Work Permit Rules more "India Industry Friendly".
7. Disseminate various policies, market information and other relevant statistics by sending more than 200 circulars (annually) to all members.
8. Involve membership participation in various forums of NASSCOM on subjects such as HRD, Technology, Exports, Domestic Market, E-Governance, IT Enabled Services, IPR, Finance, Government Policies, Quality, etc.

Source: http://www.nasscom.in/ (accessed 15 January 2011).

Figure 4.5 reproduces NASSCOM's membership criteria with a view to identifying the organisations that are intended to benefit from their activities. It is clear that NASSCOM's membership is restricted to only those HW, ITES-BPO, and SWIS companies whose revenues have reached Rs 1 crore (US$221,900 in 2005) and which are formally registered to pay tax in India. Conversely, not all companies which satisfy these criteria are members. Joining NASSCOM is optional, and membership fees start at Rs22,000 (US$500 in 2005) per year. What this means is that NASSCOM's objectives are to support and help a subset of the industry which not only meets its criteria for membership but which also envisages sufficient benefits from NASSCOM's activities to justify paying the membership fees.

Figure 4.5: NASSCOM's Membership Criteria

IT software and services organization registered in India with annual revenue from IT software and services exceeding Rs 1 crore

These include:
* Software Development Companies
* IT Services Companies
* Software Product Companies
* Resellers of Branded Software Packages
* E-Commerce Companies
* IT Enabled Service Companies
* System Integrators

Eligibility: Any firm, society, company or division thereof registered or incorporated in India and conducting business in IT software, IT services with annual revenue exceeding Rs 1 crore is eligible to apply for Regular membership.

Source: http://www.nasscom.in/ (accessed 15 January 2011)

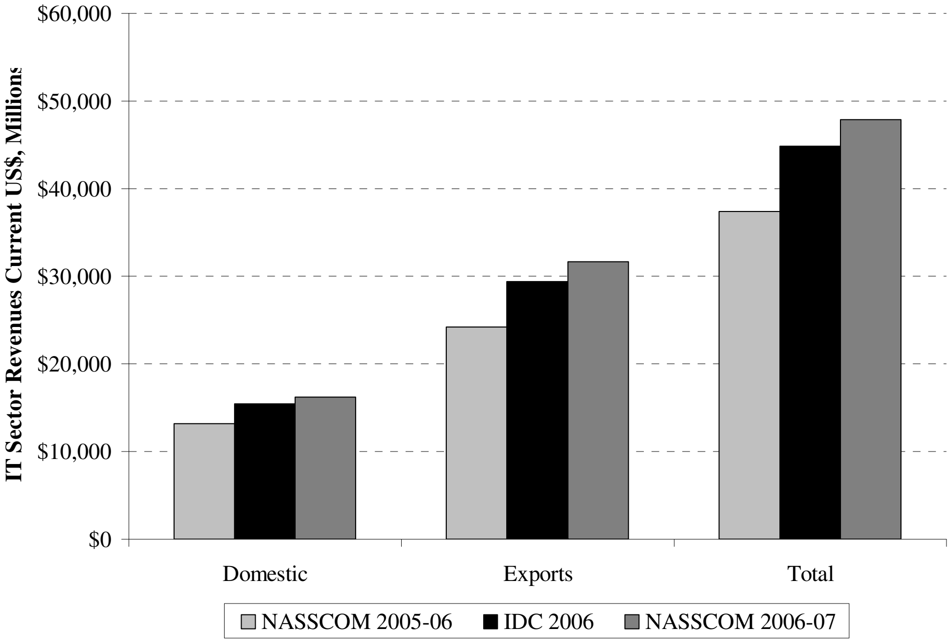
These aims and membership criteria have important implications for the use of NASSCOM's data and research for two different reasons. The first is that NASSCOM's published data on the IT industry consists of data only on their own members[34]. This is important, because although NASSCOM reports that their membership includes 1,200 firms and 95% of the entire industry's revenues[35], these firms are not a random sample and NASSCOM do not verify the 95% statistic. Desai (2003: 2) attempts to rectify this by comparing the size of the NASSCOM membership in 2002 to an alternative listing of IT companies. He finds that at the end of fiscal year 2002, the alternate list included 4,000 IT firms, whilst NASSCOM,

[34] This is true of the data presented in Chapter 3, as well as NASSCOM data used in the rest of the thesis.
[35] http://www.nasscom.in/ (accessed 15 January 2011)

which in that year also claimed to cover 95% of industry revenues, numbered only 850 members. This is a large discrepancy, and one which casts doubt over NASSCOM's statistic.

Despite this, Desai eventually argues that NASSCOM's figures are reliable. He conducts a comparison between NASSCOM's IT export figures and those provided by the Reserve Bank of India (Desai, 2003:2) and finds that NASSCOM's figures were within 10% of the bank's figures. He concludes that the difference could be due to lags in reporting. Figure 4.6 provides another verification of NASSCOM figures, this time comparing NASSCOM's figures to those from International Data Corporation (IDC), a well respected private sector research consultancy, on the size of the sector in 2006. The dark and light grey bars show NASSCOM data for 2005-06 and 2006-07 and the black bar gives the IDC figure for the full calendar year 2006. It is clear that these two sources are comparable and that any discrepancy between them is small.

Figure 4.6: Comparison of NASSCOM and IDC Figures on the IT Sector for 2006



Source: NASSCOM (2009a);
Note: IDC figures reported by *Businesswire India* ('India IT Industry grows by 31% in 2006, say IDC', 2007).

What is perhaps more reassuring than these two attempts to verify NASSCOM's figures is that the potential sources of bias arising from concentrating on NASSCOM's membership, rather than the whole industry, would tend, if anything, to underestimate many of the phenomena under investigation for RQ1a. This means that if there is evidence of NASSCOM's members having linkages in India, the extent of this is likely to underestimate the full extent of linkages from the whole sector. This is particularly true for the aspect of RQ1a which forms the basis of the second two research questions: the extent of forward linkages, or in other words, the size of the domestic market for SWIS. The fact that NASSCOM treats ITES-BPO as part of the IT sector itself rather than as a potential SWIS-buying industry, means that they exclude forward linkages between SWIS and ITES-BPO. On top of that, NASSCOM's objectives as stated in Figure 4.4 are about making it easier for Indian IT companies to succeed in export markets. This, in tandem with the nature of paid membership, makes it likely that NASSCOM's membership may well be skewed in favour of those firms that benefit most from those activities, exporters. There may well be many domestic-oriented IT companies that simply do not join NASSCOM, because the price of membership may not be worth it for companies that are not export producers. As there is a host of small IT companies and/or IT companies which do not make the membership criteria and, therefore, cannot be included in NASSCOM's figures, preliminary evidence was collected during this research project. This evidence suggests that these smaller and/or unregistered firms do, indeed, primarily produce for the domestic market[36].

The second reason for caution in using NASSCOM's data, however, is less easily identified and potentially more problematic: the possibility of research being carried out in a way that ensures favourable findings. Published research by NASSCOM is often commissioned to produce specific outcomes and to influence specific actors in accordance with NASSCOM's objectives. For example, the NASSCOM and Credit Rating and Information Services of India Ltd (CRISIL) (2007) study on linkages from the SWIS sector form an important part of the findings for RQ1a, and no doubt has been used in NASSCOM's ongoing negotiations with the Indian government. The sector continues to receive tax exemptions and other benefits as a result of government policy, and NASSCOM actively seeks to justify the continuation of this largesse. Finding that backwards linkages to the rest of the Indian economy are substantial can only help with this cause. While the results of NASSCOM & CRISIL's work are probably reliable, there is also no opportunity to examine every decision made during its study. For this reason, the discussion of its findings in Chapter 5 is contrasted with similar studies by different organisations and researchers.

[36] See Chapter 7 for more details.

These, in the main, verify its results and so alleviate some of the uncertainty around using these findings.

This was the strategy employed to alleviate worries about possible biases in all tertiary data throughout the work on RQ1a. Wherever possible, many different sources were consulted on each issue, and, in particular, NASSCOM's data was cross-referenced against other researchers. Where possible, both quantitative and qualitative work is included, and quantitative work includes both hard (e.g., revenue) and soft (e.g., opinion) metrics.

4.2.2 In depth interviewing to explain causes and processes

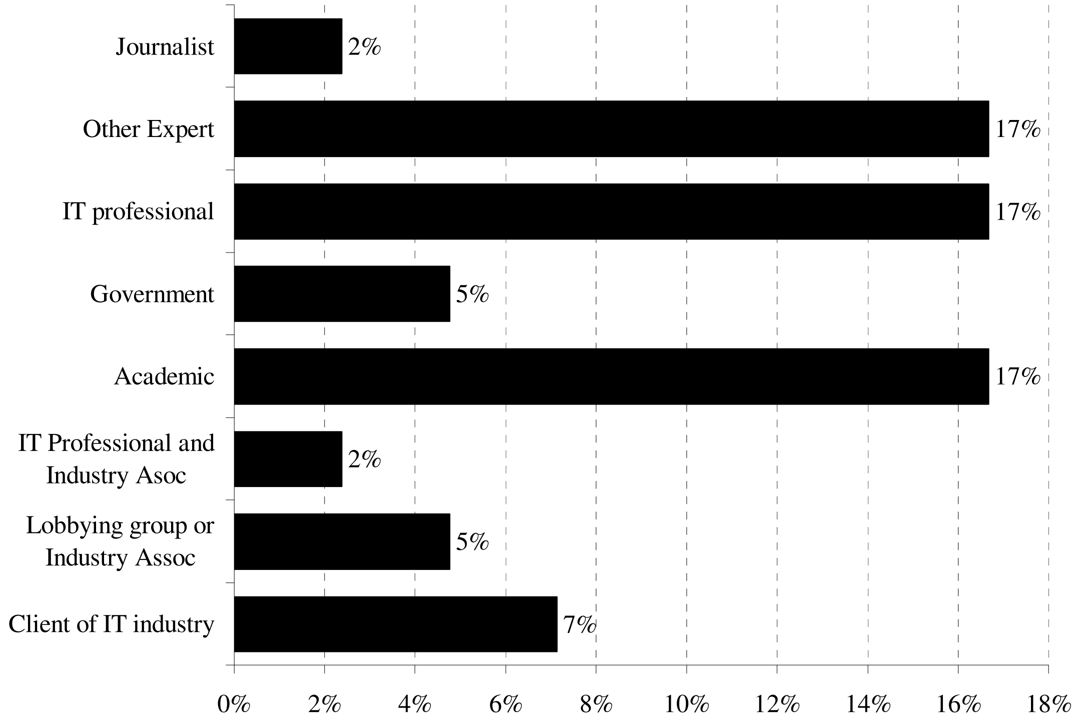
The second method used in the research for the project was designed specifically to answer RQ2 and RQ3d, or, in other words, to find out what explains the size and growth trajectory of the domestic market for SWIS and how it contributes to improved output or productivity. These are very different questions than those investigated with the first method. RQ2 and RQ3d necessitate the explanation of causal processes rather than the description of the nature or size of particular things. This points to the need for qualitative data of the sort that comes from the answers to open-ended questions (Blaikie, 2005: 203). For RQ2, the secondary research questions identify several sources of hypotheses, in particular those mentioned in the literature as being relevant to the current case study. However, the possibility that none of these hypotheses is the true answer is acknowledged. For RQ3d, the research question offers even less guidance as to possible answers. For these reasons, the method chosen had to be able to elicit new hypotheses. Again, it is a consideration which suggests unstructured, qualitative research.

Questions RQ2 and RQ3d are concerned with a social episode that occurs when domestic firms purchase SWIS from the sector. This means that there is a need for relevant words and terms to be made operational by reference to the experiences of those involved (Blaikie, 2005: 196). For example, D'Costa (2003) uses terms such as "global markets", "power" and "learning" to explain the size of the domestic market. Dahlman and Utz (2005) add "markets", "prices" and "endowments", amongst others. These, as well as many other concepts, only become relevant to IT firms or SWIS-buying firms when they interact with one another or with other relevant actors. In short, these terms are socially constructed; their meanings have been shaped by people's or firms' actions according to their subjective understanding of their circumstances, surroundings, and business processes. Identifying social actors' own understanding of their experiences and relationships was therefore a necessary step towards the objective of clarifying what the different terms meant, and determining whether they contributed to explanations that are important. Often this subjective understanding of words, terms, and explanations may not be conscious. The method chosen for these two questions, therefore, not only needed to seek new explanations and operationalise concepts in the literature, but also needed to uncover hidden mechanisms and meanings which define and describe the process of the domestic market emerging and the process by which it impacts on output and productivity. This is yet another reason for choosing qualitative research, and, in particular, it suggests the use of the method chosen: in-depth interviewing.

In-depth interviews involve private interviews in which the interviewee is considered to be the expert and the researcher the student. To avoid biasing the interviewees' responses, and consequently the data collected, the researcher must follow certain clear guidelines (Family Health International 2010). The first is that questions must be neutral, with the researcher both listening carefully to the respondent's answers and probing for clarification. Leading questions that test preconceived notions must be avoided, unless they are prompted by one of the respondent's earlier answers. Finally, the researcher must not express approval or disapproval of the respondent's answers. This method of in-depth interviewing has been identified as ideal for getting close to social actors' own explanations, meanings, and interpretations, provided that these guidelines are followed carefully (Blaikie, 2005:234). Interviews uniquely offer a great deal of scope for clarification questioning, and nuances, and contradictions can be fully investigated (Family Health International, 2010:30), even without the researcher being involved in the social episode being investigated and so taking the risk of influencing the phenomenon under investigation (Blaikie, 2005: 234). A final benefit of in-depth interviewing is that it offers an opportunity to discuss sensitive issues which might not get aired in the context of a focus group (Family Health International, 2010: 30).

The particular programme of interviewing for this project consisted of 30 interviews that took place between 19 January 2009 and 4 March 2009. Figure 4.7 shows the occupations of the people interviewed; the majority were directly involved in the domestic market either as IT professionals or as buyers of outsourced IT. However, various experts and commentators, including members of the Confederation of Indian Industry (CII) and NASSCOM, market research professionals, and several academics with experience of researching the IT sector were also included.

Figure 4.7: Breakdown of interviewees according to occupation



Admittedly, the group of respondents described in Figure 4.7 is neither a large nor a random sample. This is partly a necessary consequence of the choice to embark on a programme of qualitative research, as samples are always smaller in such studies (Blaikie, 2005: 205). Judgment was used to identify respondents so that the sample would be made up of professionals who, by virtue of their experiences, can speak more generally about different aspects of the domestic market. In particular, the sample was chosen to include experts on many of the SWIS-buying sectors in India, as well as IT executives with project experience in many sectors. In accordance with the guidelines set above, there was no set questionnaire for the interviewing process. Each respondent was asked a few questions about their own experiences, but was encouraged to take the conversation in directions which seemed relevant to them. It was not the intention of the schedule of interviews to provide a representation of the whole set of actors involved in the market for SWIS in India. However, when there was significant agreement from many respondents on causal processes relevant to the question, this was taken to be supportive of a more general relevance for those particular processes.

The interviews were recorded, then written as field notes, and eventually coded into categories based on possible answers to the two research questions. These categories were kept large and open in the first instance, as it was not the intention to distil the qualitative data into quantitative "metrics". A second round of re-categorisation was made of all of the respondent comments on eight causal mechanisms which might answer RQ2, and on seven processes which might answer RQ3d. For RQ2, some of these explanations/categories correspond to causal explanations given in the literature, whilst some arose from the answers given by the respondents themselves. For RQ3d, all of the categories came out of the interviews and consisted of processes suggested by the respondents themselves. In this way the explanations and processes which emerged from the analysis were grounded in the qualitative data collected.

4.2.3 Quantifying the scale of effects using secondary data

The third and final method is the analysis of secondary data using econometrics or other techniques. This was used in three ways to answer the research questions. The most important use was in a major econometric model which answers RQ3a-c on the impact of forward linkages from SWIS. Statistics on secondary data were also used to identify the extent of indirect linkages for RQ1b and to analyse the growth trajectory of direct forward linkages for RQ1a. These questions share some common characteristics. First, they are all concerned with providing descriptions rather than explanations, and they all require the quantification of specific metrics. Second, in identifying and measuring these quantities, answers must verify or falsify hypotheses that arose from the literature. For RQ3a-c, for example, the hypothesis which arose from the literature is that sectors that purchase SWIS experience increases in either output or productivity as a result of their investment. If the hypothesis is true, the chosen method must be able to identify that contribution and measure its size. The third similarity between the three questions is a requirement written into them to reach general macro-level conclusions.

These three considerations justify the choice of quantitative analysis of secondary data. The answer to RQ3a-c was investigated using firm-level econometric modelling in accordance with the literature on the impact of IT, as laid out in Chapter 2. The answer to RQ1b was addressed through analysis of input–output tables as suggested by Hirschman (1958), and the growth path of direct forward linkages was analysed using time series econometrics. These methods are designed specifically to quantify the size, extent, or rate of change of the metrics of interest, and they come with their own tools for assessing whether these can be classified as large or significant. Similarly, statistical tests exist for validating or rejecting hypotheses which must be verified or falsified in order to answer questions, and clear guidelines and rules exist for ensuring that these conclusions will be unbiased and robust. Quantitative work is more replicable than other methods, and this is important for understanding how quantities of interest change over time (Blaikie, 2005: 205), a consideration which is explicitly important for the answer to RQ1b. What is perhaps the most important advantage of quantitative work in this context, though, is its unmatched ability to support generalisations on the phenomenon under study at the macro level. Quantitative analyses like econometrics generally work with limited variables yet enough cases to inspire confidence that any findings are representative.

Of course, there is a trade-off with any choice of research method, and the quid pro-quo for attaining greater generality through pursuit of quantitative analysis is the need to resort to preconceived ideas about the nature of the social world and why it is the way it is (Blaikie, 2005: 242). For the research which used method 3, assumptions were made about the nature of processes involved prior to the research being carried out. For example, using firm-level econometrics to investigate RQ3a-c pre-supposed a particular form for the production function of firms in the sample. Using input–output analysis involved a similar assumption that the proportions of various inputs used in production of a particular good remain constant over time. To a large extent, assumptions like these, which formed a part of the research under method 3, were suggested by the literature and informed by other similar investigations. However, the research project sought to mitigate any problems with specific assumptions causing an incorrect basis for quantitative analysis in several other ways. The first was that method 3 was not started until after research using method 2 was completed. Immersion in the specific context and the process of carrying out qualitative research entailed much learning which helped to identify incorrect assumptions. This was especially true for RQ3a-c which sought to quantify the effects of a process which had already been explained through the pursuit of method 2—that of SWIS-buying firms and industries benefiting in terms of output or productivity as a result of their IT purchases.

As might be expected, the other strategies employed for mitigating possible issues with particular assumptions are very specific to the particular analyses undertaken using method 3. For that reason, the following chapters contain a more detailed explanation of assumptions, and a discussion of issues surrounding sampling, robustness and methodology alongside the results that arose from their pursuit.

4.3 Conclusion: A demonstration of diverse relevant research skills

This chapter describes the strategy followed for the research undertaken for this thesis. Section 4.1 outlined the ambitious aims for this research and identified how they follow from the discussions in chapters 1 through 3. Section 4.2 outlined the pros and cons and, ultimately, why and how the three methods to answer the research questions were selected. Section 4.2.1 examined the use of tertiary data to answer RQ1a, and Section 4.2.2 explained the use of in-depth interviewing to address the issues raised by RQ2 and RQ3d. Section 4.2.3 finished the discussion of methods by covering general issues surrounding the quantitative analyses needed to answer RQ3a-c and parts of RQ1.

The research undertaken to form the basis of this thesis was extensive and varied. It involved both collecting a wide range of data and the application of a diverse group of methods. The completion of this programme of research demonstrates a strong ability to carry out research on the part of this author, including the ability to select appropriate methods and data sources and the skills needed to carry out both qualitative research in the field and quantitative analysis. Within quantitative research, the project demonstrates a capability to carry out several different types of analysis, including a major econometric modelling exercise. Finally, the choice of tertiary analysis of existing research as one of the methods demonstrates an aptitude for evaluating and triangulating existing research to assess its value and strength.

But this is not the only or even the most important benefit of analysing several sets of data using several different methods. More important are the implications that the strategy has for the project's ability to uncover new facts about the subject, and to understand the consequences of those new facts. In this respect, diversity is vital because it matches appropriate methods to questions and because it confers confidence in the findings. If many different analyses of many different sets of data all point towards SWIS being a leading sector in India, it is possible to conclude with confidence that this is, in fact, true.

The remaining three chapters outline, in turn, the evidence that has been collected on the three research questions; in doing, so they provide original contributions to this subject. Chapter 5 describes the results on the first research question. It covers the current evidence on linkages from SWIS-ITES-BPO into the Indian economy.

5. Results: Evidence of extensive linkages

> "The domestic market is big now. Ten billion dollars per year in software and IT services is not to be sneezed at."
>
> Rajdeep Sarawat (Interview with author, 22 January 2009, Delhi)

This chapter describes the evidence that extensive forward linkages from the SWIS sector have emerged in India and continue to grow quickly. It is an exciting new finding because it means that there is a possibility that the gains in output and productivity which developed countries experienced when they began to use IT[37] might also be achievable in India. If this does occur, the fact that the amount spent in India on SWIS from the IT sector is now large (at around US$10bn in 2008-09 and US$14.6bn in 2010-11) means that these gains might be sufficient to impact outcomes at the macroeconomic level[38]. This chapter contains good news for other types of linkages, too. The extent and growth rate of other linkages is not as dramatic as that of forward linkages, but other linkages do exist and they have an impact on economic outcomes in India. The stimulus to the economy arising from SWIS sector purchases, combined with the domestic purchases of IT sector workers, was estimated between 2% and 3% of India's GDP in 2005. Importantly much of this impetus was felt amongst low-skilled workers, and partially felt amongst even the most disadvantaged.

It is a set of results which has serious implications for the literature that was reviewed in Chapter 3. This current research reveals that, contrary to widely held views, the IT sector is neither disconnected from India's economy nor can it be described as an enclave. Backwards and other linkages have begun to emerge showing that the

[37] As outlined in Chapter 2.

[38] The impact of forward linkages on India's firms, industries and macro economy are discussed in Chapter 7.

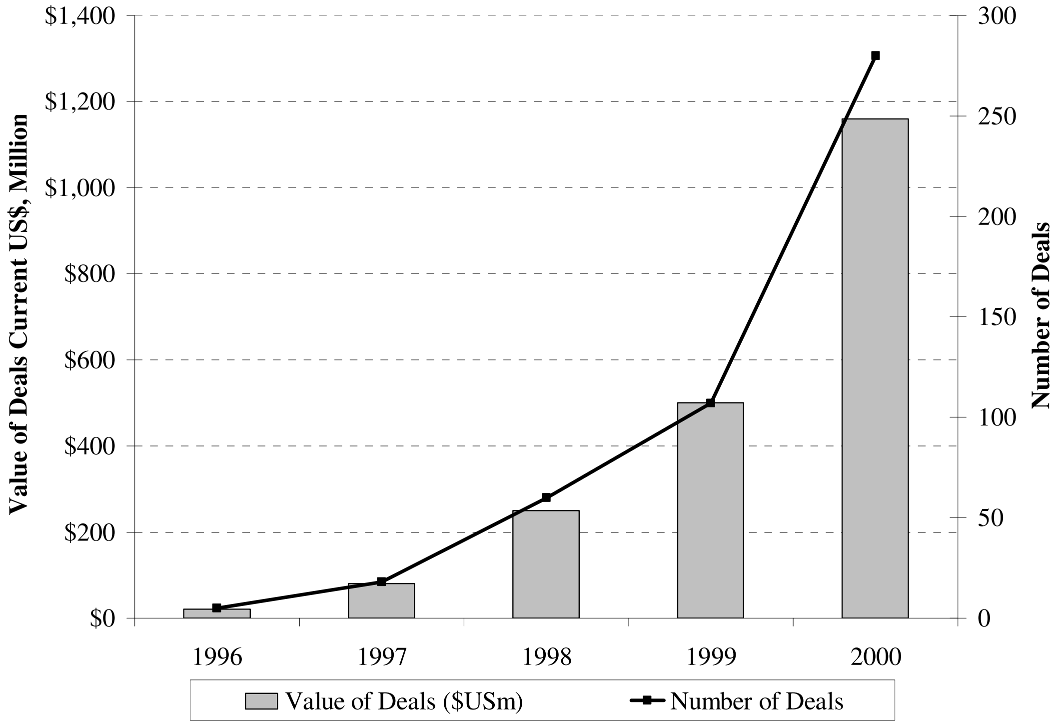
literature which described them as virtually non-existent is now out-of-date. With IT firms actively implementing SWIS solutions in Indian firms on a large and ever-increasing scale, the literature which described the domestic market as “inadequate” (Kumar and Joseph, 2005: 99) or “neglected” (Heeks, 1996: 72) is misleading and far too pessimistic. If it was published after the late 1990s, this literature is also guilty of carelessness. Since the 2000s, the domestic market for IT has been substantial, and since 2005-06 it has been growing at a rate of over US$1bn per year.

The rest of this chapter is divided into two main sections which present the new evidence collected on different types of linkages. Section 5.1 contains a synthesis of evidence on backwards and miscellaneous other linkages. Section 5.2 presents a wide variety of previously undetected or ignored data and two new secondary analyses on the extent of forward linkages. Section 5.3 concludes with a call for research on the causes of growth in forward linkages and their impact.

5.1 Backwards linkages are now visible and important

On backwards linkages, Section 3.2.1 concluded that the only unambiguous positive linkage was to the emergence of the venture capital industry (Kenney and Dossani, 2005). NASSCOM and Delloite (2008: 19) updated the data on the size of this industry. They found that investment into Indian companies by either venture capitalists or other forms of private equity has grown from 5 deals worth US$20m in 1996 to 280 deals worth US$1.2bn in 2000 (see Figure 5.1). It is a significant expansion, and one that has been led by deals in the IT sector with 66% of deals in 2000 focussed on IT.

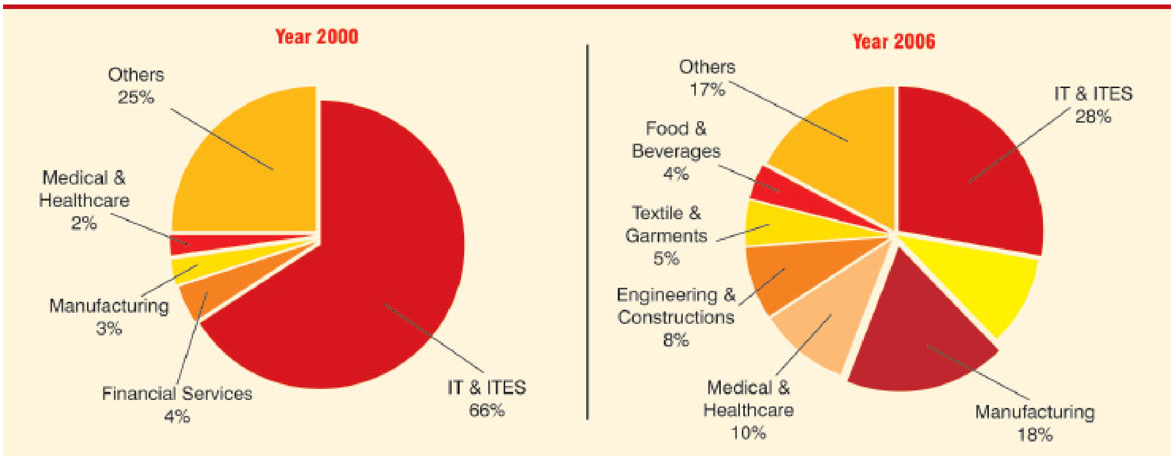
Figure 5.1: Private Equity and Venture Capital Funding in India



Source: NASSCOM and Delloite (2008: 19).

The continued expansion of venture capital in India has begun to provide investment into other sectors (see Figure 5.2). Between 2000 and 2006, private equity and venture funding has provided investment funding for manufacturing, engineering and construction, medical and healthcare, and food and beverage ventures, amongst others. This investment has undoubtedly helped to fund expansion in these other sectors.

Figure 5.2: Venture Capital and Private Equity Investment by Sector in 2000 and 2006



Source: NASSCOM and Delloite (2008: 19)

On the question of other backwards linkages from the IT sector, the traditional literature was particularly pessimistic. Far from providing the opportunities for domestic entrepreneurship envisaged by Hirschman (1958), Heeks (1996: 19) identified the sector as one whose backwards linkages were predominantly to firms and entrepreneurs abroad. According to Heeks, the problem was not only that the hardware used in the sector was generally imported, but also that the sector's other expenditures were predominantly sourced abroad. Heeks argued the most obvious reason for this pattern was the practice of delivering IT work onsite through "bodyshopping". With this mode of SWIS delivery Indian engineers travelled to Europe or the United States to work for foreign firms alongside the firms' existing employees. This meant that the sector's purchases on items related to travel, marketing, and living expenses took place in the host country rather than in India (p. 75-76). Updating Heeks's analysis reveals a change in the mode of delivery of SWIS. Between 1996 and the present, bodyshopping, or onsite service provision, has largely been replaced by the offshore model (Athreye, 2005: 7; Desai, 2003: 10, 13). Now, the majority of Indian IT firms provide their IT services from within India, and SWIS, in particular, is delivered remotely via the Internet and email, and supported by telephone. This new pattern has created a demand for local supplies of all kinds of products and services, thereby diminishing the extent of the IT sector's foreign exchange expenditures. Of these expenditures, Kumar (2005: 107) confirms that net foreign exchange earnings by the sector have been increasing as a result of a downward trend in imports. He found that between 1996 and 1999, around the same time that bodyshopping began to be replaced by offshoring, the share of export revenues being spent on imports fell from 55% in 1996 to 48% in 1999[39].

A recent study conducted by NASSCOM and CRISIL (2007) provides details on the extent of the IT sector's spending in India. The study begins with a survey on a random sample of SWIS and ITES-BPO firms to ascertain their operating expenditures on different inputs in India and abroad. The results of this survey is verified and validated against known industry-level facts and costs, and found to be within acceptable margins of comparability (p. 21). The study also includes an analysis of a sample of IT companies' balance sheets to understand the extent of domestic capital expenditures. These expenditures are then apportioned into different categories and verified against well-known costs of buildings, furniture, hardware, and so forth. The two sets of findings, one on operating expenditures and one on capital expenditures, are then scaled up from the sample estimates in a bid to reflect the expenditures of the whole sector. Figure 5.3 illustrates the results of this exercise; and it shows that, according to NASSCOM and CRISIL's estimates, in 2005-06 only 16% of items purchased by the IT sector were imported, with the remainder split

[39] Clearly there is a need for further research on this issue to update these figures.

amongst a wide variety of domestic industries, including construction, communications, travel, and transport.

Figure 5.3: Domestic and Foreign Expenditures by SWIS and ITES-BPO Sectors in 2005-06

	SWIS & ITES-BPO Expenditures (Rs Bn)	%
Transport	15.3	3.4%
Equipment Maintenance	9.5	2.1%
Buildings Maintenance	11.5	2.6%
Security	2.4	0.5%
Catering	6.6	1.5%
Legal and Accounts	8.3	1.9%
Recruitment	10	2.2%
Training	12.8	2.9%
Travel	21.5	4.8%
Communication	28.1	6.3%
Insurance	4.2	0.9%
Printing & Stationery	3.5	0.8%
Power and Fuel	8.2	1.8%
Other OPEX	168.1	37.8%
CAPEX on Construction	41.2	9.3%
CAPEX on IT infrastructure	9.1	2.0%
CAPEX on Furnishing	13.7	3.1%
Total Domestic	**374**	**84.0%**
OPEX and CAPEX Spent abroad	71	16.0%
Grand Total	**445**	**100%**

Notes: Adapted from NASSCOM and CRISIL (2007: 9, 10, 20, 21, 24).

The NASSCOM and CRISIL study goes on to estimate the impact of the expenditures in Figure 5.3 on total output in India. The expenditure figures are fed into the input–output equations published in tables for 1998-99 (which was the latest available at their time of writing)[40]. The total output impact of the IT sector's expenditures are then simulated by identifying the expansion of output required in the sectors in Figure 5.3 (direct linkages) and the expansion required to provide inputs for those sectors

[40] One methodology for using input–output tables to assess the extent of direct and indirect forward linkages in discussed in Section 5.2. It is likely that NASSCOM and CRISIL (2007) used a similar approach to assess the extent of backward linkages.

(indirect linkages). The results of this simulation on total output are presented in Figure 5.4.

Figure 5.4: Output Impact of Backwards Linkages from SWIS and ITES-BPO Sector in 2005-06

	SWIS & ITES-BPO Expenditures (Rs Bn)	Output Multiplier from I-O System	Total Output Effect including Direct and Indirect (Rs Bn)
Transport	15.3	2.17	40.9
Equipment Maintenance	9.5	1.98*	17.7
Buildings Maintenance	11.5	1.98*	21.5
Security	2.4	1.98*	4.5
Catering	6.6	2.13	14.0
Legal and Accounts	8.3	1.98*	15.5
Recruitment	10	1.98*	18.7
Training	12.8	1.23	15.8
Travel	21.5	2.17	46.7
Communication	28.1	1.27	35.9
Insurance	4.2	1.53	6.4
Printing & Stationery	3.5	2.20	7.7
Power and Fuel	8.2	2.29	18.6
Other OPEX	168.1	1.98*	313.93
CAPEX on Construction	41.2	1.96	80.8
CAPEX on IT infrastructure	9.1	2.12	19.3
CAPEX on Furnishing	13.7	1.91	26.2
Total Domestic	374	1.88	704.0

Source: NASSCOM & CRISIL 2007:25
Notes: OPEX refers to operating expenditures, CAPEX to capital expenditures. * This output multiplier is from the "All other services" category in the input–output tables; I–O = input-output.

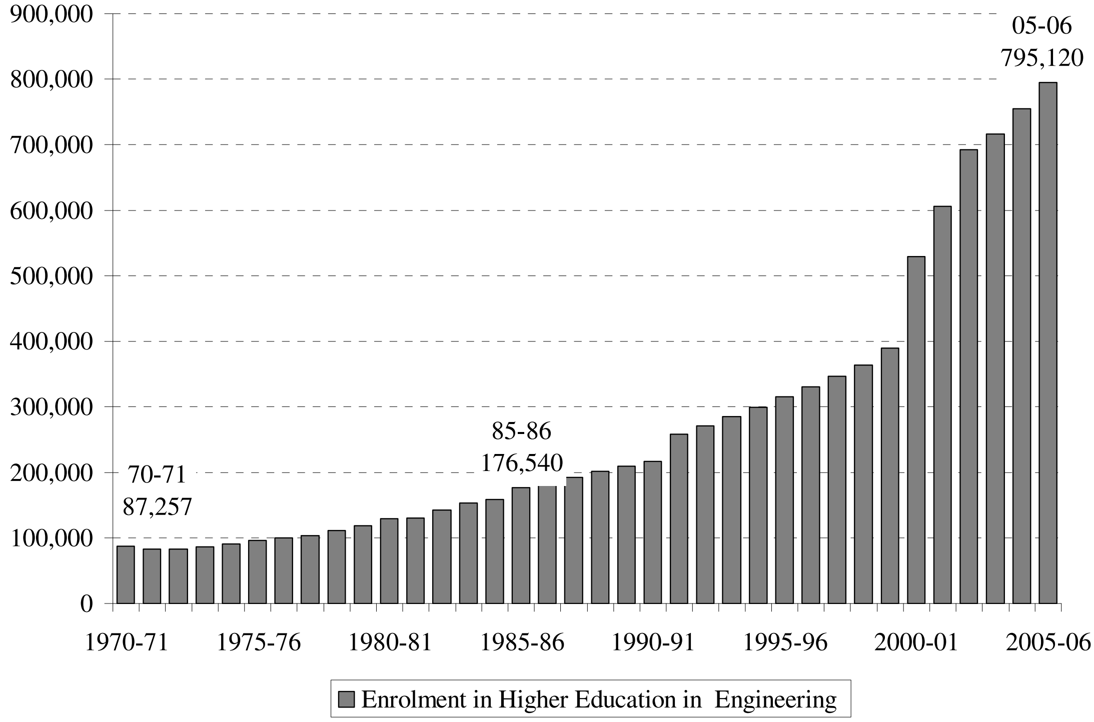
The study discovered that several of the domestic industries that the IT sector purchases from are themselves fairly high spenders in the domestic economy. Overall, for every 1 rupee spent by the SWIS-ITES-BPO industry, another 0.6 rupees accrues somewhere in the Indian economic system. To put these figures into context, this author has calculated that the total output effect from backwards linkages from the SWIS-ITES-BPO industry of Rs. 704bn is equivalent to roughly 2% of GDP in 2005[41].

There is one other backwards linkage which is not included in the above analysis by NASSCOM and CRISIL (2007), despite that study's thorough consideration of expenditures by IT firms. This is the education industry which has matured as a result

[41] Calculation uses NASSCOM and CRISIL (2007: 25) and World Development Indicators (2010).

of the industry's ongoing demand for qualified staff and the consequent need for potential IT workers to be trained. As mentioned in Chapter 2, the type of training which is most useful for a career in IT is an advanced education in engineering, or specific courses on information technology itself. Since the IT sector's inception in the country, India's output of these graduates has increased rapidly. Both public and private education establishments have expanded, with the private sector providing paid training for IT sector jobs, and the government filling in the gaps with affirmative action for disadvantaged castes (Carnoy, Dossani, and Tilak1, 2010: 2). As a result, Indian colleges and universities now produce 300,000 technical graduates every year (p. 2), a figure which outstrips the output of every other country in the world except China. Enrolment on these courses in India is continuing to rise. Figure 5.5 illustrates a growth rate in engineering education higher than that of any other country (p. 1). Not surprisingly, this growth is then reflected in the country's stock of technical graduates. In the 15 years between 1990 and 2005, the number of graduates with engineering training in India more than doubled, from 500,000 to 1.2million (p. 55).

Figure 5.5: Enrolments in Higher Education in Engineering

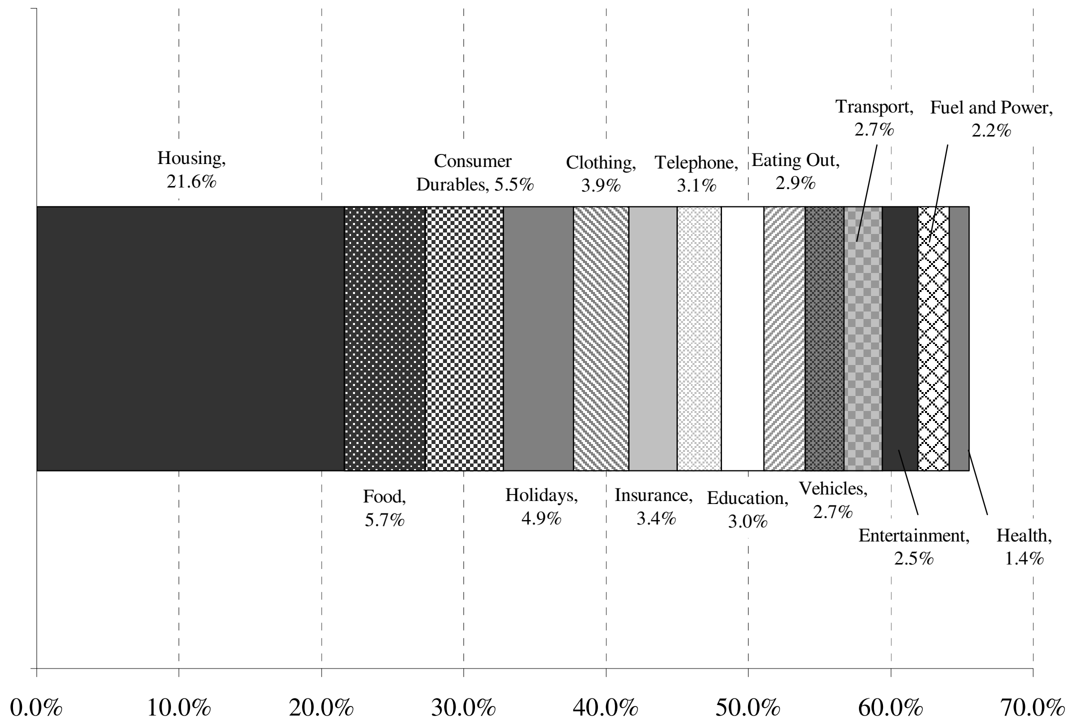


Source: Carnoy, Dossani, and Tilak1, (2010: 68).

In 2006-07, there were a total of 2,264 public and private institutions providing degree or other advanced technical qualifications in India. Between them they educated approximately 833,000 students for annual fees of between Rs 23,000 and Rs 72,000 (or between US$500 and US$1,750), depending on the school and its location (Carnoy, Dossani, and Tilak1, 2010: 44, 45). It is a large industry, and in engineering, where 85% of the students attend private colleges, it is one which is using only a small proportion of government funding (p. 16).

The news on backwards linkages from IT workers' purchases is also hopeful, according to NASSCOM and CRISIL's study. They estimate the impact of spending by SWIS-ITES-BPO sector employees in a separate analysis whose results are reported in Figure 5.6. NASSCOM and CRISIL used a similar methodology to the one just described. First, they conducted a survey amongst SWIS-ITES-BPO workers to understand their consumption amongst various categories of consumption goods, durable goods and services. Then they used these expenditures and the input–output equations to simulate total output arising as a result of these purchases. The survey found that SWIS-ITES-BPO workers have a younger demographic profile and earn a higher wage than the average worker in India, with the majority being 22–30 years old and 83% being single (p. 6, 23). Perhaps because of this demographic profile, a large proportion of their expenditure was on items that could be considered luxuries. Entertainment, holidays, and eating out used over 10% of all expenditures by respondents in the survey. Consumer durables also accounted for 5.5% of expenditures by this group, and vehicles 2.7%.

Figure 5.6: Consumption Expenditure by SWIS and ITES-BPO workers by Category of Purchase



Source: NASSCOM and CRISIL (2007: 28).
Note: Spending is shown as a percentage of total income, not disposable income. The percentage for taxation and other deductions are not shown.

Figure 5.7 covers the analysis on how these expenditures impact output in the Indian economy. NASSCOM and CRISIL calculated total domestic expenditures, reported in the third column of the table, by applying the above expenditure shares to the SWIS and ITES industries' total wage bill (net of taxes) for workers living in India. They then calculated output multipliers using the input–output tables, and multiplied the output multipliers by total domestic expenditures to establish the total output impact in the economy as a whole from IT workers' spending.

Figure 5.7: Output Effect of Consumption Spending by SWIS-ITES-BPO Sector Workers

	Output Multiplier	Domestic Spending by SWIS-ITES-BPO Sector Workers (Rs. bn)	Total Output Impact (Rs. bn)
Housing	1.96	84.20	165.1
Cars and Vans	2.48	7.80	19.4
Motorcycles and Scooters	2.43	2.80	6.9
Consumer Durables	2.61	17.20	44.9
Food Items	2.48	22.30	55.3
Clothing	2.44	15.10	36.9
Fuel and Power	2.29	8.50	19.5
Telephone	2.3	11.90	27.5
Transport	2.17	10.60	23
Education	1.23	11.90	14.6
Health	2.37	5.70	13.4
Insurance	1.53	13.40	20.4
Eating Out	2.13	11.20	23.9
Entertainment	1.98	9.70	19.1
Holidays	2.09	15.60	32.7
Other	2.32	11.70	27.2
Total		259.80	550

Source: NASSCOM and CRISIL (2007: 26).

In Figure 5.8, NASSCOM and CRISIL complete their analysis of backwards linkages arising from IT workers' consumption by mediating the figures in Figure 5.7 to reflect that these workers would most likely have been employed elsewhere had the SWIS-ITES-BPO sector not existed. They offer three scenarios for the extent of incremental consumption based on three assumptions, detailed in the table, about SWIS-ITES-BPO workers' next-best job if the sector did not exist. For the middle assumption that SWIS-ITES-BPO pays Rs. 200,000 (US$4,540) above the workers' next-best option, this author has calculated that the consumption spending of SWIS-ITES-BPO workers contributes a total of Rs. 204bn (US$4.62bn), or a further 0.6% of 2005 GDP.

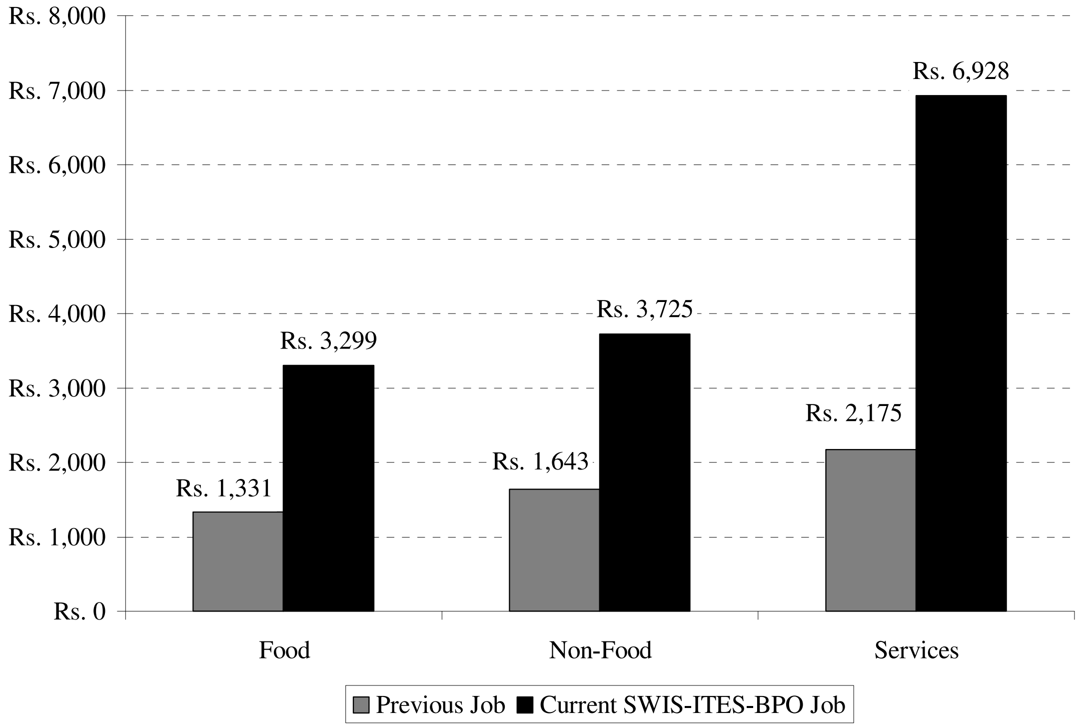
Figure 5.8: Output Effect of Consumption Spending by SWIS-ITES-BPO Sector Workers in 2005-06, for Different Second-Best Job Scenarios

	Incremental Consumption Spending from SWIS-ITES-BPO (Rs Bn)	Total Output Impact (Direct and Indirect) (Rs Bn)
IT/ITES workers have no second-best job	260	550
IT/ITES workers' second-best job pays Rs 200,000 less than current job	96	204
IT/ITES workers' second-best job pays Rs 100,000 less than current job	48	102

Source: NASSCOM and CRISIL (2007: 29).

Joshi (2009) provides some verification for these findings. She conducted a survey amongst 100 households and 20 SWIS-ITES-BPO firms in Gurgaon, Haryana. It is a study which specifically set out to identify the impact of spending by SWIS and ITES-BPO workers on production demand in other sectors and, consequently, on GDP growth (p. 23–24). While Joshi's sample is fairly small and geographically concentrated, her method does allow for a more in-depth understanding of how consumption changes when a worker goes from a non-IT job to an IT job. Her survey of SWIS-ITES-BPO workers recorded changes in household expenditures between the respondent's current IT sector job and their previous job. Figure 5.9 details these results, and it shows that the largest increments in expenditure after getting a new job in the SWIS-ITES-BPO sector are in the services industries, whilst the smallest increments are in expenditures on food.

Figure 5.9: Average Monthly Food, Non-food, and Services Expenditure in SWIS-ITES-BPO job versus Previous Work



Source: Joshi (2009: 39).

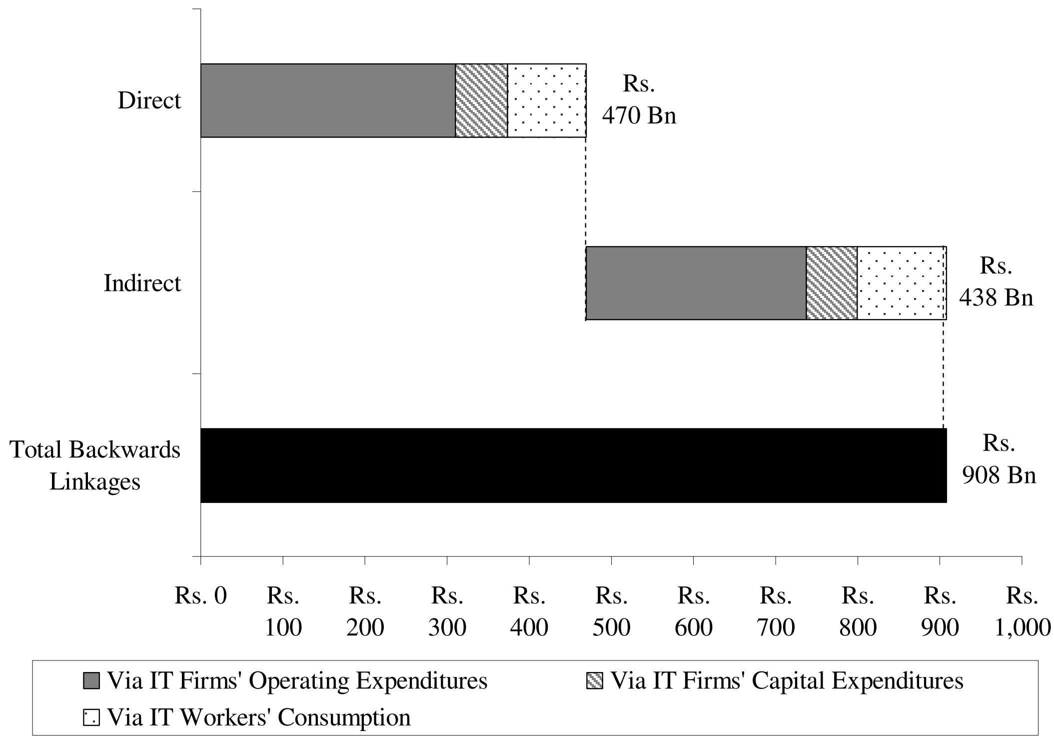
In Joshi's sample, these additional expenditures amount to roughly Rs 8,000 (US$185) per month, or Rs 106,000 (US$2,450) per year. In 2008-09, there were 1.6m SWIS and ITES-BPO workers in India (p. 39). If each of these were represented by the figures arising from the sample[42], this would constitute Rs 170 Bn (US$3.9bn) of direct expenditures arising from IT workers' consumption patterns. This figure is not directly comparable to those in the first column of Figure 5.7 because it is based on a later year than NASSCOM and CRISIL's study, but it is quite close to their estimates of SWIS–ITES-BPO workers' expenditures. This author applied NASSCOM and CRISIL's total output multiplier to Joshi's figure of Rs 170 Bn. This gives a total output effect of IT workers' consumption expenditures, once indirect linkages have been taken into account, of approximately Rs 360 Bn (US$8.3bn), or

[42] This is an heroic assumption, but one which is maintained in Joshi's macroeconomic estimates (Joshi 2009: 39).

0.75% of 2008 GDP[43], a figure which is broadly comparable to the 0.6% found for 2005 based on NASSCOM and CRISIL (2007).

Having provided verification of their figures, this author carried through NASSCOM and CRISIL's estimates to a total output effect (see Figure 5.10). It is based on the middle assumption for consumption expenditure that SWIS-ITES-BPO pays Rs 200,000 (US$4,540) more than workers' next-best option. The total output impact of linkages is Rs 908 Bn (US$20.6bn in 2005), or a total of 2.6% of India's GDP.

Figure 5.10: Domestic Output from IT Firms' and Workers' expenditures in 2005-06 (Rs. Bn)



Notes: Adapted from NASSCOM and CRISIL (2007: 9, 10, 29).

The NASSCOM and CRISIL study is not the only piece of recent evidence that makes use of India's input–output tables to identify the impact of the IT sector on the wider economy. The Department for Information Technology's e-Readiness Assessment Report for 2006 (2006: 19–22) follows a similar methodology to identify the impact of the IT sector on social outcomes. The report does not outline the results of

[43] Authors calculations based on Joshi (2009: 39).

intermediate steps in the process, such as the ones of interest around linkages between sectors, and it is not entirely clear from the discussion on the analysis whether the linkages included are exactly those in the NASSCOM and CRISIL study. Despite this lack of comparability, the Department of Information Technology's research does offer some validation for the finding that the total impact on output from the sector is substantial. Using data from 1999, they find that the total output effect of the sector is Rs 1066 Bn., or 5.4% of 1999 GDP. To triangulate this figure with that arising from the NASSCOM and CRISIL study, this author netted out the direct effect of IT output on GDP in that year[44] from this figure. This revealed a total contribution to GDP from linkages of 3.7% of GDP. If anything, this suggests that the estimate based on 2005 data in NASSCOM and CRISIL (2007), of 2.6%, is an underestimate of the extent of linkages.

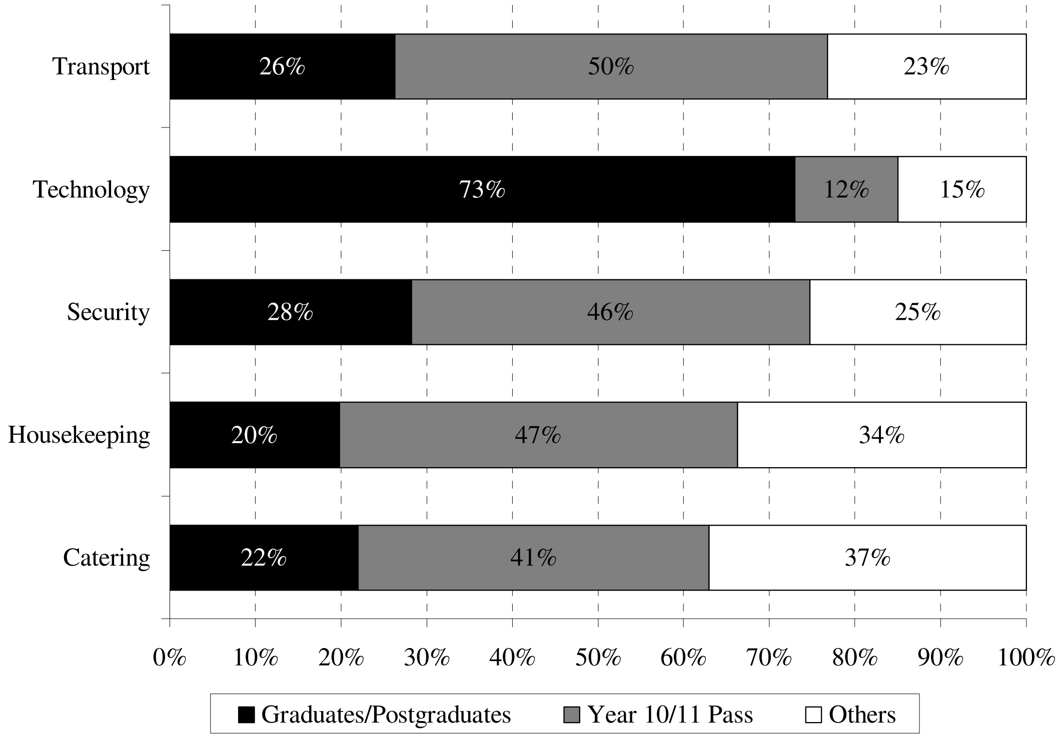
It is an encouraging picture, and one that seems to be reflected not only in quantitative effects of employment in the sector, but also in qualitative aspects. Contrary to D'Costa's (2003: 215–216) gloomy conclusion that only the middle and upper classes can expect improved livelihoods as a result of the sector's existence, current research shows that IT firms' and workers' demand for goods produced in India also leads to employment for low-skilled and poor workers. Perhaps the most extreme example of this comes from Olsen et al (2010), whose research on livelihoods in the slums in Chennai focuses on a group of people with significant "accumulated disadvantages" (p. 3–4). They find that as a result of the 2009 worldwide credit defaults and a consequent decline in IT exports, demand for goods and services produced in the slum communities declined considerably. In particular, construction, automobile

[44] Revenues to the IT sector amounted to 1.7% of GDP in 1999 (see Figure 3.3 in Section 3.2).

manufacturing, transport, and domestic services, as well as street vending, and laundry by workers in the slum were impacted (p. 7). This demonstrates that, before the decline in the world economy set in, linkages from IT firms and workers were providing jobs for poor and uneducated workers in the slum communities that Olsen and colleagues visited. It is a finding that is verified in two of the analyses of linkages already covered in this section. Joshi's (2009: 39) survey of SWIS-ITES-BPO workers in Gurgaon included a question about hiring lower-skilled workers within their households. She found that, on average, for every one SWIS or ITES-BPO worker, 0.5 domestic low-skilled workers were employed. NASSCOM and CRISIL's study included an assessment of employment arising from linkages outside of IT employees' households. They repeated the entire methodology detailed above, but used employment rather than output multipliers from the 1998-99 input–output table. They found that following the same assumptions as those which led to the numbers in Figure 5.4, the SWIS-ITES-BPO sector was responsible for a total of 3.64 million workers outside the IT sector in 2005-06. This translates to a 2:1 ratio: overall; there are 2 additional workers in the economy for every one worker directly employed by the IT sector[45]. NASSCOM and CRISIL's methodology identifies which sectors these workers were employed in. These are predominantly catering, housekeeping, construction, security, technology, and transport. Figure 5.11 details the skill profile and the level of education of the employees in these sectors. It shows that the majority are educated only to high school level or below.

[45] Authors calculations based on NASSCOM and CRISIL (2007: 9, 10, 29) and NASSCOM (2009b).

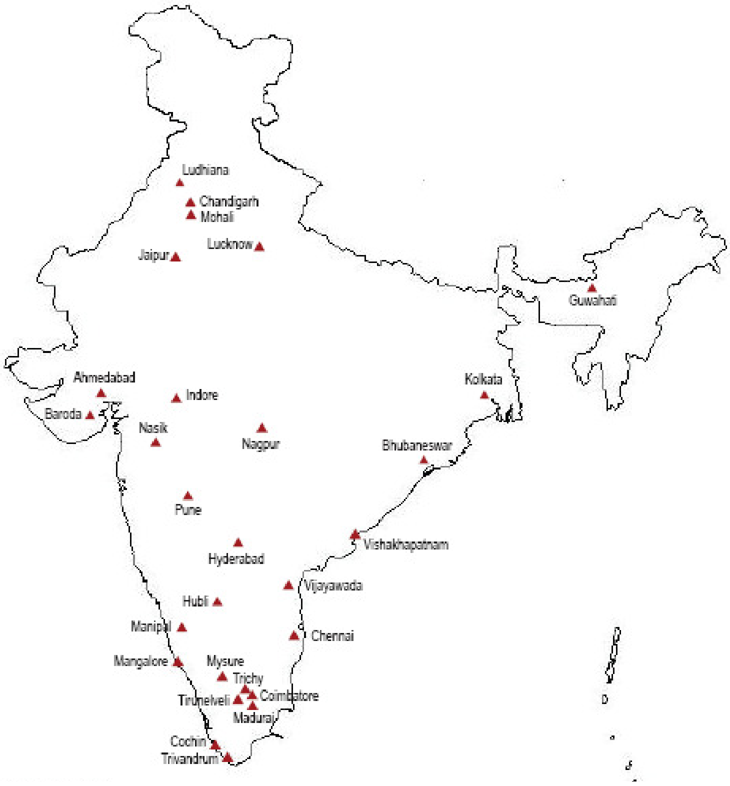
Figure 5.11: Education Profile in Sectors that are Backwards Linked to IT in 2005-06



Source: NASSCOM and CRISIL (2007: 31).

As the IT sector has continued to expand in revenue terms, it has also expanded its presence outside of the relatively wealthy areas in the south of India, which was its original geographical base. This is an important development because it means that the geographical inequality associated with the industry, lamented in the literature (D'Costa, 2003: 215), is beginning to abate. The impetus for geographical expansion has occurred because of tight labour markets in the first cities which provided a base for the IT sector, Bangalore and Mumbai. It has also been enabled by the fact that SWIS is "weightless" and costs little, if anything, to transport to its final customer (Quah, 2001). According to NASSCOM and Delloite (2008: 1), there are now 28 cities which host an IT industry as a result of this process. Figure 5.12 maps these secondary cities.

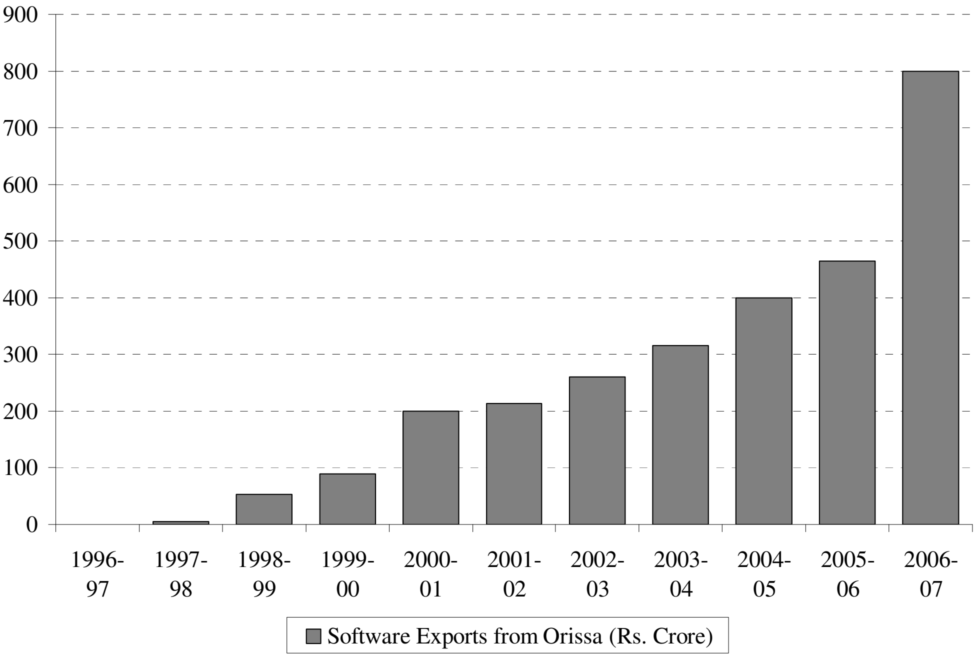
Figure 5.12: Secondary cities which host an IT industry in 2008



Source: NASSCOM and Delloite (2008).

NASSCOM and Delloite offer a case study of one of these cities, located in one of India's poorest states in the north-west of the country. Bhubaneswar is situated in Orissa, which according to World Bank (2006b) is the second poorest state in India (p. 43) and has a proportion of the population below the poverty line similar to that of many sub-Saharan African countries (p. 45). Despite this, the top four largest IT companies (Infosys, TCS, Wipro, and Satyam) have offices in Bhubaneswar and, as Figure 5.13 illustrates, the region has grown into a substantial exporter of SWIS. Exports from Orissa have grown at a compound annual rate of 176% between 1997–98 and 2006–07, and growth in the most recent year in the study was more than double the national average rate (NASSCOM and Delloite, 2008: 1). By 2006–07 exports from Orissa had reached Rs 800 Crore, or nearly US$200m.

Figure 5.13: Software Exports from Orissa



Source: NASSCOM and Delloite (2008).

Given this exponential growth in export revenues, the sector in Orissa has experienced similar growth in employment. Direct employment of SWIS-ITES-BPO professionals has grown at a compound annual growth rate of 206% between 2001 and 2007; and NASSCOM and Deloitte forecast that the sector will employ 430,000 people by 2011–12 (2008: 1). Added to this substantial difference in job opportunities is the further stimulus arising from the sector's demand for ancillary services. Using methods similar to those of NASSCOM and CRISIL (2007), NASSCOM and Deloitte (2008:1) estimate that these backwards linkages will provide another 1.7 million jobs by 2011–12, primarily in sectors like security, transport, housekeeping, and catering.

There are two more linkages from the IT sector which are likely to have a general beneficial effect on other sectors in India. The first of these is that the "brain drain" bemoaned by Heeks in 1996, discussed in Section 3.4.1, has begun to slow down and even, in places, begun to reverse into "brain gain" (Chacko, 2007) or "brain circulation" (Commander, 2008; Saxenian, 2005). For example, a survey by Vonderheid of Indian-born IT professionals in Silicon Valley in the United States finds that more than 50% of these professionals would consider returning to India, and 45% "probably would return home" (2002: 1). Authorities in developed countries changed their visa-issuing strategies during the 1990s, from offering permanent visas to offering temporary stays. This tactical change applied to the H1-B skilled worker visa which is frequently used for IT workers emigrating from India (Sasikumar and Hussain, 2008: 5), so it is likely to be an important determinant of return migration. It is also true that Indian-born IT workers in the United States and other developed countries now see India as a more desirable place to live and work than they once did. They return because of improving opportunities within the IT sector in India and because there are now jobs for them within other public and private sector organisations which are increasingly using IT technology (p. 1). A senior recruitment professional who participated in an in-depth interview as part of this current project said that, for many senior positions, salaries in India are now comparable to those that can be earned in the United States. This enables return migrants to experience the personal life benefits of being based in India without experiencing a loss of earning power. For many older professionals who have been in the industry for 10–15 years, and now wish to raise children in India, return migration is often sought to be close to family (Kris Lakshmi, 23 February 2009, Bangalore).

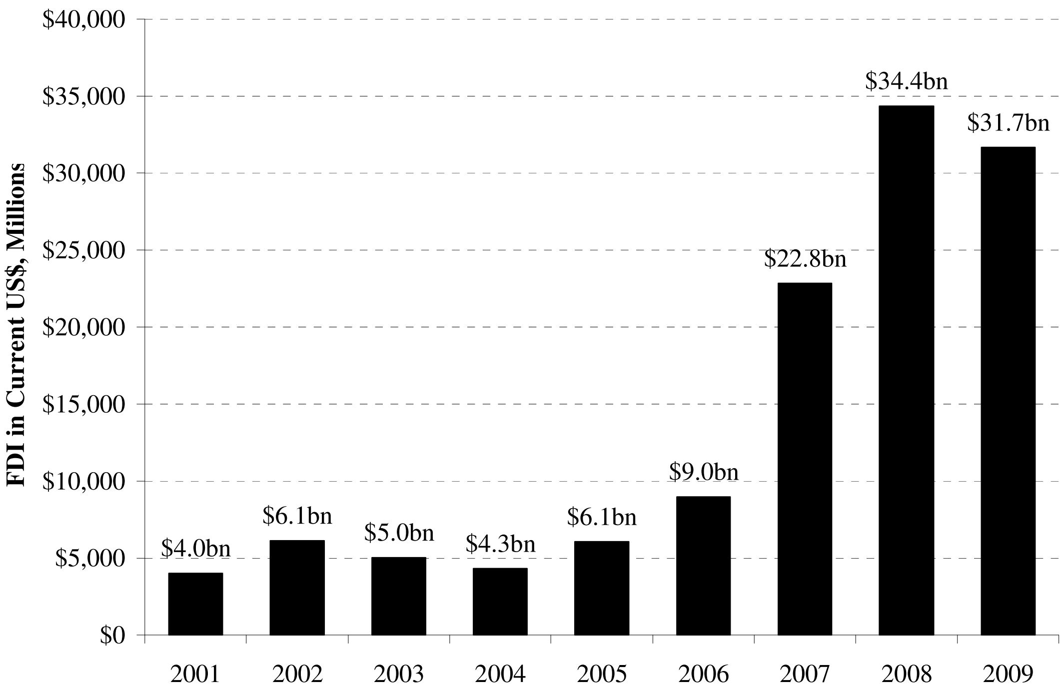
Backwards linkages arising from the expenditures of return migrants is one obvious route through which this "brain gain" phenomenon could have a beneficial impact on other sectors in India. However, there are also several other possibilities. Return migrants often bring new skills and new knowledge home. This is particularly important because in many cases knowledge on technologies like IT is tacit and complex and so difficult to diffuse. This means that returning migrants that embody the tacit knowledge required can play an instrumental role in assisting firms to expand their services in new areas (Song, Almeida and Wu, 2003). On top of this *human* capital contribution to their home economy, returning migrants often bring *social* capital in the form of contacts with developed country firms, organisations or residents and *financial* capital in the form of saved earnings from their years abroad. This offers returning migrants the opportunity to become entrepreneurs and many run successful businesses in IT and other industries (Saxenian 2005).

The other, more general linkage from the IT sector's activities comes from the solid reputation that India's IT industry has built for itself in export markets. By 2008, nearly 75% of the Fortune 500 and 50% of Global 2000 corporations source their technology-related services from India. Indian IT firms have also been listed on global stock markets and have even purchased successful companies in developed countries (NASSCOM and Delloite 2008: 21, 24). This has led many commentators to point to the IT sector as an exemplar of what India can achieve. For example, the India Brand Equity Foundation (IBEF), whose mission is to "to promote and create international awareness of the Made in India label in markets overseas"[46] cites the IT industry has having "played a key role in putting India on the global map"[47]. It is a trend which has filtered through to attitudes in developed countries. For example, Kamp reports the comments of a London-based executive at a French bank: "In Britain, non resident Indians can hardly believe what is happening. 'Made in India' is not just respectable but before anyone knew it, sought after. What has made a

[46] http://www.ibef.org/aboutus.aspx (Accessed 16th January 2011)
[47] http://www.ibef.org/industry/informationtechnology.aspx (Accessed 16th January 2011).

difference is that people know now what we are capable of. Earlier they thought India is the land where their curry came from" (2003: 1). All of this good news on India has been highlighted as an important contributory factor in the vigorous increases in the flow of foreign direct investment (FDI) to India (Kumar 2005: 114; Miller 2001: 21). Whilst it is outside the scope of the current work to identify the numerous benefits that these investments into India may have on other sectors, Figure 5.14 reveals the investments have indeed been substantial.

Figure 5.14: FDI into India



Source: World Development Indicators (2010).

Overall, the synthesis provided in this section of the new evidence on backwards and miscellaneous other linkages reveals a far more positive picture than that painted by the literature discussed in Chapter 3. Despite the pessimistic outlook given there, the IT sector's recent history has revealed many beneficial and wide-ranging impacts arising from its continued growth. This section has demonstrated that backwards linkages from SWIS–ITES-BPO have become important in the Indian economy. Not only have IT firms begun to purchase a large proportion of their inputs within the Indian economy, but the sheer size of their workforce has swelled sufficiently to become a significant force in terms of consumption demand. Together, these two effects have contributed a macro-level output effect between 2% and 3% of GDP, which is on top of the direct earnings of the sector (6.2% of GDP in 2010-11). Perhaps even more encouraging, the distribution of benefits from the IT sector's growth has begun to have a more-inclusive nature. This section has demonstrated that two ancillary jobs have been created for every one IT worker as a result of the IT sector's expenditures and the demands of its workers. In the areas visited by Olsen et al (2010), these ancillary jobs are being filled by those with the heaviest accumulated disadvantages, including little if any education and limited skills. On top of that, the IT sector has spread geographically throughout the country, and now even exists in some of the poorest and most disadvantaged areas of India.

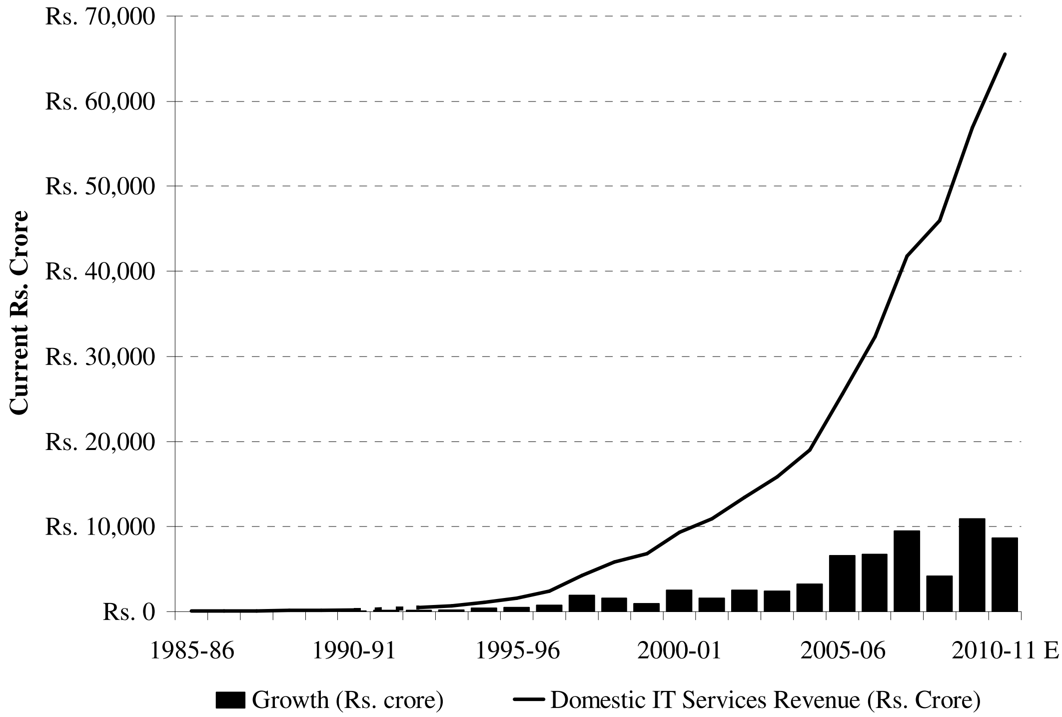
The next section evaluates the extent of forward linkages. In presenting newly found and assembled data, as well as two original analyses, the research shows that these linkages are now undeniably both sizeable and fast-growing.

5.2 Forward Linkages are Large and Growing Fast

Figure 5.15 shows revenues for the Indian SWIS sector from the domestic market, as published by NASSCOM starting in the 1980s. The line plots the revenues NASSCOM members collected from the domestic market in current Rs. crore, and the bars show growth in the same revenues. This author has carefully extracted these statistics from multiple publications; their assembly into a time series of 26 years is itself an important contribution to the state of knowledge on the sector. What becomes undeniably clear when looking at this time series is that the domestic market for SWIS has been growing at a respectable rate since the industry's inception in the 1980s. At an estimated Rs. 65,500 crore (US$14.6bn[48]), the domestic market in 2010-11 is more than 125 times larger than it was 20 years previously. This represents a compound annual growth rate of 27.4% over 20 years, an achievement which is difficult to describe as "inadequate" (Kumar and Joseph, 2005: 99), or "weak" or "constrained" (D'Costa, 2003: 222).

48 Estimated by NASSCOM (2011) in February 2011, for the year ending April 2011.

Figure 5.15: SWIS Revenue for Indian IT Sector from Domestic Market



Sources: Athreye (2005: 34); Hanna (1994: 100); Heeks (1999b:2); Kenney and Dossani (2002: 237); Kumar & Joseph (2005: 94); NASSCOM (2008a:1); NASSCOM (2009a: 6, 203); NASSCOM (2011:7,8); Sridharan (2004b: 34,37).
Note:. The original source of all data is NASSCOM, and it reflects the revenues of their members. The data is published in US$ and has been converted by this author into rupees using exchange rates from RBI (2010). The dotted line denotes two missing data points in 1991-92 and 1992-93. 2010-11 is estimated by NASSCOM as at February 2011 for the year ending April 2011. Figures exclude sales of SWIS to ITES-BPO producers. Rs 1 crore equalled US$221,900 in 2005.

If it was ever correct to portray the SWIS sector's domestic forward linkages in negative terms, Figure 5.15 reveals that period was in the 1990s and perhaps into the first years of the 2000s. It is clear from the chart that this earlier period saw both smaller revenues from the domestic market and smaller annual growth rates in those revenues. However, in the most recent period, growth has been strong, with, on average, expansions of over Rs. 5,000 crore, or US$1.1bn per year[49]. It is a pattern which is suggestive of a possible structural break in the sector's growth, but it is not clear a priori which year such a break might have occurred. The next step in the

[49] The exception to this growth was for 2008-09, when the global recession led to lower growth in IT outsourcing in India, as with the rest of the world (NASSCOM 2009c: 6).

current research on forward linkages, then, was to test for such a structural break and to identify in which year it occurred.

The methodology used is based on the classical Chow test for structural change (Chow 1960). Applied to the current problem, this test would involve splitting the time series of domestic revenue growth data into two sub-samples, one before and one after a candidate break year. Then an econometric model for growth of domestic market revenues would be estimated based on explanatory variables including a constant, its own past values and any other relevant controls. A dummy variable that takes the value 1 for one of the sub-samples and 0 for the other would also be included and the significance of this dummy variable assessed using an F-test. If this dummy's coefficient was found to be significantly different from 0, the test would demonstrate the existence of a breakpoint in the year that split the data. Of course, the Chow test pre-supposes a candidate breakpoint year, whereas in the current research it was desirable to identify the breakpoint from the data. For this task, Quandt (1960) suggested a procedure which applies the Chow test iteratively to all possible splits of the sample. This procedure involves estimating T-1 equations, where T is the sample size, and assessing the significance of T-1 dummy variables corresponding to T-1 breakpoint years by calculating T-1 F-statistics. The largest of these, supF, can then be the subject of a test whose null hypothesis is no breakpoint, versus the alternative that there is a break in the year where the maximum F-statistic is found. This procedure involves estimating substantially more parameters than a one-equation version of the Chow test; Quandt recognised that this would leave the critical values for a one-equation Chow test inappropriately small. Andrews (1993) moved Quandt's work forward by deriving the correct critical values for the procedure, and Vogelsang

(1997) and Hansen (1997) extended the theme further by modifying the critical values for models with serial correlation, and by deriving asymptotic p-values, respectively.

Figure 5.16: Test Equation for Domestic SWIS Revenue Growth

Dependent Variable is Domestic Market Revenue Growth (Rs. crore)			
	(1)	(2)	(3)
Constant	2618.96	740.16	527.35
	*3.99***	*1.34*	*1.12*
Domestic Rev Growth(-1)		0.84	1.04
		*5.96***	*7.44***
Outlier 2008-09			-6145.40
			*-2.91***
R-Squared	0%	62%	73%
Sample	25	24	24

Sources: Author estimates; adapted from Athreye (2005: 34); Hanna (1994: 100); Heeks (1999b:2); Kenney and Dossani (2002: 237); Kumar & Joseph (2005: 94); NASSCOM (2008a:1;, NASSCOM (2009a: 6,203); NASSCOM (2011:7,8); Sridharan (2004b: 34,37).
Notes: t-stats in italics; ** denotes significance at 1% level. This analysis is based on growth in Rs. crore rather than percentage growth rates because in the early years of the industry, the data included very large percentage growth from a very small base. The insignificant constant term is retained in the regression to facilitate the Q-A test.

Figure 5.16 shows the equation constructed for the purposes of undertaking the Quandt–Andrews test on the domestic SWIS revenue data. Column 3 is the preferred test equation. It models growth as an auto-regressive process of order one. A dummy variable is included for 2008-09 to correct for low growth in that year due to the global recession (NASSCOM, 2009c: 6). Figure 5.17 shows the results of carrying out the Quandt–Andrews test for a structural break in growth in an unknown year on this equation. The null hypothesis of no structural break is firmly rejected in favour of the alternative that there is a significant step change in growth of domestic SWIS revenues in the year 2005-06. In other words, there is a structural break in the size of the constant in equation (3) in the year 2005-06.

Figure 5.17: Quandt–Andrews Test for a Structural Break in Domestic Market SWIS Revenue Growth

Quandt-Andrews Unknown Breakpoint Test	
Sample 1987-88 to 2010-11	
# Breaks compared	16
Maximum Wald F Statistic:	27.92
P-value	0.00**
Year:	2005-06

Sources: Author estimates; adapted from Athreye (2005: 34); Hanna (1994: 100); Heeks (1999b:2); Kenney and Dossani (2002: 237); Kumar & Joseph (2005: 94); NASSCOM (2008a:1); NASSCOM (2009a: 6,203); NASSCOM (2011:7,8); Sridharan (2004b: 34,37).
Notes: ** denotes significance at 1% level.

Figure 5.18 shows the implications of this finding for the model of growth in domestic forward linkages from the SWIS sector. Column 3 is copied directly from column 3 in Figure 5.16, whilst Column 4 shows the results of including a dummy variable with the value 0 before 2005-06 and 1 thereafter into the equation. As expected from the Quandt–Andrews result, this variable is positive and highly significant. The magnitude of its coefficient indicates that since 2005-06, growth in domestic revenues from the SWIS sector has been, on average, around Rs. 5,750 crore (or US$1.3bn) higher it was between 1985-86 and 2004-05.

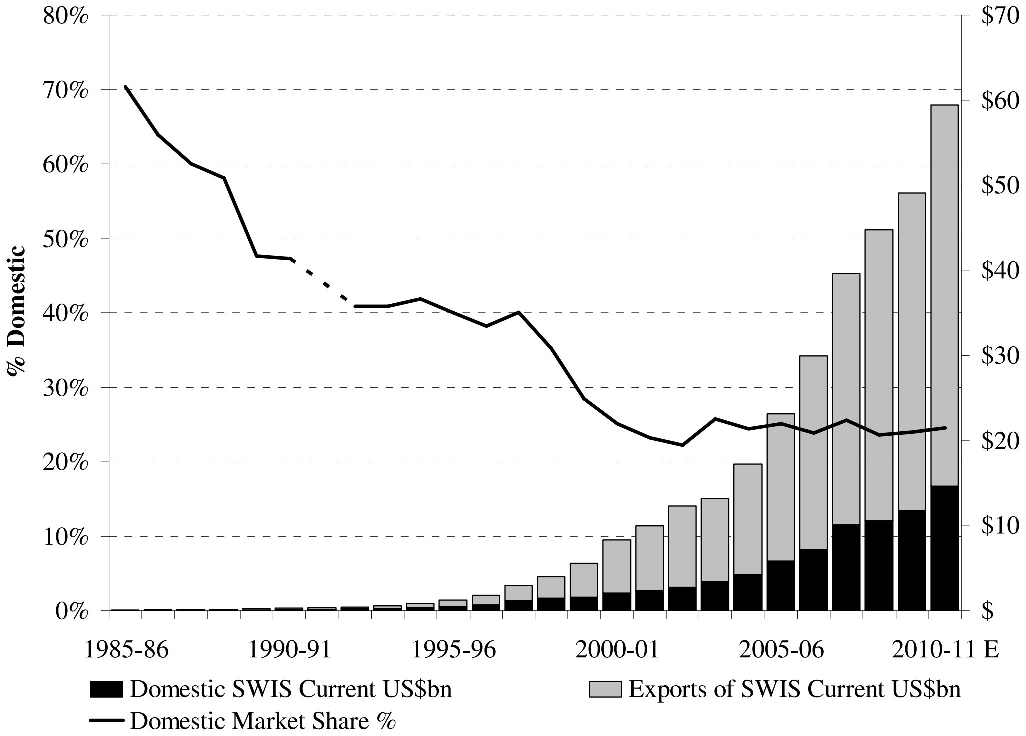
Figure 5.18: A Significant Step Up in Growth of Domestic SWIS Revenues, 2005-06

Dependent Variable is Domestic Market Revenue Growth (Rs. crore)		
	(3)	(4)
Constant	527.35 *1.12*	785.69 *2.48**
Domestic Rev Growth(-1)	1.04 *7.44***	0.30 *1.83*
Outlier 2008-09	-6145.40 *-2.91***	-5237.67 *-3.72***
Step Dummy 2005-06		5754.61 *5.28***
R-Squared	73%	89%
Sample	24	24

Sources: Author estimates; adapted from Athreye (2005: 34); Hanna (1994: 100); Heeks (1999b:2); Kenney and Dossani (2002: 237); Kumar & Joseph (2005: 94); NASSCOM (2008a:1); NASSCOM (2009a: 6,203); NASSCOM (2011:7,8); Sridharan (2004b: 34,37).
Notes: t-stats in italics; ** denotes significance at 1% level; * denotes significance at 5% level. Insignificant constant term retained in equation (3) to facilitate Q-A test.

It is a substantial acceleration and one which has succeeded in placing the domestic market for Indian SWIS on equal terms with the export market in terms of its percentage growth performance. This means that although export revenues remain larger than domestic revenues in absolute terms, comparisons between the two destinations for Indian SWIS no longer paint a picture of a "neglected" (Heeks, 1996: 72) domestic market. To illustrate this point, Figure 5.19 plots the SWIS sector's export versus domestic revenues. The graph plots total SWIS revenues in current US dollars in bars, split between those coming from the domestic market, in black, and those coming from export markets, in grey. Superimposed over the bars, the line shows the share of revenues coming from the domestic market. In the earlier periods, this chart shows clearly the story that the literature reviewed in Chapter 3 lamented—the growth in the sector was indeed mainly being driven by exports and the share of the domestic market was falling rapidly. What the updated picture shows, though, is that the domestic share has now stabilised. Starting around 2003-04, the domestic market's share of revenues has stayed between 24% and 26% of the SWIS sector's total revenues.

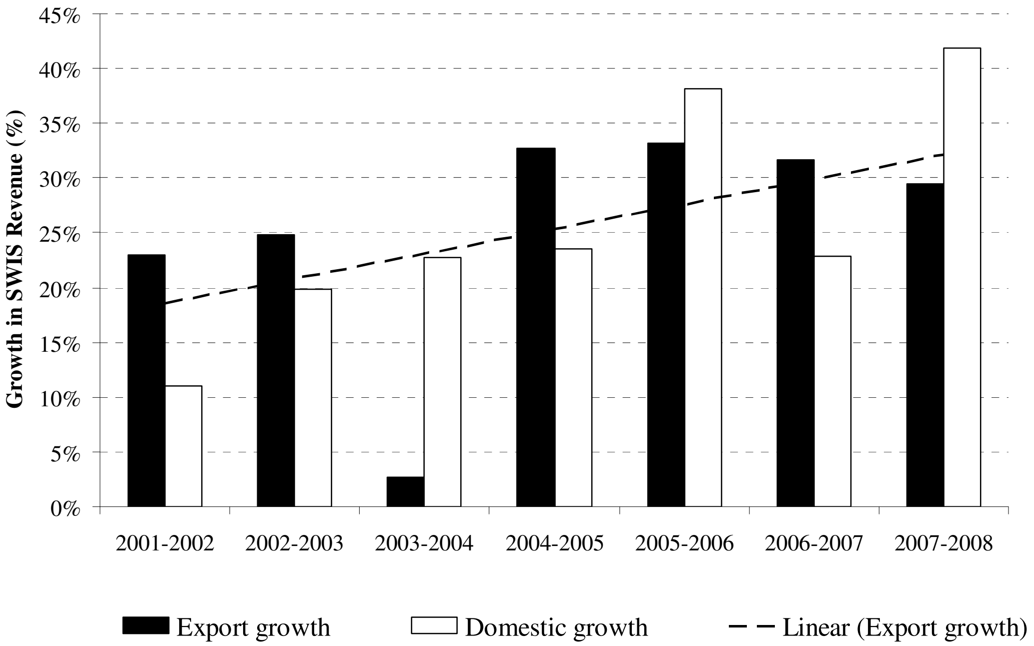
Figure 5.19: SWIS Revenue for Indian IT Sector and Share Accounted by Domestic Contracts



Sources: Athreye (2005: 34); Hanna (1994: 100); Heeks (1999b:2); Kenney and Dossani (2002: 237); Kumar & Joseph (2005: 94); NASSCOM (2008a:1); NASSCOM (2009a: 6,203); NASSCOM (2011:7,8); Sridharan (2004b: 34,37).
Note: See notes in Figure 5.15. Dashed line represents interpolation for missing data.

Figure 5.20 re-charts the same data to emphasize the growth profiles of export and domestic revenues from the beginning of the new millennium until 2007-08, when the global recession began to impact the industry. It shows that the noted stabilisation in the share of the domestic market occurred because the domestic market caught up with the robust growth in exports. Both export and domestic revenues registered double-digit growth in the first decade of the new millennium, and during this period there was no waning in the growth performance of exports; if anything, export growth accelerated along the trend line.

Figure 5.20: Growth in SWIS Revenue, 2001-02 to 2007-08



Sources: Athreye (2005: 34); Hanna (1994: 100); Heeks (1999b:2); Kenney and Dossani (2002: 237); Kumar & Joseph (2005: 94); NASSCOM (2008a:1); NASSCOM (2009a: 6, 203); NASSCOM (2011:7, 8); Sridharan (2004b: 34, 37).

What this combined new analysis shows is that the most recent five to eight years (approximately 2003 to 2008) have witnessed a marked change, with dramatically improved growth performance relative to both the sector's historical trajectory and to the continuing expansion of forward linkages abroad.

Not surprisingly, these achievements also show up in the current research on the onward impetus that the SWIS–ITES-BPO sector's sales create through indirect forward linkages in the Indian economy. Leontieff (1951) was the first to offer a method for calculating the size of such linkages for a sector. He described his method as a means of calculating the consequences of changes in a country's economic system by following the ramifications of the change through the "chain of transactions" that make up the system (p. 14). Leontieff's model was demand driven, and thus designed primarily to quantify the size of total backward linkage. Ghosh (1958) adapted Leontieff's model to provide a supply-driven version which was similarly well-suited for understanding the full extent of direct and indirect forward linkages[50]. Ghosh's methodology traces expansion in a particular sector through to those sectors that purchase its outputs, and then from those to a second "layer" of purchasing sectors, and onwards again into all subsequent layers. It is important to identify at each layer how much of the output of each sector is purchased by another sector within the domestic economy as an input to production, rather than purchased as a consumable or for export. In other words, how much of each sector's output provides an impetus for another sector's output expansion.

This complex task is simplified through the use of an assumption which states that each sector sells its output to one of several destinations in fixed or very slow-moving observable proportions. Output can be sold as either an input to other sectors, for use by government, or for consumption by citizens all within the domestic economy; or sold abroad as exports. The assumption that the proportion of output going to each of these destinations is fixed enables the process of sharing output between them to be modelled as a stable linear equation. Once such an equation has been created for the output of all sectors of the economy, the resulting large yet simple system of simultaneous equations is capable of mapping all the input–output transactions in the whole economy. It is a system which is immediately amenable to identifying the extent of forward linkages from a particular sector at every layer because the system specifically identifies the proportion of output being consumed or exported versus the proportion being used as an input in the domestic economy. The clever part of Leontieff's (1951) methodology and its adaptation to a supply-driven context by

[50] There remains some controversy over whether Leontieff's and Ghosh's methodologies can be used consistently for the same example at the same time (Cella 1984; Rose and Allison 1989). For this reason the application of Leontieff's method for backward linkages in Section 5.2 by NASSCOM and CRISIL (2007) which used the 1998-99 input output tables and survey data on purchases by the sector from 2005 is kept separate from the results on forward linkages here which use the 2003-04 and 2006-07 input output tables.

Ghosh (1958) is the expression of the system in matrix terms and the use of its solution[51]. Once found, the solution identifies the total forward linkage effect for a one-unit increase in production in each particular sector of the economy. To make comparisons between different sectors, an index is usually constructed with 1 representing the average sector, and any score greater than 1 representing an above-average score on forward linkages. Comparisons between different years can be made by identifying how the index changes over time (Miller and Blair 2009, 543–549; Pradhan, Saluja, and Singh, 2006: 47).

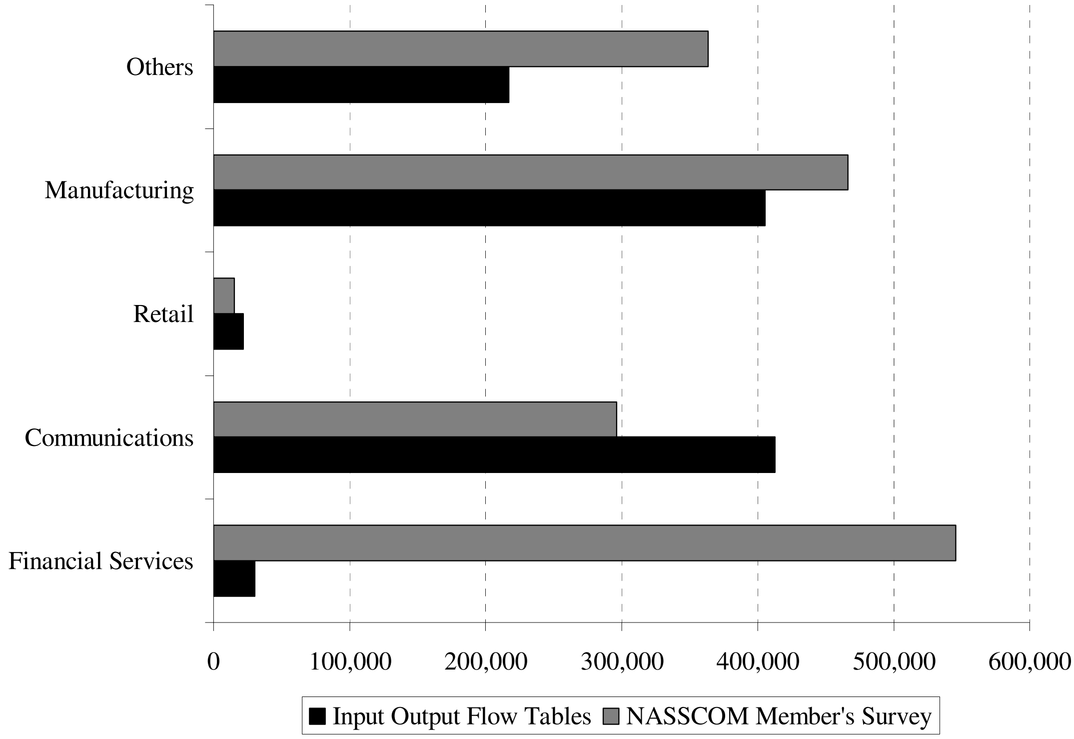
The application of Ghosh's method to the measurement and benchmarking of domestic forward linkages from Indian SWIS–ITES-BPO undertaken during the research project began with the need to understand the flow of output between industries and to final consumption within the Indian economy. Ghosh's method uses these quantities of output to identify allocation coefficients which form the basis of the linear system, which must be solved to measure total forward linkages. The flow quantities are published in India, as in other countries, as a matrix measured in monetary terms known as the input–output flow or absorption table. In India they are published by the Ministry of Statistics of the Government of India (GOI) every three years (GOI, 2010). This matrix included "Computer & Related Activities", or SWIS–ITES-BPO, as a separate sector for the first time only in 2003-04 (2–3); as of 2011, only 2003-04 and 2006-07 were published with the industry included (GOI 2010: 53; United Nations, 1999).

As a first step in the new analysis undertaken on these issues, Figure 5.21 (for 2003-04) and Figure 5.22 (for 2006-07) show the sales of domestic SWIS and ITES-BPO

[51] Miller and Blair (2009: 543) give an accessible account of this method.

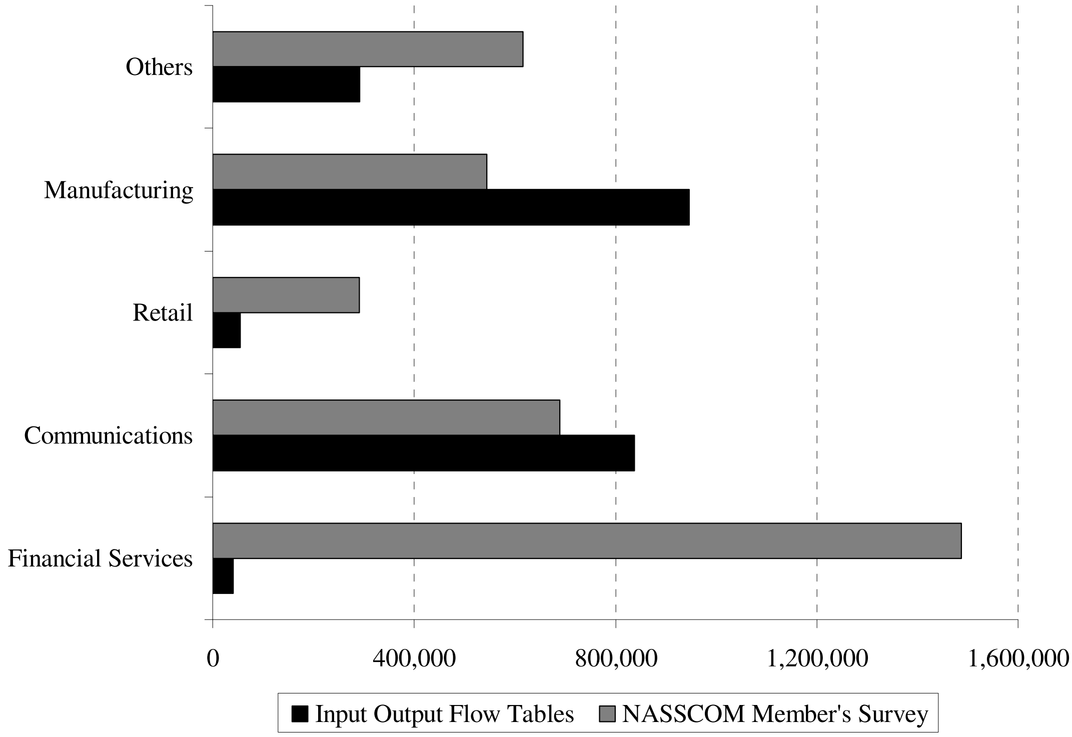
combined, split by the buying sector. Both charts show the data from the input–output absorption tables from the appropriate year (darker bars) and, as a back-up, the same information as sourced from NASSCOM's surveys of its members. The data is shown in current lakh rupees (Rs.1 lakh equals US$2,270 using 2005 exchange rates) in order to be consistent with the input–output flow tables.

Figure 5.21: Destination for Domestic SWIS and ITES-BPO in 2003-04, Current Rs. Lakh



Sources: Adapted from GOI (2010: 68–99); NASSCOM (2008a:1); NASSCOM and IDC (2006: 18).

Figure 5.22: Destination for Domestic SWIS and ITES-BPO in 2006–07, in Current Rs. Lakh



Sources: Adapted from Government Of India (2010: 1-32); NASSCOM (2009a: 203).

It is not an unproblematic first step. What emerged from the analyses shown in these two charts is that there is actually quite a large discrepancy between the two data sources. NASSCOM's member surveys find that, for 2003-04, SWIS and ITES-BPO sales to other sectors in the domestic economy are 55% higher than the Government of India (GOI) estimates, and are 67% higher for 2006-07. Perhaps even more important for the application of Ghosh's method, in both years the two sources also identify different allocations of output from the sector amongst destination sectors. The most obvious discrepancy in this respect is the vast difference in the share of sales going to financial services. NASSCOM's data shows finance as the biggest domestic buyer of SWIS and ITES-BPO in both years, but the input–output tables show this sector as only purchasing a very small proportion of the sector's output. A similar discrepancy appears in purchases by the retail sector in 2006-07. NASSCOM data shows that retailers purchased 8% of total domestic SWIS and ITES-BPO sales in 2006-07. The GOI's figures put the same share at closer to 2.5%.

Before moving to the second step in the analysis, it was important to evaluate the reliability of these two data sources. This analysis indicated that there were several reasons why NASSCOM's data is more accurate. The first is that NASSCOM asked the question about where IT sector outputs go directly to IT companies, whilst the GOI asked it indirectly through many different surveys sent to many different industries that might potentially buy SWIS-ITES-BPO (Pradhan, Saluja and Singh, 2006: 146-158)[52]. For example, in agriculture, the main source of GOI data is the Cost of Cultivation census undertaken by the Directorate of Economics and Statistics in the Ministry of Agriculture. Judging by its name, it seems clear that this survey's main concerns were the costs of inputs to agricultural production. In manufacturing, the Annual Survey of Industries census study published by the Central Statistical Organisation similarly gives "detailed information on item-wise inputs in terms of quantities and values and products and by-products" (p. 149). This use of data on inputs to understand where the IT sector's outputs are used would not cause a problem in certain circumstances. If outputs are sold in a single transaction with no intermediary, no transaction costs, and no other frictions, asking about inputs to the destination industry rather than outputs of the producing industry would yield the same numbers. However, if any of these issues do arise and their impacts are not properly captured by the research strategy, there is the potential for distortions in the data.

The second reason to use NASSCOM's data on output allocations from SWIS and ITES-BPO is that data collection methods on inputs, in the particular industries that are substantial buyers of SWIS–ITES-BPO, often rely on sample surveys rather than

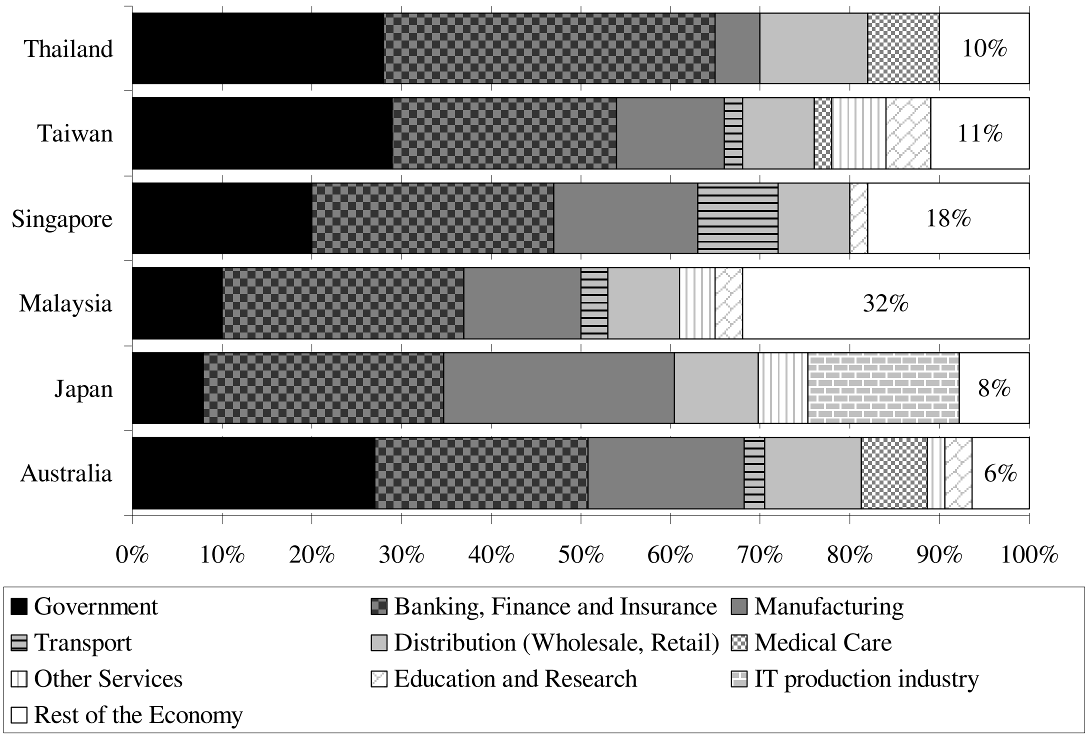
[52] This is not an oversight on the part of the statistical authorities in India. Input– output tables are more often used for Leontieff's demand-driven method, and in this mode, asking about inputs is more appropriate.

censuses (p. 150–153). For example, Figure 5.22 revealed a discrepancy between the two data sources on the extent of purchases of SWIS and ITES-BPO by the Indian retail sector in 2006-07. On measurement of retail, Pradhan, Saluja and Singh find that “there are certain problems, especially in the case of retail trade, where there are innumerable establishments and no census is possible. In such cases sample surveys can be done to obtain the required data” (p. 153). It seems clear that in a country with innumerable retail establishments and a much smaller number of SWIS or ITES-BPO companies[53], a sample-based survey of the latter is a better indicator than a sample-based survey of the former for identifying the extent and value of transactions between the two.

The final reason to trust NASSCOM’s data is that it appears much more consistent with what might be expected, given experiences from elsewhere in the world. It has been well documented that both finance and retail were enthusiastic adopters of IT in the United States in the 1990s (Baily and Lawrence 2001: 309; Mann 2003: 4; Stiroh 2001: 19; Triplett 1999: 318,). Figure 5.23 details the sectors which made purchases of IT in 1992 in six Asian countries. This indicates that these same industries have been enthusiastic adopters of IT throughout Asia too.

[53] http://www.nasscom.in/ (accessed 15 January 2011) reports that 1,200 NASSCOM members comprised an estimated 95% of the entire IT industry’s revenues.

Figure 5.23: Proportion of Total IT Expenditure by Sector for 6 Asian Countries in 1992



Source: Hanna (1994: 40).

These three reasons together made a compelling case for using NASSCOM's data on output from SWIS–ITES-BPO in this research rather than that available from the GOI input–output flow tables. To do this, however, the revenues reported by NASSCOM had to be allocated to the 130 sectors on the input–output flow tables, and the Ghosh allocation coefficients had to be recalculated. Unfortunately, NASSCOM only publishes sector-wise destinations of output from SWIS and ITES-BPO in the five aggregate sectors listed in Figures 5.21 and 5.22. Using NASSCOM's data in the new research necessitated splitting the revenues into smaller categories to match the input-output tables. This was done using the share that each individual industry took of the larger category in the input–output flow table for the relevant year[54]. The other

[54] For example, the category Financial Services is made up of 2 sectors on the input–output tables: Banking and Insurance. In 2003-04, the input–ouput tables show that these two sectors purchased Rs 30,300 Lakh of SWIS or ITES-BPO; of that total, 95% was purchased by the banking sector and 5% by the insurance sector. For the same year, NASSCOM reported domestic SWIS and ITES-BPO sales in the domestic market of Rs. 545,500 Lakh. In order to use this figure to measure forward linkages in that year, it was necessary to apportion that amount (Rs. 545,500 Lakh) to Banking and Insurance. The

methodological issue to resolve was to choose an assumption regarding the treatment of secondary products in the input–output tables[55]. The commodity technology assumption[56] was adopted because it was the most logical in terms of economic interpretation (United Nations, 1999).

Figure 5.24 shows the index of total forward linkages arising out of this analysis. The index number plotted represents the extent of total (direct plus all indirect) forward linkages relative to the average sector in the Indian economy. A score of 1 on the index would indicate that SWIS–ITES-BPO had forward linkages to the same extent as the average sector. What is important about the findings in Figure 5.24 is that in the three years between 2003-04 and 2006-07, this index increased by close to 20%[57]. In a list of 130 sectors ranked by the total size of their domestic forward linkages, SWIS–ITES-BPO moved from number 101 in 2003-04 to number 92 in 2006-07. To give this improvement context, in 2003-04 SWIS-ITES-BPO was between Wooden Furniture and Eggs & Poultry on the list, whilst in 2006-07 it was between Motor Vehicles and Construction.

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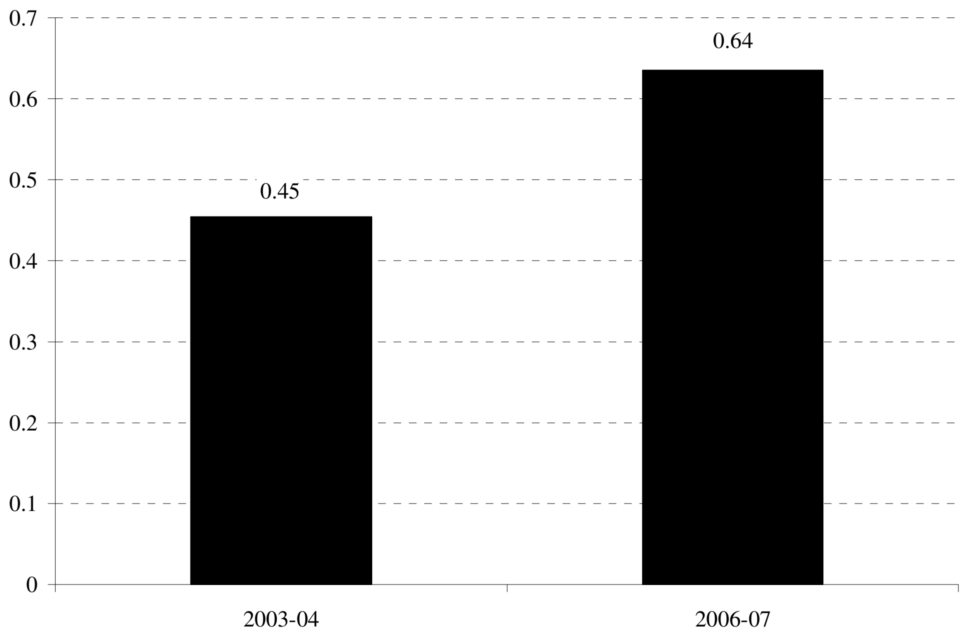
pragmatic choice taken here is to apportion 95% of it (Rs. 518,200 Lakh) to Banking and the remaining 5% to Insurance (Rs 27,300 Lakh).

[55] Miller and Blair (2009: 208–210) offer a comprehensive discussion of the theoretical and empirical literature on the treatment of secondary products.

[56] This assumption is needed for the treatment of industries that produce more than one product. For example, the automobile components industry may also produce certain machine tools. The commodity technology assumption states that production of the secondary product (machine tools) uses the same inputs as are used by firms which produce that product as their main output (i.e. firms in the machine tool industry). The alternative industry technology assumption states that production of the secondary product uses the same inputs as the rest of the industry that actually produces it (i.e. the same inputs as automobile components).

[57] The finding that total forward linkages are growing very quickly is robust to data sources. With data from the input–output tables, the index calculated for 2003-04 is 0.40, and for 2006-07 it is 0.59.

Figure 5.24: Index of Total Forward Linkages for SWIS and ITES-BPO, 2003-04 and 2006-07



Sources: Calculations based on from GOI (2010: 1-32); NASSCOM (2009a: 203); NASSCOM (2008a:1); NASSCOM and IDC (2006: 18)

It is yet another piece of strong evidence to show that SWIS-ITES-BPO from the IT sector is becoming more important in the Indian domestic economy. The analysis of Figure 5.24 suggests that SWIS-ITES-BPO is both being used in more sectors and being used in sectors which are themselves becoming more pervasive.

It is premature at this stage to make any decisive statements about output or productivity effects of these forward linkages for two reasons. The first is that the analysis in Figure 5.24 is in need of updated data which may or may not reveal a sector with above-average forward linkages as of 2011. The second is more esoteric, and arises from theoretical controversies in the Ghosh methodology. The assumption that the output of a particular sector would be allocated according to fixed proportions in this model implies that an expanding sector will always be able to sell its expanded outputs to the same set of customer sectors and that its existing customers will expand with it (Miller and Blair, 2009: 549). Hirschman, however, was not positive that this would always be the case. According to Hirschman, an expanding sector which was short of inputs for production may well be compelled to invest in sectors which produce those inputs, or, in other words, backwards linkages. On the other hand, for forward linkages, the same urgency may not necessarily be felt. The expanding sector may or may not invest into sectors which constitute forward linkages[58]. Hirschman described what would happen if neither the expanding sector nor the linked sector choose this investment with an analogy: if the forward linkage is a road which invites traffic, it may or may not actually find that traffic (expanded output) arriving (1958: 100). What this means is that for forward linkages, input–output analysis is only sufficient to establish that a sector's output is becoming more pervasive or that it is being used in sectors which are themselves becoming more pervasive. It is not, however, sufficient to prove that these input–output transactions are a causal mechanism for increased output growth. For SWIS in India, this question is addressed in Chapter 7.

To conclude then, the research described in this section has established that at an estimated US$14.6bn[59] of SWIS, the domestic market in 2010-11 is now a significant industry in absolute terms. Its history reveals strong growth for well over 20 years and, importantly, it also shows that there was a significant upwards breakpoint in 2005-06. From that time, growth in the domestic market has been so vigorous that the traditional literature is now inconsistent with current statistics. Even the comparison of domestic versus export revenue growth, the staple empirical evidence for pessimistic views of the sector in that literature, has witnessed a turnaround since 2003. Growth in the domestic market has now caught up with the robust expansion of

[58] See Chapter 1.
[59] Estimated by NASSCOM (2011) in February 2011, for the year ending April 2011.

SWIS exports. Internally, the sector's output has become more pervasive, allowing the sector to climb the rankings of most forward-linked industries. According to Ghosh's methodology, it has improved by 20% in a period of only three years between 2003-04 and 2006-07. As of 2006-07, SWIS and ITES-BPO had a similar reach in the domestic economy as the motor vehicles or construction industries.

5.3 Conclusion: An Urgent Need for More Answers on Forward Linkages

This chapter documented the results of exciting new research on the current extent of linkages. It first provided a new synthesis of recent research (published and unpublished) from the private sector, the government, and academia. This showed for the first time that there is now sufficient evidence to be confident that backwards linkages from SWIS-ITES-BPO have emerged. It also showed that backwards linkages and are beginning to provide both a stimulus to India's economy and opportunities for low-skilled and disadvantaged workers. The second part of the chapter detailed the results of an even more important set of research. This presented a complete set of time series data, which has either not been collated or not been previously reported in the literature, on the size of forward linkages from the SWIS sector. It also included new econometric analysis of that time series, and original input–output research to assess the extent of indirect forward linkages. What these new data sources and analyses show is that forward linkages are, in fact, both large and fast-growing. They also show that something changed in the domestic market around 2005-06, and since then, growth has been significantly faster.

Uncovering the true extent and dynamics of forward linkages is the most important original contribution of this research project. One reason for the importance of these findings is that they shed new light on the literature reviewed in Chapter 3. There, it was argued, the literature is very pessimistic on forward linkages and, consequently, on the role of the IT sector as a whole. In fact, on the question of IT being a leading sector, the literature answered with a resounding no, and even argued that the sector is more like an enclave, which is the opposite of a leading sector (Balasubramanyam and Balasubramanyam, 1998). To some extent, authors in this literature cannot be blamed for their pessimism. Extensive backwards linkages have emerged predominantly because of the shift from the onsite to the offshore provision of SWIS and ITES-BPO. This shift has been taking place slowly since the mid 1990s, but evidence of its impact has been visible only since SWIS–ITES-BPO was incorporated into India’s input–output tables in 2003-04. On the other hand, the domestic market for SWIS has been growing quickly for the last decade, so the authors published in more recent years, including some of those contributions reviewed in chapter 3 (section 3.3), should have noticed this growth. In many cases, the pessimism arose from the comparison to exports from the sector. Judged relative to exports’ stellar trajectory prior to 2003-04, the domestic SWIS market did indeed look neglected. Judged in relation to any other industry, though, a 27% compound annual growth rate over 20 years with a revenue expansion from nearly zero in 1985-86 to US$14.6bn in 2010-11 can hardly be judged as weak.

The findings in this chapter on the extent and rapid growth of forward linkages demand further investigation into both their causes and their effects. This chapter’s work reveals that there is a serious need for explanations of the extent of forward linkages. The theorising that already exists on this issue, in Dahlman and Utz (2005) and D’Costa (2003), is based on the out-of-date perception that forward linkages are “constrained” and “weak” (D’Costa, 2003: 222). These existing analyses implied a future for forward linkages which is far from the sector’s actual experience. D’Costa (2003) and Dahlman and Utz (2005) each suggested that there would be no accelerated expansion in the domestic market in the short- to medium-term future—but since their publications, this has, in fact, happened.

It is a development that raises another burning question: What does this accelerated expansion in forward linkages mean for India's economy? On the one hand, some authors (e.g., Mody and Dahlman, 1992; Miller, 2001: 12) remain unconvinced that IT is appropriate for countries at India's stage of development. The implication of such analyses is that the money spent on IT in India identified in this chapter may well have been better spent elsewhere. On the other hand, if these authors are too negative, there is the potential for a positive ending. Many of the contributions reviewed in Chapter 3 argued that a larger domestic market for SWIS would be good for India's development (Chandrasekhar, 2001: 1; Heeks, 1999b: 9; Kumar and Joseph, 2005: 99: Joseph, 2002: 2: McCartney, 2006: 10; Singh, 2002: 34; amongst others), The evidence from developed countries, covered in Chapter 2, also confirmed that it is possible to get a strong return in terms of output and productivity from using IT.

These questions are taken up in the next two chapters. Chapter 6 begins by reporting what the new research undertaken in the project found on explanations for the true extent and growth trajectory of forward linkages. Chapter 7 covers the new research on the impact of IT from the sector in India's economy.

6. Results: Software and IT Services Become Appropriate for India

> "Indian entrepreneurs big and small were at this point focusing on the possibilities of building a unique business approach—based on the idea that you could vastly expand the pool of Indian consumers if you were willing to focus on extremely low-cost products. When IT met this strategy, its presence exploded."
>
> Nandan Nilekani, *Imagining India*, (2009: 346)

This chapter provides the second major contribution of the thesis. It describes the results of the current research on explanations for the extent and growth of forward linkages from the SWIS sector. The research found that there are two different but overlapping periods of growth in forward linkages. The first has been ongoing since the 1980s, and the second started in 2005-06 with the significant acceleration in the sector's growth rate[60]. Section 6.1 covers the reasons for the ongoing, yet slower, growth started in the earlier period. It attributes this growth to a process of private sector investment arising from a particular sequence and style of liberal economic reform. Section 6.2 contains the most important research findings of the chapter that explain the faster growth in forward linkages since 2005-06. The section finds that the acceleration occurred when, starting at the end of 2004-05, the SWIS sector entered into new types of deals with India's SWIS-buying sectors. These deals both persuaded Indian companies to invest into SWIS and demonstrated an emerging appropriateness of the technology for modern India, referred to by Nandan Nilekani in the epigraph. Section 6.3 contains a short discussion of other explanations which were investigated

[60] The existence of this acceleration was established in Chapter 5

but which proved themselves to be, at best, only contributory factors, and at worst, irrelevant. Section 6.4 concludes by contrasting the narratives arising from the research with debates in the literature.

6.1 Liberal Reform Led to Some Investment into IT

When asked for reasons for growth in the domestic market, 14 of the 30 of the carefully chosen experts, interviewed in 2009 as part of this project's qualitative research, mentioned, without being explicitly prompted, liberal economic reforms in India's potential or actual SWIS-buying industries. Given that nearly 50% of the interviewees cited economic reforms and their effects on SWIS purchasing behaviour, this is a strong finding.

Government policy in potential SWIS-buying sectors in India has been of the same ilk as that which was followed for manufacturing and other industries (outlined in Chapter 2). The literature on these sectors shows that liberalisation has been pursued in a piecemeal fashion, with each episode of government reform removing or relaxing an aspect of control on what firms in the sector can do, but never retracting the influence of the state completely[61]. Section 2.2 describes the sequence of piecemeal liberalisations as being "pro-business" starting in the 1980s, and only turning to be "pro-markets" in 1991 (Rodrik and Subramanian, 2004). Pro-business reforms included de-licensing and removing or relaxing controls on private sector entry in industries previously reserved for the state. They also included the removal or relaxation of tariffs and other protections on intermediate goods[62], but not on final consumption goods. These liberal reforms were beneficial for Indian firms as they reduced obstacles and bureaucracy, freed them to make business decisions as they wished, and reduced the cost of their capital inputs. Pro-market reforms, on the other hand, included the removal of tariffs or other protections on final consumption goods,

[61] See Okada (2004) and Virmani (2006) for manufacturing; Banga (2005), Chakravarty (2004), and Virmani (2004b) for telecommunications; Banking Frontiers (2007) and Talwar (2001) for banking; and Carpenter (2004) for insurance.
[62] Intermediate goods are products or services which are used to create another final product.

and on controls on foreign firms trading in India (Virmani, 2006). Amongst other effects, these reforms posed a threat to many Indian firms because they exposed them to competition from foreign companies. In the context of explaining the upturn in growth in the 1980s, Virmani (2006) argued that this particular sequence of reform was important in prompting investment in manufacturing and, in turn, economic growth. During the pro-business period (but before pro-market reform was enacted), Indian firms understood that they had a window of opportunity in which to prepare for the upcoming threat of competition from abroad (p. 35). The argument goes that the carrot of pro-business policy, together with the impending stick of pro-market policy, successfully convinced many incumbent businesses that there was an urgent need for investments in upgrading. This increase in investment was part of the reason for the increase in economic growth in the 1980s, and a major reason for Indian companies' success when foreign competition did arrive after the 1991 reforms.

What emerged from the 2009 fieldwork is that, given this window of opportunity to invest, upgrade, and secure a position from which to compete against foreign entrants, one strategy that Indian firms in potential SWIS-buying sectors identified was to invest into IT. This became a key reason for the growth of forward linkages from SWIS into India in the early years of the industry. Perhaps the best example highlighted in the research of a defensive use of SWIS purchasing comes from the same example that Virmani (2006) focussed on: manufacturing firms'. A senior IT consultant involved in SWIS projects in Indian manufacturing in the 1980s said: "It is all about liberalisation.... Gone are the days when you are in a protected market…the consumer has a choice now; if you are not as efficient in making refrigerators as Korean companies, you will have trouble" (Ashank Desai, 17 February 2009, Mumbai).

More recently, other potential SWIS-buying sectors such as insurance, banking, telecommunications, and wholesale/retail, have experienced the same sequence of reform as manufacturing, but much more gradually. These sectors have experienced pro-business reform including some de-licensing and private sector entry into markets previously reserved for the state. There have been some pro-market reforms, too, and in some cases, an opening of protected markets to foreign competition. Where pro-market reform has not yet arrived, there is a clear and generalised expectation amongst business people that it will, in fact, arrive soon (Pederson, 2000: 276). As of 2009, when the interviews took place, the different potential SWIS-buying sectors were at different stages in their reform stories. However, the interviewees were still able to link episodes of reform to spurts in SWIS purchasing for many of them. Insurance was a particularly interesting example, because, at the time of the interviews, it was experiencing a window of opportunity like those described by Virmani (2006).

In insurance, pro-business reform contained in the Insurance Regulatory and Development Authority Act of 1999 opened up the legal possibility of private companies selling to Indian consumers for the first time since 1972. At the same time, the Government of India (GOI) undertook to reduce its share of the market from 100% to 55%. New entrants to the market could accept foreign investment, but only up to 26% ownership by the foreign company (Sinha, 2005: 6). This meant that many of the eight to ten companies which entered the market at that time were joint ventures between Indian and multi-national companies, with the multi-national companies decidedly in the role of junior partner. For the following ten years, these entrants to the insurance market remained protected from foreign competition, although exposed to foreign practices through their junior partners (see the Birla Sun Life advertising in Figure 6.1). They were also given space to grow as the share of the previously monopolistic state insurers diminished. It was not until 2008 that an amendment to the Insurance Regulatory and Development Authority Act was proposed in parliament. The amendment would not bring unfettered competition from foreign insurers to the Indian market, but would "provide for the increase in shareholdings by a foreign company from the current limit of 26% to 49%" (India Brand Equity Foundation, 2010).

Figure 6.1: Birla Sun Life Advertising in Mumbai 2009

Source: Author's photo.

An IT consultant who works with insurance companies in India explained how reform shaped the IT and, particularly, SWIS-purchasing needs of these companies. The insurance players who entered around 1999, under the guidance of their foreign junior partners, all purchased "core platform" systems to automate collections of premiums and payments of claims. These necessitated the purchase of hardware, as well as substantial SWIS projects to set-up and maintain the software systems. In 2009, insurance once again became a growth area for domestic SWIS sales. One interviewee referred to the recently proposed (2008) amendment to the 1999 act, and said that it implied that insurance was about to be "opened up further". His understanding was that this meant that there were now "35 to 40 players in the market…all needing to do something different" to defend their positions against competitors which would soon be receiving large capital and know-how investments from abroad. In these circumstances, he said, "anyone that can use IT as a differentiator will be able to create enough of a customer service differentiation that they are able to take or even just preserve market share". He reported that these additional players were buying software and complementary IT services aimed at delivering good customer service. In particular, his consultancy company was advising several insurers on the purchase of customer relationship management[63], policy administration, and underwriting systems (Adarsh Parekh, 27 February 2009, Bangalore).

A similar story played out in banking during the 1990s. The beginnings of liberal reform in the sector in 1991 were decidedly pro-business, but the threat of later pro-market developments was made clear from the start. On the pro-business side, national banks were partially privatised, with the stake of the government permitted to fall below 51% and Indian private sector investment allowed to hold the remaining share (Talwar, 2001: 76). New, wholly private sector-owned banks were also allowed to enter the Indian market for the first time. On the pro-market side, foreign banks were, in the letter of the law, allowed to invest in the country. In practise, this has taken place on such a limited case-by-case basis that it has not represented a serious competitive threat to Indian incumbents. By 2001, foreign firms' share of total assets in the banking system had only reached 8%, and by 2007, only one foreign company had been allowed to own more than 10% of an Indian bank (Banking Frontiers, 2007; Talwar, 2001:75). However, it is clear to Indian banks that at some point there will be

[63] Customer relationship management is explained in Section 6.2.1.

more foreign competition in the banking sector. Despite this particular threat seeming a fairly long way off, the 2009 fieldwork interviewees related spurts in IT- and SWIS-buying in the 1990s to banking reform. Perhaps the most obvious example was the round of purchasing that followed the entry of the new private sector banks in the early 1990s. These banks were well-known amongst the interviewees to be high tech and to have the best IT systems for handling money into and out of bank accounts[64]:

> Banks are another good example, the private banks which arrived in the ’90s like ICICI and HDFC [Industrial Credit and Investment Corporation of India and Housing Development Finance Corporation Limited]…. They were new, they had no legacy systems, and they didn’t want to hire lots of people…. So they didn’t want manual processes, they wanted to optimise their use of people; they saw technology as the solution. [Sudha Kumar, CEO of an IT strategy consultancy, 4 March 2009, Bangalore]

> ICICI? The core banking system they installed in the ’90s is world-class. They still need to do more on customer service. But on core banking, what they have is top-of-the-range. [Harsh Gulati, IT consultant and sales executive, 20 February 2009, Pune]

According to the interviewees, the entry into the market of these new private sector banks prompted a round of purchasing of these types of systems, with even the public sector banks eventually following suit. It is a pattern that interviewees have seen in several different industries as a result of reform. As one IT consultant with over 30 years experience in the domestic market put it, “Every time there is a liberalisation, you will see that spike" (Rajesh Varrier, 24 February 2009, Bangalore).

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[64] These are called Core Banking Systems by these particular IT experts.

Carrying the case study on banking through to the present day reveals an interesting story. Adarsh Parekh gave a detailed description of Axis Bank, a private sector bank which entered the Indian market in the 1990s. According to Parekh, Axis has a world-class core banking system, and is a close competitor to ICICI, but is short on customer service. He explained that he would like to sell a "mobile banking" system to Axis. With it, customers would be able to get their balances, pay bills, and do other basic banking transactions via SMS[65]. Parekh was sure that this would give Axis a clear advantage over ICICI because of these better customer services. However, he was not having any luck in this particular sales pitch despite its obvious benefits: Axis saw no imperative to make this investment (Adarsh Parekh, 27 February 2009, Bangalore).

According to Parekh, and several others who expressed similar views, the problem arises from the use of reform to push firms into making investment decisions. Firms invest when there is a clear economic threat to do so, but will not when no such threat exists. To put it another way, incremental reform, when sequenced correctly, may bring about investment, including investment into IT and SWIS, but when there is a break in reform, there is also a break in investment. Parekh said that this is the situation that now applies to banking: "Banking has been de-regulated for some time, so that the opportunity to use IT as a competitive edge has passed" (Adarsh Parekh, 27 February 2009, Bangalore). He suggested that the short-lived nature of the effect of reform means that no single reform, or even group of reforms, has been capable of bringing long-lasting change in the growth rate of SWIS-buying in any particular industry. If he is correct, and it is an assertion which needs to be verified with future

[65] Short message service via mobile phone.

research[66], it would be an important finding. It would mean that although reform has been an important driver of investment and growth into SWIS, it is not a strong enough force to drive consistent or ongoing change. This assertion is in agreement with certain theoretical critiques of liberal reform which argue it is an ineffective means for achieving long-term economic growth. For example, Deranyiagala (2001: 81-85) re-evaluates the effects of trade liberalisation using a general equilibrium framework, and finds the argument that long-run growth should follow such reforms has a “shaky” theoretical basis (p. 82).

Unfortunately, a full investigation of these issues and a validation of whether and how they apply in India is outside the scope of this research. The current project’s attention now moves to Section 6.3, which is an explanation of growth in forward linkages around and after the significant acceleration in 2005-06.

[66] This avenue for further research is discussed in Chapter 8.

6.2 SWIS as an Appropriate Technology and “Pay-per-use” Deals

This section provides the most important findings of this chapter, and the second original contribution of the thesis itself (following the analyses in chapter 5 that disprove much of the traditional literature). It explains the acceleration in forward linkages in 2005-06 and their faster growth thereafter. It is an important section for two reasons. The first is that it addresses a significant gap in the literature. The extent of forward linkages after 2005-06 was neither predicted nor noticed in the academic literature, and, perhaps for this reason, it has been met with a dearth of explanations. None of the analyses of the domestic market for SWIS reviewed in Chapter 3 predicted a rapid expansion. In fact, both D’Costa (2003) and Dahlman and Utz (2005) indicated that it was unlikely, if not impossible, to occur in the short- to medium-term future. The second reason is that the findings on how the SWIS sector came to have extensive forward linkages in the domestic economy teach lessons that are important indicators for the future. These lessons identify particular circumstances that need to occur if the impressive growth in forward linkages is to continue along its current trajectory.

Section 6.2 is split into three parts. The first introduces the trigger for the acceleration: a landmark deal between IBM and Bharti–Airtel at the end of 2004-05. The second and third sections explore, respectively, two conditions: the nature of software, and the nature of Indian society, which combined to make this deal, and others like it, so successful. The final section concludes by comparing the analysis of this section to the existing literature, and makes comments about the future for the domestic market.

6.2.1 A Deal between IBM and Bharti–Airtel

The initial trigger for the acceleration in domestic SWIS was an innovative agreement between IBM India, a SWIS firm, and Bharti-Airtel (BA), an Indian mobile telephony provider, which was reached at the end of 2004-05. This deal marked an "inflection point", according to the chairman of NASSCOM (Ganesh Natarajan, 12 February 2009, Mumbai), and a "very significant event that changed the market dynamics", according to a senior IT industry analyst and consultant (Praveen Sengar, 30 January 2009, Delhi). The deal comprised an agreement that IBM would handle BA's entire SWIS needs for a ten-year period and was subject to other agreements, some of which are included in Figure 6.2, which is from a study of the Indian domestic market conducted by NASSCOM in 2006.

Figure 6.2: IBM and Bharti-Airtel Deal, 2004-05

End-to-end Outsourcing: An Example
Name of the Vendor: IBM
Name of the Client: Bharti
Type of Engagement: End-to-end IT Outsourcing
Size: Estimated to be in the range of US$700-750 million for a ten-year period

- Till date, the biggest IT activity in the telecom sector has been the IBM-Bharti deal. For the Bharti case, IBM is maintaining hardware, software, and provisioning IT services, including billing, CRM, data warehousing, e-mail and intranet services. IBM is also managing Bharti's data centers and IT helpdesks and enhancing its disaster recovery capabilities.
- The total deal size for the 10-year period is likely to be in the range of US $700-750 million. For the first five years, it is likely to be in the range of US $250-275 million.
- The agreement specifies that payments made to IBM India will be linked to the percentage of revenue generation by BTVL and pre-defined service level agreements. The percentage-linked revenue payment is modeled to decrease with BTVL's increase in revenue.
- The deal includes all customer-facing IT applications, like billing, customer relationship management and data warehousing. In addition, Internet, e-mail and online collaborations are also included.

Source: NASSCOM and IDC (2006: 15).

The most important aspect of the deal was that it introduced a new way of paying for IT outsourcing. IBM set up the systems and provided maintenance and support to BA without charging any upfront fixed cost. After that, BA paid IBM a percentage of their revenue. If IBM adhered to the service-level agreements, they would get 100% of that share of revenues; if not, they would get a lower share. Several interviewees said that this financing arrangement, which many of them referred to as "pay-per -use", was instrumental in allowing the deal to move forward. BA was able to avoid the type of large upfront investments into IT systems which often worry potential Indian IT buyers, because they are thought to be risky. As Adarsh Parekh put it: "Indian businesses are very cost and cash conscious. They say 'What's the real difference it's going to bring? Why should I invest another 100 crore or 50 crore[67] or whatever the amount is. Why should I?' You've really got to show them" (27 February 2009, Bangalore). Kiran Karnik, chairman of one of the biggest IT firms in India, agreed: "You need to look at a different model in a lot of places in India because the user perceives an upfront payment as expensive and risky. People are not sure that it will be useful. That's the India cultural mindset. We are more risk averse than Americans" (13 February 2009, Mumbai).

This attitude amongst Indian IT buying clients is similar to Hirschman's description of entrepreneurs in developing countries (1958: 10–14)[68]. Since they have not themselves previously witnessed the return from a particular developmental investment, in this case a software system, they are reticent about making that investment. What the terms of the IBM–BA deal did was to excuse BA from taking that entrepreneurial risk. Instead, in a clear echo of Hirschman's (p. 67) description of how linkages should work, IBM made an investment into BA's business by building a system which was an output of the SWIS sector and an input to the mobile telephone sector. This meant that IBM was able to fully demonstrate to their client the benefits

[67] Rs.50 crore was equivalent to just over US$10m, and Rs. 100 crore was equivalent to just over US$20m in 2009.
[68] Discussed in Chapter 1.

of the system in situ. Any worries that BA had about whether such a system would work in India, and for them in particular, were duly avoided.

This was not the only reason why the new financing method was so important, however. More significant were the implications of the financial structure of the deal for the cost of BA's SWIS use. The terms of the deal allowed a positive profit for IBM only if their negotiated percentage of BA's revenue stream, minus the costs of the SWIS needed to service that revenue stream, left enough of a margin. Since the percentage of revenue that IBM might claim could only decrease under the terms of the deal (see Figure 6.2), IBM would do well only if the SWIS cost of servicing BA's customers decreased quickly and/or BA's revenue increased quickly. What happened was that both of these outcomes occurred, allowing IBM to do particularly well. In fact, it did so well that a typical comment in the interviews described IBM as "laughing all the way to the bank" (Kris Lakshmi, 23 February 2009, Bangalore). Several of the experts explained that this positive outcome for IBM depended on certain conditions being in place. The first set was that the system IBM installed at BA have significant economies of scale (defined and discussed in 6.2.2), and that IBM engineer the system to maximise them. The second set was that BA find a ready market for their mobile communications, and be able to attain scale quickly (discussed in 6.2.3). When these conditions combined, BA's operations grew quickly, allowing economies of scale to occur. This meant not only that BA's revenue increased, but also that their average SWIS costs of servicing customers became very low.

This chain of events not only secured a healthy profit for IBM, but also had major benefits for BA. BA was assured that the proportion of their revenue that was spent on

SWIS was guaranteed to stay at a particular, acceptable, and pre-negotiated percentage. It had a system which had a very low SWIS cost-per-customer and was capable of adding more customers quickly. According to many of the interviewees, this was an integral reason why, throughout the contract period, BA was able to charge relatively low prices whilst remaining profitable and expanding rapidly both inside and outside of India. As of March 2010, this strategy has led to BA being the fifth largest mobile operator in the world, with 165 million subscribers in Africa and South Asia (Leahy, 2010: 1). More important for the current context, it has provided a clear example of a success story from SWIS use in India. The IBM–BA deal demonstrated to India-based IT companies that it was possible to make money in India, and demonstrated to potential Indian IT buyers that it was possible to automate their businesses for a risk-free and acceptably low cost by partnering with an IT-company.

Not surprisingly, deals with a pay-per-use structure between the Indian SWIS sector and many other Indian sectors proliferated after the IBM–BA deal, with a clear increase in 2005-06. Through these deals, it has become evident that the combination of necessary conditions—significant economies of scale and systems to maximise them, and a ready market able to attain scale quickly—is relevant more generally in India. Software systems installed in the country are routinely engineered to maximise already inherent economies of scale, and many different SWIS-intensive products find widespread demand within India’s borders. This combination has led to pay-per-use deals being so successful and so commonplace, that a typical response from IT executives working in the domestic market is that this is “the only way” to structure any deal (Harsh Gulati, 20 February 2009, Pune). The following two sub-sections discuss these conditions in turn. The first discusses how economies of scale and other beneficial scale effects arise from and are engineered into software systems used in India. The second discusses how a large demand for SWIS-intensive products has arisen as a result of changes in India's economy and society.

6.2.2 Software Used in Production and Beneficial Scale Effects

Figure 6.3 offers some examples of how SWIS is used in India. The examples included are of Indian companies in the SWIS-buying sectors which comprise the domestic market for SWIS (that is, they match the SWIS buying sectors identified in chapter 5). These companies and their software systems have been specifically selected to illustrate a wide range of uses offered by the Indian SWIS sector.

Figure 6.3: Examples of SWIS Use in SWIS-buying Sectors from India

Year	Client Firm	Client's Business	SWIS Firm	Project
2004	bharti Airtel	Mobile Telecoms	IBM	10-year contract for hardware, software and IT services to cover billing, customer relationship management, data warehouseing, email, Intranet services, IT helpdesks, disaster recovery.
2005	ASHOK LEYLAND	Manufacture of large motor vehicles (buses, trucks, defense vehicles)	WIPRO	30-month contract for strategic cost reduction. Includes supplier management and dynamic pricing. Wipro will train the purchasing team to use best-in-class purchasing practices and technologies, and assist with knowledge transfer to these tools.
2005	Central Bank of India	Retail and corporate banking.	TATA CONSULTANCY SERVICES	Core banking solution covering 1,000 branches and including implementation of technologies from Australia and China. Provision of Internet banking, phone banking, and mobile banking. Data center and disaster recovery.
2005	YES BANK	Retail and corporate banking.	WIPRO	7-year deal for outsourcing of entire technology requirements. Includes implementing core infrastructure and hardware, branch rollouts, networking, data warehousing, and disaster recovery.
2006	fieldfresh	"Linking Indian fields to the world". New joint venture for export of agricultural products from India.	ramco	Supply-chain management requirement, including financial, inventory, sales, procurement, and corporate performance management. Tailor-made components including aircraft space availability, farm accounting, transportation-related requirements, and farm maintenance.
2007	 India Police	Policing	HCL	Solution to track telephone calls made in 18 cities, and to record complaints registered by phone. Automated police control rooms, improvements in communications with police response vehicles. Conferencing facilities with control rooms in different cities. 24-7 response facilities.
2007	ARCH PHARMALABS LIMITED	Pharmaceutical R&D, primarily outsourced.	CollCraft	Using Uhuroo collaboration suite (web 2.0 technology) to improve information sharing between researchers working on different projects across different labs. Reduction of information clutter. Providing records of information which previously only existed in someone's head and was getting lost when people left.
2008	ACDI VOCA	Non profit international development. Improving efficiency in agricultural supply chain.	Infosys	Supply chain management from profiling of farmer clusters to crop planning, scheduling, tracking and forecasting. The application allows farmers to access technical information including database searches for data and images, access to region-specific weather updates and market information, i.e., daily sales volumes and average prices.

Sources: Adapted from CII & Accenture (2007); Collcraft Technologies (2008); Dataquest (2008); Hindu Business Line (2006); Infosys (2008); NASSCOM and IDC (2006).
Note: These case studies have been taken from industry body reports, IT company websites, and news reports.

All the examples in Figure 6.3 are systems with a different cost and/or benefit structure as compared to other, more traditional technologies used in production. In particular, they all offer some benefit in terms of lower costs or higher returns as the size of the SWIS-buying firm increases. This section uses these examples to illustrate how these scale effects occur.

The most important beneficial scale effect from IT systems is the one which was important in the IBM and BA deal: economies of scale. Economies of scale, arising from high fixed costs and low marginal costs, mean that as the scale of production gets larger[69], average costs get lower. This effect arises in software systems because of how they work and because of the nature of software itself. Many business software systems organise the information that a firm holds about another entity with which the firm does business, and automates the information tasks that the firm performs with or for that entity. So, for example, manufacturers and wholesalers (such as Ashok Leyland or Field Fresh) organise all their information relating to each supplier and/or buyer and automate their inventory procurement or sales tasks. Telecoms firms (such as Bharti-Airtel) install systems which organise all their information pertaining to each customer and automate functions like call routing and billing. Banks' (such as Central Bank or Yes Bank) "core banking" systems organise all their information by customer/account and automate functions like deposits into and payments from accounts, as well as paying interest, charging overdrafts, and cashing cheques.

These types of systems introduce economies of scale into production because for its owners, software code is free to copy[70]. Once a line of coded software has been

[69] Here the focus is on internal economies of scale, i.e. one company with one IT system dealing with lots of customers. The same benefits of scale are also available if one IT system is used by lots of smaller firms to deal with lots of customers. This possibility has not, so far, been utilised very much in India, but it may become relevant in future and is discussed in Section 6.3.4.

[70] Software is not free to copy if copyright law and licensing arrangements prevent it. This is rarely a consideration within the large software systems created by Indian IT outsourcing firms for their clients, because the software is owned either by the IT firm or the client company, and within the terms of their

created, it can be used repeatedly without incurring any additional costs and without being degraded. This is important because it means that once a system has been designed for one person or entity that a firm does business with, the cost of adding data on subsequent suppliers or customers or accounts is negligible. The code or programming written to manage the first entity can simply be copied and used again to insert more data and so manage a larger business. In this sense, the software costs of doing business are subject to economies of scale. There is a large fixed cost to initially purchasing and installing the software system, but the variable cost of expanding the quantity of data as the firm grows is so small that the reward for investing in that first large fixed cost is both a declining average and a negligible marginal software cost as the company grows.

A second beneficial scale effect is the ability to learn from gathered data. Typically, any system like those described in Figure 6.3 not only organises a company's information, but it also stores this information and, in many cases, can analyse it on an ongoing basis. In the case of manufacturers and wholesalers, once sufficient knowledge of suppliers and buyers behaviour has been accumulated, analyses with names like "corporate performance management" or "supplier management and dynamic pricing" can be undertaken. These analyses identify which suppliers are or are not performing well on criteria that matter for the firm's own profitable functioning, and identify what prices to set for the firm's output for different purchasers at different times. Once these analyses are completed, the firm can use the results to make informed decisions on how best to manage, for example, the supply

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particular agreement, they do not restrict one another from copying parts of the coding or programs when the relevant copying is part of what the system is designed to do (for example, to add new customers, accounts, or suppliers).

chain[71]. In the case of telecommunications and other firms with customer-centric systems, collection and storage of customer data and analysis called "Customer Relationship Management" (CRM) is possible. Data on services purchased and revenues collected by different types of customer are analysed for the purposes of targeting marketing and sales communications. These targeted communications enable firms with these systems to earn more money from each customer than would be possible without the system in place. In both cases, increasing returns to scale occur because these analyses are not possible without a critical mass of data collected from a critical mass of suppliers, customers, or accounts. Once this critical mass has been reached, more learning is available from additional analyses as the size of the dataset grows. As the company using the software system gets bigger, the system continues to collect and analyse ever-more data, allowing the company to continue to make better decisions and, therefore, higher profits. It is a source of increasing returns to scale that is an explicit and conscious version of "learning by doing", which plays an important role in endogenous growth models such as that of Lucas (1988). In those models, the source of learning by doing is knowledge and experience that is remembered by workers who repeat tasks many times. Here, the software, databases, and analytical tools play an analogous role. Together, they store the results of repeated tasks, and analyse this data, so that the firm can learn from its experiences.

There is a third type of scale effect arising from the use of software systems of the kind often found in Indian SWIS-buying industries. While this scale effect likely arises with all of the projects in Figure 6.3, it is particularly relevant in two which have not yet been mentioned in this sub-section. These are the projects undertaken by

[71] Decisions like these were shown in Chapter 2 to be of prime importance for profitability and competitive advantage wherever outsourcing of non-core business is the dominant mode of competition.

Arch Labs and Uhuroo—Internet technology designed to improve information-sharing between researchers working on different projects across different labs—and undertaken by India Police and Hindustan Computers Limited—to track telephone calls and register complaints. These are both examples of systems which were installed to enable firms to improve handling information on entities which remain internal (e.g., lab projects, police investigations) rather than, as with the examples discussed above, on entities such as suppliers and customers which are external to the firm. These types of systems are specifically designed to alleviate problems of co-ordination and communication that might otherwise occur as the firm grows. In fact, these are problems which have been recognised in the literature for a long time. The classic argument is that as firms get larger, it becomes more difficult for workers within the firm to co-ordinate activities with one another without transaction costs increasing disproportionately. Similarly, over a certain threshold size of firm, it also becomes more difficult for managers to monitor all their staff (Alchian and Dempsetz, 1972; Coase, 1937). That software systems can help in alleviating these sources of diminishing returns to scale is well documented in the literature on IT (Radmer and Van Zandt, 1992: 267).

It has been argued here that economies of scale arise simply because of the nature of software code, and that the other two scale effects can arise within software systems designed to handle specific tasks. What also emerges from the 2009 fieldwork is that there are decisions that can be made within the software engineering process to maximise all of these scale effects. SWIS firms working in the domestic market under pay-per-use deals reported that wherever possible they always choose to maximise benefits from scale in the systems they create. These decisions are made because of financial incentives present in the terms of these deals: IT firms make more profit if the per-use cost of servicing their client's business falls. When asked to comment on the implications of these types of deals, the president for the domestic market business for one of India's biggest IT firms confirmed, "It forces you to get economies of scale" [S. Venkatramani, 17 February 2009, Mumbai]. He added that finding ways to maximise economies of scale was an important focus of research and development in his firm, and in other firms focussed on the domestic market:

> "The number of people in India is just amazing…10 million transactions a day, 70 million accounts…when you test, when you configure, when you adopt, when you test your product…you really, really learn some wonderful experiences of what I call performance engineering in systems. How do you get the maximum out of the systems?"

As a result of all this research and development, several of the interviewees said that SWIS-buying industries in India were using some of the most easily scaleable systems in the world, with the lowest unit servicing costs. An IT industry veteran who is familiar with systems in the mobile telephony industry reported, "In India, mobile phones have the lowest call costs in the world, but are incredibly profitable because they have scale. They count on volumes. They made the trade-off between volume and margins, and they are winning" (Kiran Karnik, 13 February 2009, Mumbai).

In Indian banking, a similar situation is occurring. An interviewee working for a Western bank, using ICICI as an example, explained:

> "They've proven scale right. The issue is for an ICICI bank with 100 million customers, adding another million in another country is basically not a big deal…for example…they give you the highest rates in London on deposits.

> There's a reason for that. It's because the cost of service is so low." [Arindam Banerjii, 4 February 2009, Mumbai]

There remains one more condition which must also be satisfied for beneficial scale effects of SWIS to be useful to Indian SWIS-buying firms: sufficient demand for the products that they make. Significant demand for mobile phones was important in the IBM–BA deal because it was this demand that guaranteed increasing revenues, and so increased IBM's revenue. Similarly, in other pay-per-use deals, increasing demand is essential both for the resulting system to be used enough to activate scale effects and for IT companies to make profits. The next section covers this second condition.

6.2.3 India's middle-classes and demand for SWIS-intensive products

There is another special characteristic - as well as being free to copy - of software and SWIS-intensive products which sets them apart from other products. This time, the special nature of software has implications not only for its use in production, but for its consumption and, in particular, the circumstances under which it will be consumed. Quah (2002) investigates this aspect of software. He classifies software and many other SWIS-intensive products as "knowledge products" or products whose properties resemble the properties of knowledge itself. He argues that the most important aspect of this similarity is there is a requirement with knowledge products for the consumer to learn something in order to use it (2002: 72). Quah explains what he means using a contrast with knowledge in endogenous growth models; in these models, new knowledge reaches the consumer through two filters. First, it is patented and then it is embodied in a machine that does a particular job. Consumers buy this machine, and the task is completed without the consumer having to engage with the new knowledge itself (p. 76–77). With knowledge products, Quah argues, consumers are not able to be so passive. Using applications like online retailing or banking with SMS, as examples, he argues that it is not possible to package these types of products in a way that exempts consumer engagement with new knowledge. Instead, consumers must learn “norms and conventions”, and they must identify and master “subtleties” before they can use the product. Even then, completing any task will involve the user learning some of the new knowledge (such as how to fill in an online form, or how to send an SMS to the bank) and doing part of the work. All this presents a cost to the consumer, in addition to the cost of the product because the consumer must invest time and effort into learning how to use the product (p. 78). Quah argues that different people will find this cost uniquely burdensome, depending on the cost of their time, their background, and their level of education (p. 87).

There is an important implication of these requirements on the part of consumers. If, for some reason, consumers are not willing or able to commit the time or do not have the ability to learn how to use the product, knowledge products will simply not sell. This will hold true regardless of what suppliers offer. Quah explicitly recognises that at the time of his research, empirical evidence that this situation applies to software was not available (p. 72). However, he explores the implications for developing countries under the assumption that it is true with a mathematical model (p. 82–88). The model begins with producers who create products over two periods, and can choose in each period whether to produce knowledge products as an entrepreneur, or take a traditional job producing a composite good in return for a wage[72]. Because knowledge products by definition use and commercialise new knowledge, it is assumed that the process of creating them is uncertain and involves much trial and

[72] The composite good is an abstraction which represents all alternative goods which could be produced, besides knowledge products.

error. For this reason, the knowledge product producer can only create an experimental product in the first period. In the second period, if he continues as a knowledge worker, he may build on this experience to produce a final, finished, product which may or may not turn out to be commercially viable. Profits in each period are determined by how successful the (experimental or final) knowledge product is, and an assumption is made that this success is not dependent on how much the items or services cost to produce, but on how many of them consumers collectively buy[73].

Producers are rational and profit-oriented, so they determine in the first period how much of the experimental (in the first period) and final (in the second period) knowledge product they would supply to the market under the assumption that the final product is a success. They then work out how much profit this would earn overall[74]. If this earned amount exceeds the total wage they could earn for producing the composite good in both periods, they decide to produce the knowledge product; if not, they opt for the waged job and no knowledge products are produced. Consumers are also assumed to be rational. They choose how much of different versions of the knowledge product and how much of an alternative, composite good to buy, given their monetary budget and the price of these products. Importantly, they also take into account the additional cost of knowledge products (on top of their ticket price), which comes from the time and effort that each consumer has to spend in order to learn how to use the product. This cost is always higher for the experimental product than for the

[73] A single fixed cost is assumed for all knowledge products regardless of experimental, finished, and/or economic success or failure. This is justified because software is free for its owners (the knowledge product worker in this case) to copy, so that variable and marginal cost is zero. It is also assumed that individual consumers cannot easily copy software (and it is illegal to do so), so they are willing to pay a price of more than zero in order to consume the knowledge product.

[74] It is assumed that in equilibrium, producers know how consumers will react to their product so that they can work out how much of it they will sell and so how much profit they will make.

successful final product, and it is different for different consumers. Quah denotes this additional cost as ***v***.

Quah solves his model, and shows that in equilibrium producers never choose to bring a failed final product to market[75], so consumers must choose to purchase the experimental knowledge product during the first period, the successful final product in the second period, or neither. He then diagrammatically explores the quantity of different knowledge products consumed in societies with different average levels of ***v*.** He finds that there is a threshold level of average ***v*** above which the cost of learning or the amount of time required for a particular society is too high, so that neither the experimental nor the successful knowledge product is consumed (p. 89–90). This might well correspond to the situation where the majority of people do not have the ability, time, money, or energy to engage with the new knowledge, perhaps because it is a developing country where many people are poor and poorly educated. Importantly though, the model also identifies a middle range of a society's average ***v*** which is ideal for supporting the expansion of knowledge product sales. This range arises in a society with a large number of consumers with middling personal ***v***'s. This group is important because it includes people interested in purchasing the experimental knowledge product during the first period *and* people interested in purchasing the successful final product in the second period. Quah's model finds that no knowledge product producers would continue to the second period, where success is possible, unless they get a return in the first period from the experimental product. Similarly, no producers will create the experimental product whose return is less than the wage available for producing the composite good, unless there is a possibility of a later

[75] It is never rational to bring a failure to market because this step incurs a fixed cost which will not be outweighed by revenues from sale of the product.

success. Quah labels the crucial group with middling ***v***'s "the middle class" (p. 90), and he argues that in a developing country, large markets for knowledge products depend on this group being large. For our context, this implies that a large middle class is also essential for pay-per-use deals to be successful. Large markets for SWIS-intensive products in India depend on having enough people in the population with the time, energy, background, and willingness to invest in the learning process that is required to use them.

By 2005-06, India's economy and society had been slowly experiencing an increase in the size of the middle class for some time. For reasons outlined in Chapter 2, Section 2.2, the pattern of economic growth in India since 1980 had both favoured the existing middle class and enabled many poor people to become middle class. This led, in 2005, to the middle class numbering between 50 million and 274 million people[76]. The original research carried out in the current project validates that this growth, as Quah's model predicts, has indeed led to an increase in demand for knowledge products in India. The detailed data from the interviews repeatedly finds that it is the mass of middle-class consumers that buy SWIS-intensive products in India. In turn, the project also finds that their demand for these products is an important causative factor in explaining the acceleration in forward linkages.

Twenty interviewees, or nearly 67% of those interviewed, without being prompted, raised the subject of the new middle class, discussing increased disposable incomes, growth in the number of Indian consumers that can afford non-essentials, or the rise of the middle class as a reason for acceleration in growth of forward linkages in 2005-

[76] Numbers are dependent on how the middle class is defined. See the discussion in Section 2.2.

06. The chief executive officer of a consultancy working on marketing and strategy for several SWIS-buying firms put it this way:

> Starting [in the] 2000s, all of [the firms in potential IT-buying industries] started classifying India as a strategic market…these are growth markets, and these are large markets…so they started saying that they needed specific growth and marketing plans for the Indian market…. I think the need to service the demands that are arising just locally, because of population and growing middle class, will definitely keep the [domestic SWIS outsourcing] market going, I am confident about that. [Sudha Kumar, 4 March 2009, Bangalore]

An IT executive who works in domestic market sales concurred:

> "The middle class is expanding, led by the knowledge [SWIS, ITES-BPO] industries, they have more money to spend…[and] there is a requirement for IT there". [Harsh Gulati, 20 February 2009, Pune].

What emerged from the interviews is that the middle class in India is enthusiastic about IT and about SWIS-intensive products. They are even effusive about experimental and sometimes complicated products. An important example which was often cited is that of the Indian railway's automation. It is a significant example because online selling was identified by Quah as a key example of a knowledge product that requires effort, learning, and time on the part of consumers (2002: 72). Despite this, the interviewees agreed that the automation of ticket sales for long-distance train travel had a huge impact amongst middle-class consumers in India. Eleven of the 30 (36.6%) experts said, without being asked specifically, that it was something that middle-class consumers were incredibly enthusiastic about and had quickly adopted.

Interviewees with expertise on marketing to the middle class said that the enthusiasm for IT and SWIS-intensive products was a general one that applied to all groups within the middle class. A market research executive with 20 years experience in India illustrated the difference between Indian and Western middle-class consumers. He explained that, after having undertaken a cluster analysis on attitudes towards IT in India, his company attempted to label the clusters: “We once tried to impose some Western ideas, like ‘computer-inept’ or ‘computer-scared’ [but] there’s nothing like that. There’s only people who don’t know and would like to know, or people who know and love it; [those are] the only two segments” (Mohan Krishnan, 19 January 2009, Delhi). India’s middle-class consumers also have the background and time which offers them the opportunity of learning how to use the technology. Krishnan gave a broad description of “typical middle-class consumers” based on research his firm had undertaken amongst this group[77]. Predominantly urban, he said, they typically live in areas well served by fast broadband. They are generally young and are fast learners with the technology, and feel comfortable using it. For some, familiarity with technology arises from work in the ITES-BPO or SWIS sector, whilst many others know of someone who works in the industry, or have seen Western uses of the technology on television.

It is a situation which matches closely with Quah’s description of a society which has a middling range of $\boldsymbol{v}$. India’s middle class has the time and opportunities (such as

[77] The demographic and geographic components of this description are verified by data presented in ADB (2010).

access to broadband and education) required to constitute the right kind of market for SWIS-intensive products. They have also, by the definition of what constitutes "middle class", enough income to be able to afford luxuries. In fact, the only note of caution on middle-class demand for SWIS-intensive products sounded by interviewees in the 2009 fieldwork was related to money. They took pains to emphasise that middle-class demand in India is highly dependent on the value received in exchange for money. This attitude is so widespread that Subbu Hariharan, a banker, labelled it the "Indian psyche". According to him, and others, the Indian middle class demands quality products, wants to be seen consuming quality products, and is prepared to pay extra for quality, but they want the price to be as low as possible. This is not surprising given the income levels of Indian middle-class consumers. Of a total estimate of 274.13 million middle-class consumers in 2005 estimated by ADB (2010: 8), an overwhelming majority, 223.82 million, earned between \$2 and \$4 per day, enough to put them above the poverty line used in that study (\$2 per day), but not by much. These consumers have an "unflinching focus on price" (Subbu Hariharan, banker, 5 February 2009, Mumbai), and are "very focussed on value" (Alok Kumar, IT purchasing manager of a large conglomerate, 12 February 2009, Mumbai). For them, high quality at a low price is essential for bringing them into the market for a particular product.

It is because of this focus on value that a guaranteed low price per-use for SWIS, as is available to SWIS-buying firms through pay-per-use deals with the IT sector, is so important in allowing domestic market deals to be brokered. Although India's middle-class consumers want IT and IT-intensive products, and have sufficient time, money, and education to learn to use it, they are not wealthy by Western standards. What was so important about the IBM–BA deal was that it was the first to show that this does not stop IT and IT-buying companies from making money by working together. If middle-class demand is sufficient to activate scale effects when the technology is used in production, then the price of the technology can be low: this allows the price of the final product to remain low, which in turn, because of the existence of a large middle class, ensures significant demand.

6.2.4 A virtuous circle of scale effects and low prices

This section has demonstrated that Indian SWIS-buying industries that have bought SWIS under pay-per-use deals since the IBM–BA agreement have been able to take advantage of a new appropriateness of the technology for the Indian context. Through a combination of new analysis of the nature of software and an application of existing models, the section has shown that there is a virtuous circle around SWIS use in India. If prices of SWIS-intensive products can be kept low, there will be a large market for them amongst India's middle class. Prices can remain low even after purchase of SWIS because, whenever there is a large enough market, economies of scale built into the software systems can deliver automation for low per-unit costs. The IBM–BA deal was the first to demonstrate that this virtuous circle of large markets, scale effects, and low consumer prices could be successful in India. That the structure of that deal has been copied many times as domestic market growth has accelerated verifies that it is a virtuous circle that works in many other IT-buying industries in India too.

This appropriateness of the technology for the Indian domestic context was not foreseen by analyses of forward linkages from the SWIS sector in the literature discussed in Chapter 3. Its possibility and implications have also been missed in the literature on the economics of IT. While several contributions have identified economies of scale or other beneficial scale effects as arising from the use of IT, discussion of the implications of these has focussed on industry structure or on the location of industry and assumed that IT is sold directly to consumers, not used within firms (Quah, 2000, 2001; Varian, 2001). This section adds to that literature in two important ways. First, scale effects have been identified and explained in a new context, and in detail. Second, a new implication of scale effects—appropriateness in developing countries with large middle classes—has been identified. A useful extension to this analysis would be to understand whether and how this appropriateness exists in other developing countries with large, emerging middle classes. This avenue for further research is discussed in Chapter 8.

In the meantime, the ability of Indian IT-buying industries and the SWIS sector to continue to capitalise on the appropriateness discussed here will be important for the future of the domestic market. The challenge for IT companies which wish to continue to expand in India is twofold. First, they must continue to provide SWIS to those large companies which have not yet become mature IT users. Second, they must identify ways of harnessing scale effects to enable affordability outside of these large companies[78]. The Indian IT industry is aware that small- and medium-size companies are far more numerous than large firms, and IT experts in the 2009 fieldwork frequently discussed possible ways to address this market. As of 2009, the IT industry and India's smaller companies were experimenting with both novel technologies and new financial arrangements. In particular, one IT analyst explained that "cloud computing" will be important to the domestic market in the future (Seepij Gupta, Delhi, 30 January 2009). This will allow small- and medium-size firms to connect with one another and to share software online on a pay-per-use basis. An IT executive

[78] Evidence from the 2009 fieldwork that large companies constitute most of the domestic market addressed by NASSCOM members is discussed in Chapter 7.

working in Indian manufacturing also reported that plans are under way to provide business software similar to that used in large companies, but scaled down to fit the needs of small- and medium-size companies. This software would not be built for each individual company, but instead it would be developed and repeatedly copied so that thousands of identical products, applicable to thousands of similar small companies, would be produced and sold (Vasu Rao, Bangalore, 2 March 2009). Another interviewee, a senior vice president at NASSCOM, emphasized the value of new mobile technologies and cheap, widely applicable “apps” which can be delivered through mobile phones. He was positive that new devices with touch screens and voice recognition, both of which will be invaluable to illiterate Indian small business owners, will become incredibly important in the future (Rajdeep Sarawat, 22 January 2009, Delhi).

The responses from the interviewees suggest that there may well be room for continued growth in forward linkages. For its part, and as a leading sector must, the SWIS sector is actively investing into continued expansion of domestic forward linkages.

6.3 Other explanations are not much help

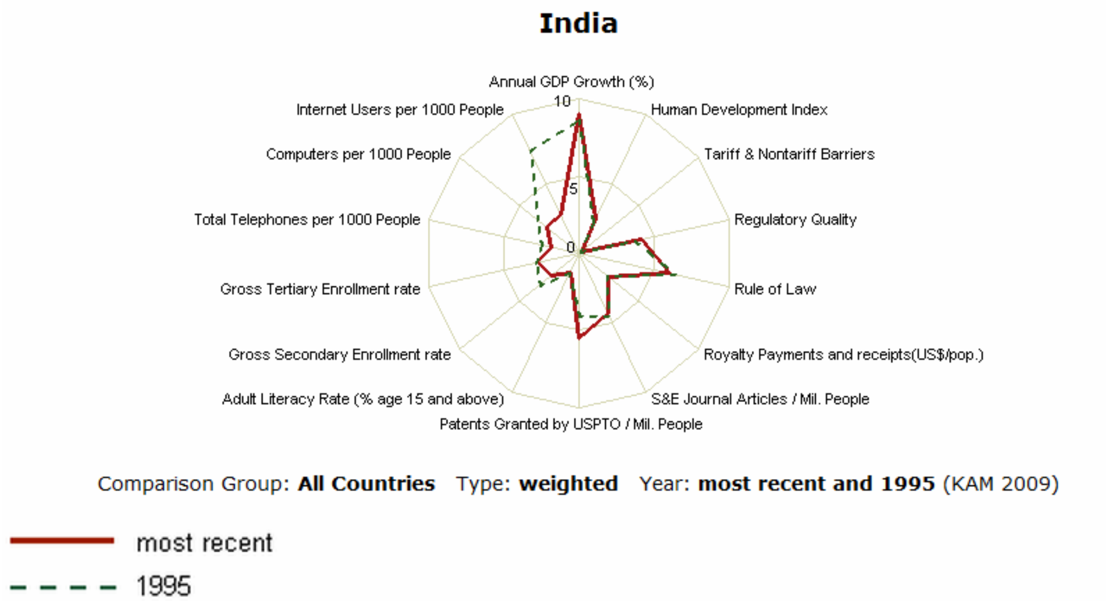
This section briefly covers possibilities for growth in forward linkages which the research found to be either of secondary or of no importance. These possibilities were discussed during the 2009 interviews or investigated using secondary data, and as such, there is a reasonable amount of evidence to suggest that they are not major causes of growth in forward linkages.

Comparative advantage and the relocation of production for global markets

Section 3.3.2 discussed Dahlman and Utz's (2005) analysis as one set of processes by which acceleration in forward linkages might occur. In their framework, if India scored relatively well on endowments and macroeconomic or regulatory environment measures, markets might efficiently allocate knowledge-enabled industry, services, and agriculture within its borders. This would mean that India's IT-buying firms might then begin to supply global markets with their products, and that global firms in those sectors, would find it optimal to relocate to India. If this happened, these firms could possibly find it optimal to install complicated IT, including SWIS, and be willing to pay the price for the help they needed to do so. It was argued in Chapter 3 that the process of accumulating endowments is generally a slow one. It was also argued that for India to score *relatively* well on these measures, it would need to overtake other countries on measures important for knowledge-enabled industries. To be certain that Dahlman and Utz's (2005) mechanism is not also a contributory factor however, Figure 6.4 shows the change in the World Bank's Knowledge Assessment Methodology (KAM) basic scorecard between 1995 and 2007-08.

The scorecard maps observations for India on 14 variables[79]. The data is normalised so that for a country to perform better over time on a particular score, it must not only improve in absolute terms, it must also improve faster than the rest of the comparator group of 140 countries. If Dahlman and Utz's model was indeed the correct one to explain the trend break for the Indian domestic market for IT services, we should be able to observe a contemporaneous improvement in its endowments and macro-environment relative to the rest of the world.

Figure 6.4: Change in India's Knowledge Assessment Methodology Scorecard from 1995 (dotted line) to latest data (solid line, data mainly from 2007-08)



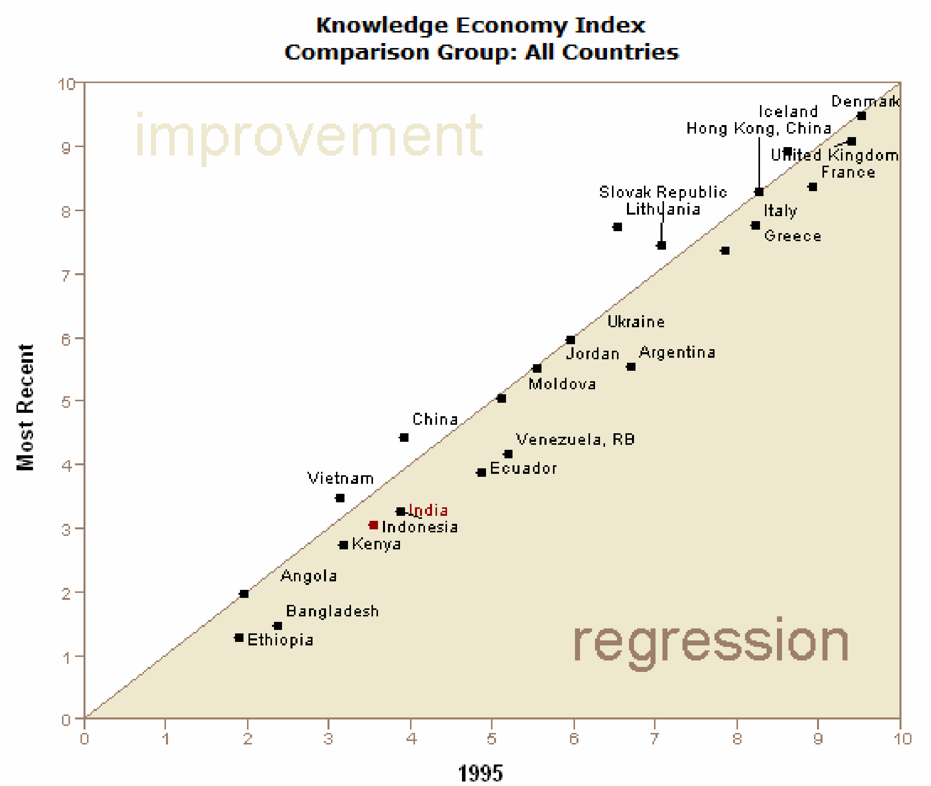
Source: World Bank (2009)
Note: The dotted line refers to 1995. The solid line maps 14 variables labelled most recent as at 2009.

According to the chart, India improved relative to the rest of the world on 8 out of the 14 measures, but fell further behind on the 6 others. However, the magnitude of the positive changes are all smaller than the negative ones, so the chart seems to report an overall deterioration rather than improvement. This is reflected in the World Bank's weighted aggregation of the normalised scores in Figure 6.6 into a single Knowledge

[79] Dahlman and Utz treat these measures as causal factors for emergence of a knowledge-based economy, and, by extension, the argument is that they are causes of increased use of SWIS. However, some of the variables cited (in particular GDP growth and human development) may also actually measure the results of use of SWIS. Since none of the variables where causality is debateable has altered to any degree in Figure 6.6, this should not affect the argument of this section.

Economy Index (KEI)[80]: Figure 6.5 plots the index in 1995 and its most recent value in 2008 for all 140 countries. The year 1995 is plotted against the x-axis and the most recent data against the y-axis. These two axes have the same scale, so that a marker on the 45-degree line indicates no change in the KEI. Markers above the 45-degree line indicate improvement, and below the 45-degree line indicate regression. The red mark for India is near, but below, the 45-degree line, indicating a minor deterioration between 1995 and the most recent data[81].

Figure 6.5: India (and other countries) performance over time on the Knowledge Economy Index from 1995 to latest data (mainly from 2005)



Source: World Bank (2009)
Note: The x-axis refers to 1995. The y-axis refers to most recent data. Of the 12 variables that comprise the KEI, the "most recent" data is from 2002-03 in 1 case, 2005 in 5 cases, 2006 in 5 cases, and 2008 for the remaining 1 variable.

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[80] The KEI includes all of the scores in Figure 6.6 except GDP growth or human development index. These 2 measures are excluded as they may also be interpreted as results of the use of SWIS rather than causes.
[81] It is a result which would not be entirely surprising to Adrian Wood. His prolific research on comparative advantage has held that India's endowments are best suited to labour-intensive manufactures. His 1999 article, co-authored with Jorg Mayer, concludes that this is a situation that is unlikely to change in the short term (1999: 35).

None of this analysis precludes the possibility of endowments (such as Internet access, or the prevalence of computers) increasing in absolute terms and being useful to the expansion of demand for SWIS which has been discussed in this chapter. What figures 6.4 and 6.5 demonstrate is that India has not experienced an improvement in knowledge-specific endowments and/or market environment relative to the rest of the world. This means that the kind of change that Dahlman and Utz's (2005) analysis identified as needed if India is to become an ideal location for production of SWIS-intensive products for world markets has not happened, and suggests that their theorising is therefore not useful for explaining the significantly improved growth trajectory of forward linkages since 2005-06.

Uneven and combined development

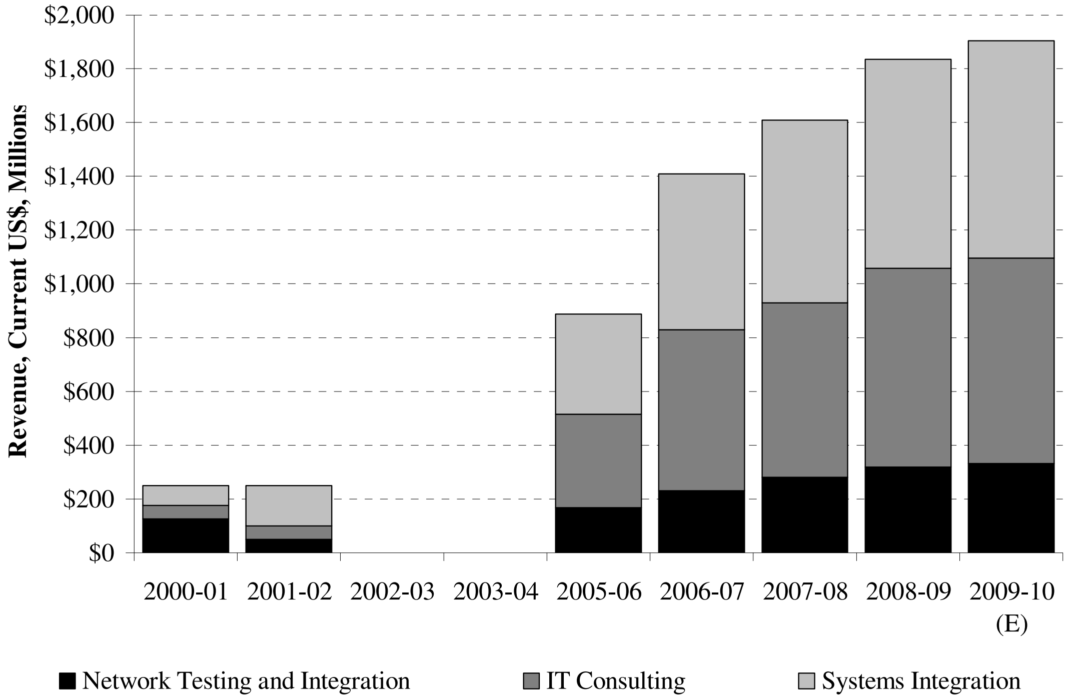
Another possibility arises from D'Costa's (2003) dependency theory of uneven and combined development, which found that the extent of the domestic market remained small because both India's potential IT-buying firms and SWIS firms were involved in a pattern of development that prevented them from learning how to work with one another. In particular, SWIS firms were generally prevented from upgrading the skill and value profile of their work in export markets, which in turn prevented finding ways to address the domestic market. If this explanation of a small domestic market was true, then any change to this systematic deterrent on domestic market growth could be an explanation for acceleration in 2005-06.

Although D'Costa's own work should be an obvious starting point for evaluating his theory, his many publications (2003, 2004, 2006)—which put forward the idea that upgrades in Indian SWIS are generally being thwarted by the nature of their export relationships—fail to offer significant and convincing empirical evidence to that effect. Only one of these publications, a chapter in a book co-edited by D'Costa, offers any data on what Indian IT firms actually do (D'Costa 2004). The data is a breakdown of 400 companies' claimed specialisations in 1988 into fairly broad categories (p. 63, Table 3.2). By D'Costa's own admission, these categories could include both complex and less complex projects, but the commentary around the data argues, without supplementary evidence, that Indian firms' specialisations are actually at the low end of each category[82]. What is perhaps more damning for his methodology is that he uses data from only one point in time six years prior to his publication date of 2004 to argue that there has been little improvement in IT firms' capabilities over the lifetime of the industry. It is a difficult interpretation to accept, because in the previous chapter of D'Costa's co-edited book, another author reports a doubling of export revenues (from US$75m to US$150m) for the high value "systems integration" category between 2001 and 2002 (Sridharan 2004b: 36-37, Table 2.3). It is a striking contradiction in narrative between the two authors and the two chapters in a single book.

Figure 6.6 corrects for D'Costa's empirical omission by reporting a time series on Indian IT Sector export revenues earned from higher-value project categories. Revenue from these exports has increased from $250m in 2000-01 to $1.9bn in 2009-10. In other words, revenue from these categories is now roughly 7.5 times higher than it was 9 years ago.

[82] For example, D'Costa interprets the statistic that 46% of his sample claim specialisation in high-end "Enterprise Solutions" as evidence that these firms are specialists in legacy systems and the phasing out of old hardware, He writes that, "[U]nder 'enterprise solutions' (Table 2.3) we also have systems integration, an area of considerable technical complexities. However, the category is broadly understood to mean integrating various components, which not coincidentally includes not only various turnkey projects and ERP but also various legacy systems. For example, old hardware could be phased out or new software applications added on" (2004: 65).

Figure 6.6: Indian IT sector revenues from high value export projects



Source: Adapted from NASSCOM (2008: 203); Sridharan (2004b: 36-37, Table 2.3)
Note: Financial years run from April to April. Data for April 2002 to April 2004 is unavailable. 2009-10 is estimated by NASSCOM in 2008. This is denoted as E in the figure.

In returning to the subject of learning, the IT sector experts interviewed for this research confirm the new evidence. They often repeated that learning occurs in their export relationships and can be applied in the contracts that they negotiate in India. Chapter 7 returns to this process of learning and cross-border knowledge transfer, and details how it is vital to the findings on the impact of forward linkages. For now, it is sufficient to note that D'Costa's (2003) model of uneven and combined development was never, according to these interviewed experts, a significant drag on the extent of forward linkages. For that reason, changes in that mechanism could not have caused the acceleration.

Government of India as an IT buyer

The Government of India (GOI) is a substantial buyer of outsourced SWIS, and therefore it has had a direct effect on growth of the domestic market for IT. Figure 6.7

details a selection of government IT projects which use SWIS purchased from the IT sector. These projects are important because they promote IT usage in India as the population engages with these systems. They are also important because they demonstrate the capability of India's SWIS sector and offer experience which enhances that capability[83]. Several of the projects undertaken by the GOI use IT to deliver services to businesses which may have had no previous experience using IT. These projects are often large and complex, and often need to address the same kinds of concerns as reported by all Indian businesses (NASSCOM and IDC, 2006: 21).

Figure 6.7: Government IT Projects which purchased IT services

CENTRAL GOVERNMENT		
Income Tax	A pan-India network to cover 745 Income tax offices in 510 cities and 12000 online users over a hybrid network comprising optical fiber leased lines, ISDN for backup and VSAT connectivity for remote locations	Ministry of Finance/Central Board of Direct Tax
Passport Visa and Immigration Project	Electronic recordkeeping and verification of passport and immigration information	Ministry of External Affairs/Ministry of Home Affairs
DCA21	Modernization and computerization program of Ministry of Company Affairs; envisages electronic-filing of companies' documents through an entirely paperless process	Department of Company Affairs
National Citizen Database	Project objectives include preparing a National Population Register (NPR), National Register of Indian Citizens (NRIC), National Register of Residency (NRR) - for non-citizens and providing a National Identity Number (NIN) to each person, a Multi-purpose National Identity Card (MNIC) to each citizen, and a Multi-purpose Residency Card to non-citizens	Ministry of Home Affairs/Registrar General of India (RGI)
E-Biz	To promote e-business adoption by establishing a single-window for G2B services for Central, State, and Local Governments; to enable on-line event-driven interactions by re-engineering and forms and procedures thereby reducing time for establishment, and reducing burden of compliance	Department of Industrial Policy and Promotion / Department of Informatio Technology

Source: NASSCOM and IDC (2006: 21).

However, government officials interviewed during the 2009 fieldwork reported that government spending on SWIS only began to rise significantly in 2006-07 when an

[83] Government purchasing was also important in technology-enabled growth in East Asia because of this mechanism, according to Wade (1990).

"e-government project"—designed to automate many government services—was launched. This took place later than the trend break in 2005-06.

Other explanations

During the fieldwork, other explanations for the acceleration in forward linkages were analysed, but then discounted. These include: saturated export markets (possibly true in the United States, but not in Japan and Europe); recession in export markets (which happened too late to explain acceleration in 2005-06); and pressure from global suppliers or buyers in potential client firms' value chains (most Indian SWIS-buying customers seem more concerned with domestic, not international, sales).

6.4 Conclusion: A very different picture to that suggested in the literature

The experience of the domestic market for outsourced SWIS covered in this chapter is, at first glance, an example of successful de-regulations and liberalisations. Reforms have led to a more open and less regulated economy and to private sector participation in many industries; in turn, this has led to investments into the tools that facilitate competition in a modern global world, namely, software systems. However, under closer examination, the theoretical model given to support such reforms in the publication by Dahlman and Utz (2005) cannot explain major dynamics in the market. The acceleration in the size of the domestic market for SWIS in 2005-06 does not correspond to any significant improvements relative to the rest of the world in either India's endowments for hosting SWIS-intensive businesses or in its regulatory environment. In short, it does not correspond to any change in India's comparative advantage in SWIS-intensive production. This chapter has found that there are, instead, two different causes of growth in domestic forward linkages from the SWIS sector.

The first, covered in Section 6.2, outlined a role for reform, which saw gradual, piecemeal liberalisations in potential SWIS-buying industries as being responsible for the ongoing, slower growth in SWIS purchasing before 2005-06. What emerged from the 2009 fieldwork is a clear corroboration of the expected effects of this reform by India's own policymakers, elucidated by a GOI economist (Virmani, 2006). Reform in potential SWIS-buying industries started with pro-business policies, and then, later, moved on to pro-market reforms. This particular sequence and style of reform gave potential SWIS-buying industries a window of opportunity to prepare prior to the introduction of competition from foreign companies. The section demonstrated that, given this window, many Indian firms in potential SWIS-buying sectors decided to invest in SWIS. The second, which is the more important contribution to the thesis, was outlined in detail in Section 6.3. This gave the reason for exceedingly rapid growth since 2005-06. The section revealed that the cause of acceleration in forward linkages was a demonstration and realisation that SWIS had become an appropriate technology for the Indian context. The realisation occurred because of an innovative deal between IBM and Bharti-Airtel at the end of 2004-05. The appropriateness arose because a characteristic of the technology—economies of scale—closely matched an emerging characteristic of the Indian economy: large, middle-class markets. In introducing a new way of paying for SWIS outsourcing, the IBM–BA deal accomplished two things. First, it alleviated the need for Bharti-Airtel to make a risky upfront investment of the kind that Hirschman identified as difficult for developing-country entrepreneurs. Second, it demonstrated that SWIS is sufficiently appropriate for the Indian context for it to be possible for IT companies to make profits whilst still delivering SWIS at an acceptably low per-use price. It was a great financial success for both IBM and Bharti-Airtel, and many similar deals have been struck in the domestic Indian market since 2005-06.

Taken together, the findings of this chapter are revealing about how forward linkages from the SWIS sector came about. If it is also found that forward linkages from SWIS have an important impact in India, the findings are also revealing about how to get firms in developing countries to invest in productivity and growth-enhancing new technologies. Interestingly, neither of the two theoretical papers from the literature turned out to have much traction. The extremely market-oriented model of Dahlman and Utz (2005) and the Marxist model of D'Costa (2003) both placed too much emphasis on, respectively, the optimal or the power-brokered location for the supply of SWIS-intensive products around the world. In doing so, both models missed the importance of the local story. Neither one of these two analyses suspected that SWIS might become appropriate for India, and so neither noted an important role for Indian domestic demand. It is an omission that may not have been so problematic if the subject of analysis was not SWIS and SWIS-intensive products. According to Quah (2002), for knowledge products, demand has veto power over sales, regardless of supply conditions. This means that the demand-side cannot be overlooked in favour of solely supply-side analysis.

Another interesting outcome from this chapter concerns the role of the Indian government in bringing about domestic forward linkages from the SWIS sector. There is no doubt that the government's own purchases of SWIS have been a contributory factor, and have provided demonstrations of what SWIS can do. In addition, the sequence and style of reform pursued by the Indian government has been shown to be one of two major causes of forward linkages' expansion. The gradual, piecemeal reform discussed in this chapter has actually had results very similar to those expected of traditional infant industry policy. Potential SWIS-buying industries have been helped to invest and upgrade by "pro-business" reforms, while tariffs and other trade barriers remained in place. Full liberalisation and the threat of competition from technologically advanced foreign firms have been used as a threat to ensure that upgrading actually does happen, so that support from the government does not have to last forever. This intrusion of government into outcomes in potential SWIS-buying sectors is surprising, given that the idea of liberal reforms is ostensibly to roll back the influence of the state and end interventionist industrial policy. It is even more surprising given that these reforms were enacted during a period in which government interference in specific industries was politically constrained (Pederson, 2000: 276).

Still, the most important findings of this chapter are not about the role of government. The acceleration in forward linkages in 2005-06 has been attributed to leading sector behaviour on the part of the SWIS sector. In entering into pay-per-use contracts with India's IT-buying sectors, SWIS firms have exempted their clients from taking the entrepreneurial risk of large, fixed-cost software systems. Instead, as Hirschman (1958) might have predicted decades earlier, a leading IT sector made investments into IT-buying industries by producing software systems which are outputs of the SWIS sector and inputs to IT-buying sectors. This has allowed SWIS firms to fully demonstrate the benefits of their software systems, and so alleviate concerns that their clients might have about the usefulness of the systems. By waiting until their clients use the system for payment, and agreeing to a per-use fee, SWIS sector firms have also been able to ensure that the system will never cost more than a known, acceptable proportion of the price of their customers' final output.

Chapter 7 moves to the final set of results from the research project, and covers the findings on the impact of SWIS use in India in terms of productivity and output.

7. Results: Forward Linkages have a big impact on output and productivity

This chapter provides evidence that forward linkages from the SWIS sector lead to significant increases in output and productivity. Estimates from the new research described here demonstrate that these effects were responsible for between 1.3 and 2.4 percentage points, or between 10% and 20% of GDP growth per year between 2005 and 2008. This means that they have an impact which is comparable to that experienced from use of IT by the United States and Europe during the 1990s[84].

The work contained in this chapter has an important place in the literature. The most meaningful reason for this is because the chapter contains the third and final major contribution of the thesis, and completes the argument that forward linkages from the SWIS sector make an important contribution to India's economy. The work contained here also contributes to the literature on the impact of information technology. For all the considerable effort expended in that literature, no previous publication has contained comprehensive empirical analysis of outsourced IT. Even on related issues which have received a lot of attention, in particular the impact of non-IT outsourcing or in-house IT, there are very few existing contributions which focus on developing countries[85]. Of these, none has as rich a quantitative dataset as that used here, and none includes, as this chapter does, complementary qualitative research.

The remainder of the chapter is laid out as follows. Section 7.1 begins with an econometric examination of the impact of outsourced SWIS in production. Section 7.2 complements this research with a qualitative account of why outsourced SWIS is so important to those firms and sectors that buy it. Section 7.3 discusses the results in

[84] See Chapter 2.
[85] Literature on the impact of non-IT outsourcing and in-house IT was reviewed in Chapter 2.

different sectors and the impact of SWIS at the macroeconomic level. Section 7.4 concludes by highlighting the importance of this chapter's work and identifying several interesting avenues for further investigation.

7.1 Estimating the impact of forward linkages using econometrics

This section forms the main body of new evidence on the impact of SWIS outsourcing. It describes research which analyses a large sample of firm-level data from India. The research first establishes the impact of forward linkages from the SWIS sector on output, and then goes on to investigate the implications of SWIS for specific aspects of firms' total factor productivity. The section is split into four sub-sections; these cover, in turn, methods, data, initial analysis, and econometric results.

7.1.1 Methods

The form of the econometric model which sets out to quantify the impact of SWIS on output is based on techniques which are used in the literature to research the impact of in-house IT and of general materials or services outsourcing[86]. It has been designed specifically for this project using a combination of approaches from both sets of literature. This combination of approaches was necessary because, on the one hand, outsourced SWIS plays a similar role in production as other outsourcing, in that it occurs outside the firm. On the other hand, though, outsourced SWIS also has the potential to either complement or substitute for IT used in-house by firms. This means that any evaluation of outsourced SWIS must include an evaluation of in-house IT or risk misattribution of output or productivity effects. Methods from both literatures use a framework in which output can be linked to the capital and labour used to produce it through a production function like equation (1)[87].

$$Y = AF(K, L, M) \qquad (1)$$

[86] Introduced in Chapter 2

[87] If there are constant returns to scale in the sample under consideration, equation (1) can also be expressed as a "per worker" version, where all variables are divided by *L*. This is common in the literature on developed countries, particularly for the United States, where the data supports constant returns to scale (e.g., Stiroh, 2002: 13).

Here Y refers to gross output; K to stocks of capital; L to the size of the labour force; M to intermediate inputs (including materials, energy, and any other purchased inputs to production) and $F(.)$ to the function which determines the amount of output which is produced from a given quantity of inputs. A refers to total factor productivity (TFP) and measures the efficiency with which all inputs are converted into output.

The literature on the impact of in-house IT modifies this production function to include IT assets, which typically include both hardware and software, as special types of capital (Jorgenson, Ho, and Stiroh, 2007; Stiroh, 2002,). This yields a new production function in the form of equation (2). Here, K is re-defined to mean non-IT capital, and IT is hardware and/or software assets.

$$Y = AF(K, IT, L, M) \qquad (2)$$

The literature on non-IT outsourcing postulates that firms which outsource experience improvements in TFP[88] (Olsen, 2006). This leads to equation (3) in which OSS refers to the outsourcing of services, and OSM to the outsourcing of manufactures or materials. Y, K, L, M and $F(.)$ are defined as before.

$$Y = A(OSS, OSM)F(K, L, M) \qquad (3)$$

In both sets of literature, it is common to assume a Cobb-Douglas functional form for $F(.)$ and then take logs. This gives a log linear production function, like equation (4) in the IT literature and equation (5) in the outsourcing literature, which is amenable to

[88] See Chapter 2.

quantification of parameters using either national accounts data[89] or econometrics at the firm- or sector-level[90].

$$\ln(Y) = \ln(A) + \alpha_K \ln(K) + \alpha_{IT} \ln(IT) + \alpha_L \ln(L) + \alpha_M \ln(M) \quad (4)$$

$$\ln(Y) = \gamma_1 \ln(OSS) + \gamma_2 \ln(OSM) + \alpha_K \ln(K) + \alpha_L \ln(L) + \alpha_M \ln(M) \quad (5)$$

In equations (4) and (5), "ln(.)" is the natural logarithm, the γ's are the elasticities of output to non-IT outsourcing, and the α's are the elasticities of output to the other inputs. All other elements of the equations are defined as before.

Combining equations (4) and (5) and replacing outsourcing of services and manufactures with outsourcing of SWIS, denoted as *OSSWIS*, leads to equation (6). This form is designed specifically for this project and is the basis of the empirical work below that sets out to measure the impact of SWIS on output.

$$\ln(Y) = \gamma \ln(OSSWIS) + \alpha_K \ln(K) + \alpha_{IT} \ln(IT) + \alpha_L \ln(L) + \alpha_M \ln(M) \quad (6)$$

Estimating equation (6) using macro-level data, as in the bulk of the literature on the impact of in-house IT, is inappropriate for the current context because the method relies heavily on neo-classical assumptions of frictionless factor markets and unconstrained profit maximisation (Oliner and Sichel, 2000) which are unlikely to

[89] Some examples from this large literature include Gordon (1998, 2000, 2003); Jorgenson and Stiroh (1995); Oliner and Sichel (1994, 2000, 2002).
[90] Examples of econometric approaches from the fairly extensive literature on in-house IT include Baily and Lawrence (2001); Basant et al. (2006); Bresnahan, Brynjolffson and Hitt (2002); Brynjolffson and Hitt (1993); Greenan, Mairesse and Topial-Bensaid (2002); Sadun and Van Reenan (2005); Stiroh (2001); World Bank (2006). The much smaller literature which examines the impact of non-IT outsourcing using econometrics includes Amiti and Wei (2004, 2006); Banga and Goldar (2004); Criscuolo and Leaver (2005); Egger and Egger (2001); Gorg and Hanley (2003, 2005); Gorzig and Stephan (2002).

hold true in India[91]. Instead, gamma, the elasticity of output to SWIS, is quantified in the results below through the estimation of log-linear econometric models, a method which requires considerably fewer assumptions (Stiroh, 2001: 10–11), and which has the advantage of enabling the results to be subjected to a battery of robustness tests.

To investigate the impact of SWIS on productivity in more detail, the research project then undertook a study of how SWIS impacts the technology component of firms' TFP, that is, their technical efficiency[92]. This part of the project involved the estimation of a stochastic frontier model, a type of econometric analysis which was designed specifically to measure and then analyse aspects of TFP (Battese and Coelli, 1992, 1995). The technique involves estimating a log-linear version of the production function, and identifying its parameters for those firms in the sample that use their inputs the most efficiently. In other words, it involves identifying the production function of those firms that are at the production possibilities frontier[93]. At the same time, the procedure also estimates, for each individual firm, a "distance" away from this production frontier. This distance metric measures the difference in output between what a firm would produce if it were as efficient as those high performers and what it actually produces; in other words, it is an output-based measure of technical inefficiency. In the work for this project, stochastic frontier modelling was used to estimate equation (7). The firm-level inefficiencies were then stored and used as the dependent variable in a regression with SWIS purchases and other variables which might affect technical efficiency. This is shown as equation (8).

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[91] For example, Besley and Burgess (2004) find that that regulation in the labour market constrains firms and is deleterious for manufacturing output.

[92] A technically efficient firm uses the most efficient technology for converting inputs into output. This means it cannot raise output without increasing one or more inputs. It also cannot produce the same output with less of any particular input, unless it increases the amount of other inputs used.

[93] The set of maximum possible amounts of output which can be produced with a given set of inputs is referred to as the production possibilities frontier. It is referred to as a "frontier" because changes in this set occur as new, more efficient production techniques are discovered and the maximum possible amount of output increases.

$$\ln(Y) = \alpha^*_K \ln(K) + \alpha^*_{IT} \ln(IT) + \alpha^*_L \ln(L) + \alpha^*_M \ln(M) - \ln(E) \quad (7)$$

$$\ln(E) = \beta_{SWIS} \ln(SWIS) + \sum \beta_j z_j \quad (8)$$

In equation (7) the asterisked alphas denote elasticities at the frontier, and "-ln(E)" is the output measure of inefficiency. In equation (8), this measure is multiplied by -1, so that it can be interpreted as a positive measure of efficiency. The betas measure the elasticity of technical efficiency to SWIS purchases and also to a group of other controls denoted by z.

7.1.2 Data

The main source of data used to quantify equations (6), (7) and (8) is the PROWESS database, published by the Centre for Monitoring the Indian Economy (CMIE, 2009). This rich data source includes a panel of approximately 25,000 large- and medium-size firms from 2005 onwards. Included firms are those registered on India's major stock exchanges, as well as many public-sector enterprises. The CMIE (2009) reports that the database includes most organised industries, banking, and services, and, as evidence to support this claim, it estimates that the included firms contribute 75% of all corporate taxes and 95% of all sales taxes collected in India. PROWESS reports assets, expenditures, and outputs for these companies over several years, although not all years are populated with all of the relevant measures for all firms. Despite this patchiness, and despite the project's timings precluding use of data from after 2008, the database still offers a large dataset for the purposes of estimating equations (6), (7) and (8). In total, there are an estimated 33,600 populated observations on nearly 12,800 firms, with most firms reporting data in either two or three of the four years in the sample. Figure 7.1 shows the breakdown of these populated observations by year and sector. Roughly half of the observations are from manufacturing firms, and the other half are split approximately equally between finance and non-financial services.

Figure 7.1: Populated Sample by Sector and Year, Number of firms

	2005	2006	2007	2008	Total
Manufacturing	5,594	5,054	4,122	2,510	17,280 (51%)
Finance	3,061	2,623	1,847	885	8,416 (25%)
Services	2,688	2,346	1,819	1,015	7,868 (23%)
Total	11,343	10,023	7,788	4,410	33,564 (100%)

Source: Author's calculations based on CMIE (2009).

Unfortunately, the PROWESS database, and, consequently, the sample used here, suffers from attrition, particularly in 2007 and 2008. This does not appear to have significantly affected the sector-wise composition of the sample, with the split for Manufacturing (50%) and Services and Finance (25% each) remaining consistent through all four of the years. Despite this, the potential for attrition bias does remain a concern and is the subject of robustness tests discussed below.

Appendix A2.1 includes a detailed data dictionary for all dependent and independent variables used in the analyses, including an account of all transformations that were carried out on them. It illustrates that the data used here underwent a careful treatment designed to ensure accurate identification of the impact of SWIS outsourcing. Capital variables are net of cumulative depreciation so as to better capture their productive value rather than their cost at purchase. In addition, all of the production function variables measured in financial terms (output, capital (including IT capital), intermediate inputs, and SWIS outsourcing), have been corrected for inflation using individually appropriate price indexes. Price indexes for non-services variables have been sourced from the Reserve Bank of India's (2011) Wholesale price indices. For services variables, GDP deflators have been constructed from real and nominal output in the appropriate sector, as published in the Indian National Account Statistics (Ministry of Statistics and Programme Implementation 2011). Software, both in-house assets and outsourced, is deflated using a recent index of software prices constructed by Prud'homme, Sanga, and Yu, (2005) for Canada. No equivalent index exists for India, but a decline in software prices of approximately 6% per year, as was found in Canada, is broadly consistent with qualitative data on the price of domestic market SWIS collected during the 2009 fieldwork.

Appendix A2.1 also gives a complete definition of the variable used to measure SWIS outsourcing in the analyses which follow. PROWESS does not report expenditure on SWIS separately, but instead includes it in the data field titled "Expenditure on Software and Other Professional Services". The definition of this latter metric shows that it includes expenditures on SWIS and on all other "Expenses reported by a company on external professional services engaged by the company for services other than for audit, consultancy, software development, IT-enabled services, cost audit and legal services" (CMIE 2009). Using this metric as a measure of SWIS outsourcing is justified, because a major portion of what is included in it is SWIS outsourcing[94]. This is verified by the distribution of expenditure as measured by this variable across sectors in the sample. Average expenditure per firm is higher in sectors which are known to use IT-intensively in production around the world and which contributed a large share of the Indian SWIS sector's domestic revenues in 2006-07 (see Appendix A2.2).

[94] There is some precedent in the non-IT outsourcing literature for using metrics, including the outsourcing of interest and miscellaneous expenditures which cannot be better classified elsewhere. Banga and Goldar (2004) use a similar composite variable to evaluate the impact of outsourced services amongst Indian manufacturers. Gorg and Hanley (2003) use an even wider metric, "other direct and indirect costs", to measure the extent of outsourced services in the Irish electronics sector.

7.1.3 Initial Analysis

Figure 7.2 shows the number and share of firms that purchased more than Rs. 1 Crore[95] of SWIS in the populated sample. It also shows their share of total output and profits during the sample period.

Figure 7.2: Presence and Importance of SWIS Outsourcers

	Sample split by SWIS spending:			Those using >1 crore SWIS contribute (in real terms)…	
	Firms Spending <1 crore	Firms Spending >1 crore	% of Sample Spending >1 crore	Output (%)	Profits (%)
2005	10700	643	6%	53%	64%
2006	9309	714	7%	57%	62%
2007	6969	819	11%	60%	65%
2008	3702	708	16%	65%	69%

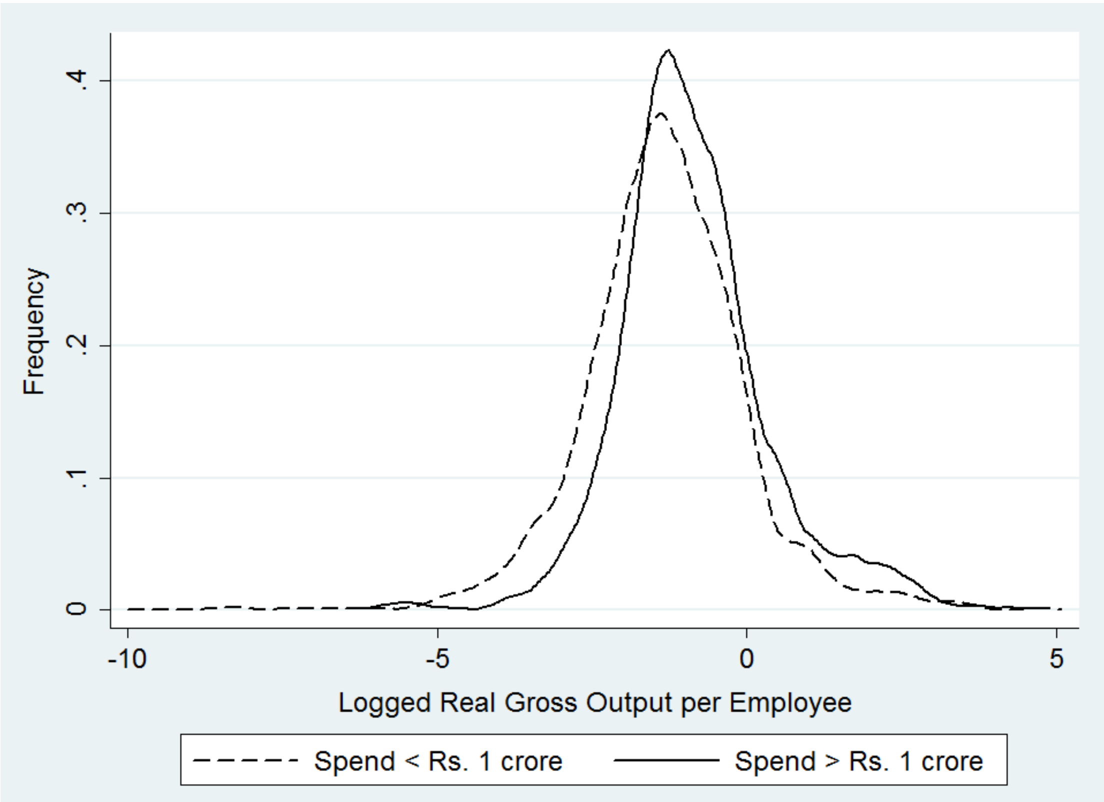
Source: Author's calculations based on CMIE (2009).
Note: Figures reported are annual averages in the populated sample. Rs.1 crore was equivalent to US$221,900 in 2005. Profits shown are net of taxes.

Column 4 in Figure 7.2 reports the percentage of the sample in each year that spends more than Rs. 1 crore on outsourcing. This proportion increased rapidly over the four-year sample, but had still only reached 16% by 2008. This confirms that SWIS outsourcing was not a widespread practice, but that its rapid growth in aggregate is reflected in this sample of firms. The share of output for those firms buying more than Rs. 1 crore of SWIS is much higher than those firms' share of the sample. This illustrates both the large size of the firms which go in for SWIS and their importance in terms of their contribution to economic activity. The share of profits is even higher than the share of output, illustrating that firms buying SWIS are more profitable than other firms in the sample.

[95] Rs. 1 crore is chosen as a lower bound for the purpose of describing the data in Figure 7.2. This has the effect of separating firms with large purchases of SWIS from the many firms in the sample with very small expenditures of SWIS, as measured by the composite variable.

To begin an examination of the relationships between SWIS outsourcing, output, and productivity, Figure 7.3 compares the distribution of the natural logarithm of real gross output per employee in SWIS buying and non-SWIS buying firms. Figures are presented in per-employee terms to facilitate comparisons between the relatively large SWIS purchasing firms, and smaller firms in the rest of the sample[96]. It is clear from this analysis that the two distributions overlap for the majority of their range. However, the distribution for SWIS buyers (the solid line) is above that of the other firms in the sample (the dashed line).

Figure 7.3: Distribution of Log Real Gross Output per Employee, SWIS Outsourcers vs. Others



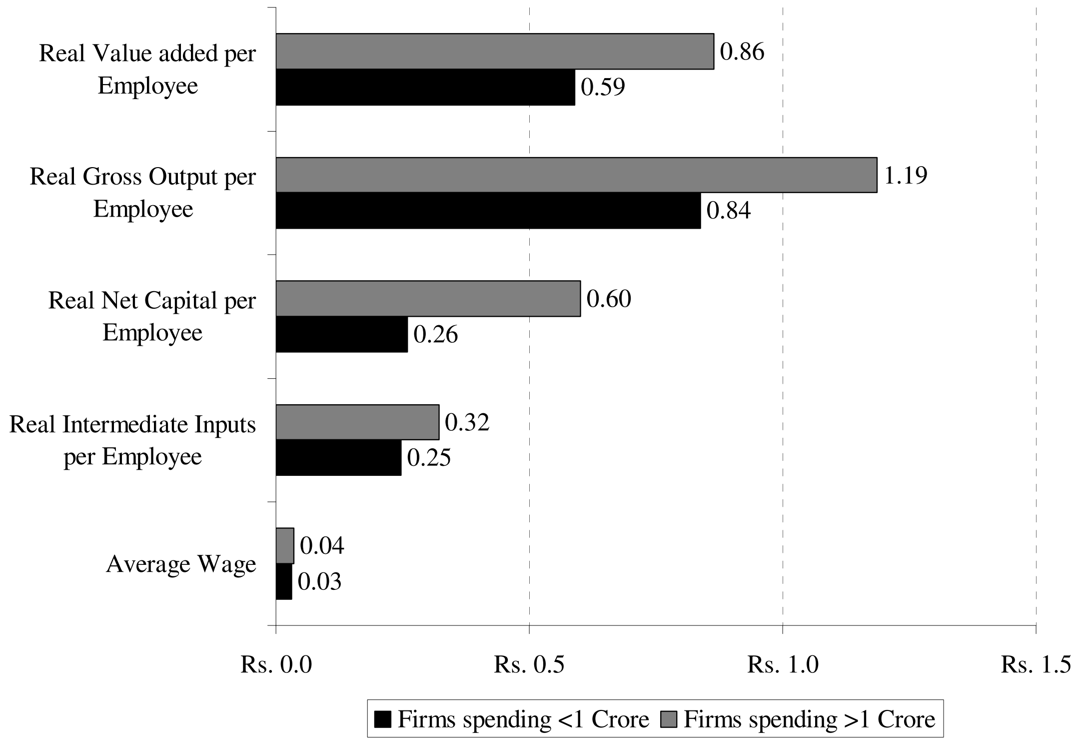
Source: Author calculations based on CMIE (2009).
Notes: Kernel density function for log of real gross output per employee, measured in 2005 Rs. crore in the whole of the pooled sample (2005–2008). Rs.1 crore was equivalent to US$221,900 in 2005.

To explore this simple indicator of output and productivity alongside measures of inputs to production, Figure 7.4 shows averages of real gross output per employee and

[96] Summary statistics for production variables on a per-firm (rather than per employee) basis are reported in Appendix A2.3.

input usage per employee in the sample. The figures included indicate that, on average, employees in SWIS-buying firms produce 40% more real gross output and 46% more value-added per employee than other firms. However, the chart also shows that, on average, in firms which purchase SWIS, each employee uses more than double the amount of capital as other firms. This suggests that the difference in output per employee is not simply the result of SWIS spending, but may also be a result of higher capital intensity in firms which buy SWIS. The final entry on the chart shows average wages; these are 16% higher in SWIS-buying firms than in others in the sample. This suggests that highly productive workers may also contribute to stronger output per employee in these firms.

Figure 7.4: Output, Inputs per Employee and Wage for SWIS Outsourcers vs. Others, Rs. crore

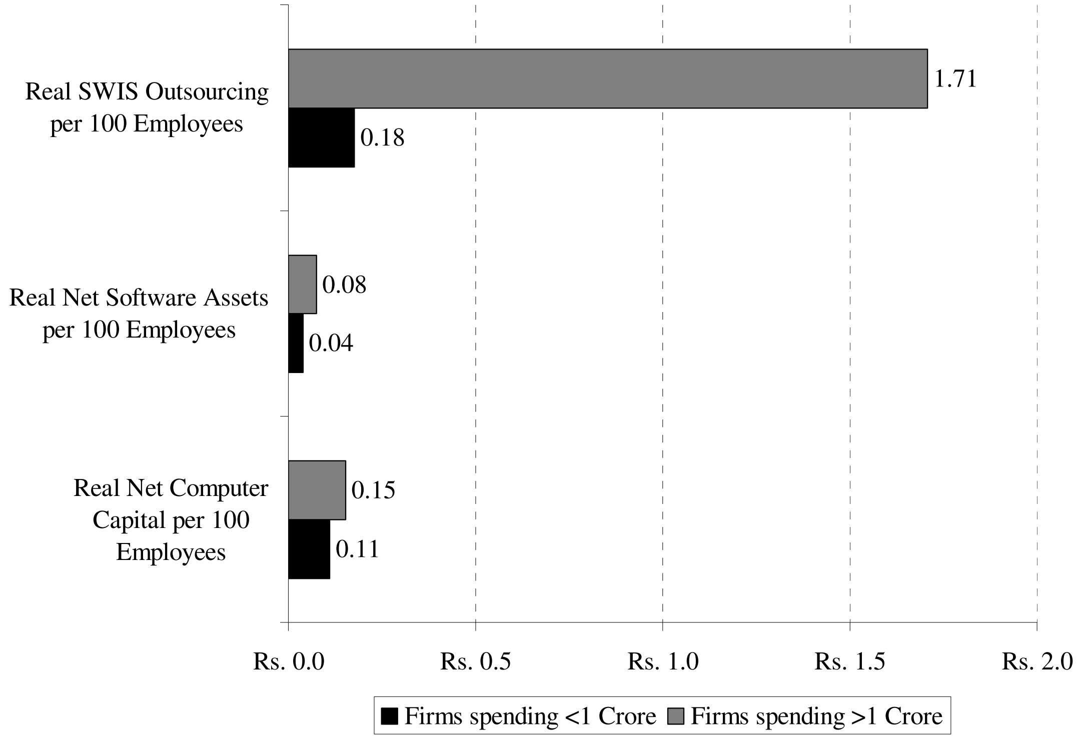


Source: Author calculations based on CMIE (2009).
Notes: Figures reported are averages over the entire pooled sample (2005–2008). Figures for gross output, capital, and intermediate inputs are in constant 2005 rupees crore. Capital is shown net of accumulated depreciation. Rs.1 crore was equivalent to US$221,900 in 2005.

Figure 7.5 continues the summary of inputs by presenting averages of IT usage metrics per 100 employees. It shows that those firms which purchase outsourced

SWIS also use higher levels of IT capital in-house. This suggests that firms that buy SWIS have more IT-intensive production, and that it is important to investigate whether it is this IT intensity which drives the gains in output per employee shown in Figure 7.3, and not the SWIS outsourcing itself.

Figure 7.5: IT Usage per 100 Employees, SWIS Outsourcers vs. Others, Rs. Crore



Source: Author calculations based on CMIE (2009).
Notes: Firm-level unweighted averages over the entire pooled sample (2005–2008). All figures are in constant 2005 rupees crore. Software assets and IT capital are shown net of accumulated depreciation. Rs.1 crore was equivalent to US$221,900 in 2005. Employees do not include directors or owners.

The econometric models laid out in the next section address these issues by disentangling the effects of SWIS outsourcing from the effect of other inputs.

7.1.4 Results on output

Figure 7.6 shows the results of estimating equation (6) using the populated sample from the PROWESS data. All variables in all columns are significant at the 0.1% level. This reflects both the strength of the production effects being measured and the precision benefits of having a large sample size. Column 1 shows a benchmark estimate of the production function without outsourcing included and with in-house IT combined with ordinary capital. Column 2 splits out in-house IT from ordinary capital, and column 3 splits IT capital into hardware and software. Columns 4 and 5 introduce SWIS outsourcing to the models in columns 2 and 3. These provide the first estimates of equation (6). In both column 4 and column 5, real SWIS outsourcing is highly significant, and its coefficient indicates that doubling expenditure on SWIS outsourcing leads to a 9% increase in real gross output.

Figure 7.6: Econometric Estimates of Equation (6)

Dependent Variable is Log of Real Output	(1)	(2)	(3)	(4)	(5)
Log real capital	0.1776***	0.1520***	0.1529***	0.1382***	0.1392***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Log labour	0.2123***	0.2162***	0.2214***	0.2137***	0.2145***
	(0.008)	(0.009)	(0.009)	(0.010)	(0.010)
Log real intermediate Inputs	0.3593***	0.3532***	0.3542***	0.3226***	0.3236***
	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)
Log real IT capital		0.0498***		0.0357***	
		(0.003)		(0.003)	
Log real in-house Hardware			0.0441***		0.0290***
			(0.003)		(0.003)
Log real in-house Software			0.0254***		0.0207***
			(0.003)		(0.003)
Log real outsourced SWIS				0.0896***	0.0897***
				(0.004)	(0.004)
Constant and Year Dummies	Yes	Yes	Yes	Yes	Yes
N	33,558	33,558	33,558	33,558	33,558
R-Squared	43.7%	43.7%	43.6%	44.7%	44.7%

Source: Author calculations based on CMIE (2009).
Notes: Estimated using OLS with cluster robust standard errors to account for panel data. Robust standard errors in parentheses. All variables are in 2005 rupees crore. Rs.1 crore was equivalent to US$221,900 in 2005. *** Significantly different from zero at the 0.1% level.

The coefficients on labour and capital from columns 2 and 3 are fairly robust to the inclusion of SWIS outsourcing. Their output elasticities in columns 4 and 5 are within 90% confidence intervals for the same elasticity in the models without outsourcing. This suggests that the majority of the impact of SWIS outsourcing comes through increases in TFP, not through changes to firms' use of labour or capital. The coefficients on in-house IT capital, on the other hand, do not remain stable between columns 2 and 4 or between columns 3 and 5. Regardless of whether hardware and software are combined into one variable or not, the inclusion of SWIS outsourcing reduces the size of their estimated output elasticity by between 20% and 35%. This shows that estimating the impact of in-house IT without controlling for SWIS outsourcing leads to misleading results, as some of the impact of SWIS outsourcing is misallocated to in-house IT capital. To put this into context, the estimate for in-house IT in column 4, which controls for SWIS outsourcing, is 3.6% more real gross output per 100% increase in in-house IT capital. This estimate is substantially lower than the estimate for the same elasticity column 2, in which SWIS outsourcing is excluded from the regression. It is also lower than both the only other comparable estimate for India at 11.5% (Basant et al., 2006) and the mean estimate from a meta-analysis of developed country studies at 5% (Stiroh 2002).

Figure 7.7 takes the results in column 4 of Figure 7.6 and subjects them to the first set of robustness tests[97]. In the figure, column 1 reproduces the base specification for comparison, and column 2 performs the first robustness test. The need for this test arises from the panel attrition in the PROWESS data and hence the modelling sample[98]. To test for any bias arising from loss of firms over time from the database, the model is re-estimated using only observations in earlier years of the sample, before any significant attrition took place. The estimated coefficients on all variables are very similar to the baseline estimates in column 1. This suggests that attrition bias is not driving any of the results. Column 3 adds other control variables expected to

[97] The model from column 4 was chosen as a base specification for robustness tests because there is some correlation between in-house hardware and in-house software. Combining these two variables into one measure of in-house IT capital also produces a higher R-squared.
[98] This was illustrated in Figure 7.1.

influence productivity into the base regression. The main effect of this on the estimated production function is an approximate 50% decrease in the elasticity of output to labour. This suggests that the productivity controls included mainly work to augment labour productivity.

Figure 7.7: Robustness Tests on Sub-samples and Productivity Controls

Dependent Variable is Log of Real Output	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
	Base	**05 and 06 only**	**Productivity controls**	**Manf**	**Services**
Log real capital	0.1382***	0.1345***	0.1295***	0.1718***	0.1569***
	(0.011)	(0.011)	(0.012)	(0.022)	(0.012)
Log labour	0.2137***	0.2161***	0.1165***	0.0890***	0.2582***
	(0.010)	(0.010)	(0.012)	(0.009)	(0.018)
Log real intermediate Inputs	0.3226***	0.3106***	0.3088***	0.5802***	0.1978***
	(0.007)	(0.008)	(0.007)	(0.016)	(0.008)
Log real IT capital	0.0357***	0.0380***	0.0481***	0.0068**	0.0489***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)
Log real outsourced SWIS	0.0896***	0.0872***	0.0886***	0.0478***	0.1359***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.007)
Constant and Year Dummies	Yes	Yes	Yes	Yes	Yes
Productivity controls	-	-	Yes	-	-
N	33,558	21,400	33,558	17,300	16,300
R-Squared	43.7%	43.7%	43.6%	44.7%	44.7%

Source: Author calculations based on CMIE (2009).
Notes: Estimated using OLS with cluster robust standard errors to account for panel data. Robust standard errors in parentheses. All variables are in 2005 rupees crore. Rs.1 crore was equivalent to US$221,900 in 2005. Column 2 includes only data from 2005 and 2006. ** Significantly different from zero at the 1% level. *** Significantly different from zero at the 0.1% level. Productivity controls are age, age squared, and the firm's expenditure on royalties.

Columns 4 and 5 show the results of estimating the model separately for manufacturers and services firms. Many of the coefficients in these specifications are different from the baseline estimates in ways that are expected, given the different activities of manufacturers as compared to services firms. For example, services firms' output is more elastic to labour inputs and less elastic to increases in materials than that of manufacturers. This is expected because manufacturing is more materials intensive and less labour intensive than many services industries. In both column 4 and column 5, the impact of SWIS outsourcing is positive and significant at the 0.1% level. In services firms, the coefficient suggests that a 100% increase in SWIS outsourcing leads to 13.6% more output, whilst in manufacturers the same proportional increase in spending leads to only 4.8% more output. A much starker version of the same pattern is discernible in the coefficients for in-house IT, where a 100% increase in IT capital gives a 5% increase in services output, but less than a 1% increase in manufacturing output. Taken together, these estimates suggest that the services industries in the sample get greater benefit from their IT use than the manufacturing industries, a finding that is reflected in the wider literature on IT (Stiroh, 2002: 6). Columns 4 and 5 also suggest an interesting avenue for further research: these models clearly show some interesting differences to one another and to the aggregate picture, and their further development could well be revealing.

Figure 7.8 reports a set of re-estimations of equation (6) that control for endogeneity. As with any econometric model, endogeneity problems here can either arise from reverse causality or from one or more variables which are not included in the model but which cause both dependent and explanatory variables to change together. The literature identifies possibilities for both of these. Reverse causality concerns arise because high-productivity firms may be better able to afford purchases of IT, whether in-house or outsourced (Olley and Paikes, 1996: 1264). Similarly, high-productivity firms may also be more likely to outsource non-core competencies such as IT, as part of their strategy to maintain their productivity lead (Nolan, 2001). Concerns around possible excluded variables which drive both choice of inputs and the level of output are even more widespread. Two of the most often cited issues in the literature on IT are organisational set-up and the need for highly skilled/well managed workforces;

these are well documented to be both complementary to IT investments and productivity-enhancing in their own right (Basant et al., 2006; Bresnahan, Brynjolfsson, and Hitt, 2002). In the literature on outsourcing, cross-border activities present a similar issue; firms which export or import products are both more likely to outsource across borders and be more productive because of exposure to international best practices (Amiti and Wei, 2005: 4). If all these issues were not enough, even without endogeneity arising from the inclusion of IT and/or outsourcing, production functions are subject to their own well-known, excluded-variable problems. These arise because inputs are not truly independent variables, but are chosen by firms, possibly according to what they observe of their own circumstances; or, in other words, according to values of other variables not included in the econometric model (Griliches and Mairesse, 1998).

Methods for dealing with these issues depend on whether the source of endogeneity predominantly varies *between* firms or *within* each firm. If the source is an excluded variable that changes rarely or very slowly over time, but is different across firms, controlling for unobserved firm-level heterogeneity, using either fixed effects or first differences, will correct most of the bias in elasticity estimates. On the other hand, if the source of endogeneity is reverse causality or a third variable that changes within firms over time, an instrumental variables version of fixed effects is necessary. Because the possible sources of endogeneity around equation (6) could vary both within and between firms, the approach here is to undertake all 3 of these possible solutions and to compare the results. Column 1 in Figure 7.8 reproduces the baseline OLS estimates from before. In column 2, fixed-effects estimates are given; and in column 3, first differences. Column 4 shows an instrumental variables fixed-effects (IV-FE) estimator suggested by Blundell and Bond (1998).

Figure 7.8: Controlling for Endogeneity

Dependent Variable is Log of Real Output	(1) Base	(2) Fixed Effects	(3) 1st Differences	(4) IV-FE (GMM)
Log real capital	0.1382***	0.0660***	0.0519**	0.0971***
	(0.011)	(0.018)	(0.019)	(0.024)
Log labour	0.2137***	0.0558***	0.0640**	0.0216
	(0.010)	(0.016)	(0.023)	(0.019)
Log real intermediate Inputs	0.3226***	0.1781***	0.1600***	0.1535***
	(0.007)	(0.014)	(0.014)	(0.019)
Log real IT capital	0.0357***	0.0239***	0.0250***	0.0285***
	(0.003)	(0.005)	(0.005)	(0.006)
Log real outsourced SWIS	0.0896***	0.0576***	0.0534***	0.0468***
	(0.004)	(0.007)	(0.007)	(0.010)
Log of real output (t-1)				0.4457***
				(0.004)
Constant and Year Dummies	Yes	Yes	No constant	No Year Dummies
N	33,558	33,558	20,622	20,622
R-Squared	44.7%	44.5%	4.5%	-

Source: Author calculations based on CMIE (2009).
Notes: Robust standard errors in parentheses. The dependent variable is log of real gross output. ** Significantly different from zero at the 1% level. *** Significantly different from zero at the 0.1% level. Column 2 is estimated using fixed effects; column 3 is estimated using OLS on first differenced data; column 4 is estimated using general method of moments and uses both lags of the variables and lags of first differences of the variables as instruments (as suggested by Blundell and Bond, 1998). Year dummy variables were tested and found insignificant the model reported in column 4.

Columns 2 and 3 in Figure 7.8 eliminate any bias arising from unobserved variables that predominantly vary across (between) firms. The estimates can only exploit variation within firms over time to identify the output elasticities of the various inputs. In both of these two models, both the IT capital variable and the SWIS outsourcing variable remain positive and highly significant. However, the output elasticity for SWIS outsourcing falls from 9% per 100% increase in expenditure to 5.8% for the fixed-effects model, and to 5.3% for the first-differences model. This shows that there are unobserved firm-level characteristics which are related to the use of outsourced SWIS and which also have a positive effect on output. Column 4 further develops the fixed-effects model of column 2 by using instrumental variables to eliminate sources of endogeneity that vary within firms over time. In other words, this specification corrects for endogeneity in both the within-firm dimension and the between-firms dimension. Importantly, SWIS outsourcing still remains positive and significant with a coefficient that implies 4.7% more output from an additional 100% expenditure.

In the literature on outsourcing, it is common to interpret the OLS coefficient as an estimate of the long-run impact of outsourcing, and the estimate that controls for endogeneity as the short run (Egger and Egger, 2001; Fixler and Siegel, 1999; Olsen, 2006). This is justified under two conditions. The first is that the source of endogeneity is unobserved variables correlated with outsourcing, such as skill profile of workers or organisational set up of the firm. The second is that over the long run, firms change these unobserved factors to complement their decisions on outsourcing. For IT variables, a similar argument can be made if the omitted variables are IT-related inputs, such as Internet availability, which arrive as part of the same phenomenon as the firm's purchased IT. In this case, the OLS estimate can be interpreted as the "broader impact of the IT revolution", with the endogeneity-corrected estimate interpreted as the impact of a firm's investment into its own IT (Stiroh 2002: 6). Of course, the other, more pessimistic possibility is that the OLS estimate is simply an over-estimate of the effect of IT and that the IV-FE estimate is the only unbiased one (p. 23–24). It seems likely that both of these possibilities—the OLS estimate is true for the long run impact, the IV-FE estimate is the only unbiased one—are too extreme for this research. Firms are unlikely to prioritise the impact on productivity from SWIS outsourcing over the impact of more general in-house productivity when deciding, for example, on the skills profile of their work force. On the other hand, it is likely that both some productivity enhancing internal changes and some additional benefits from the wider IT revolution will be accrued by the firm as a result of the decision to invest in outsourced SWIS. This suggests that the true impact appropriated by firms from SWIS outsourcing is somewhere between the OLS and IV-FE estimates.

On this basis, the upper and lower bounds of the effect of investment into SWIS on output can be calculated using the OLS and IV-FE elasticities given above. The elasticities range from 0.047 (for the Fixed Effects–Instrumental Variables GMM model) to 0.090 (for the OLS estimate). Figure 7.9 uses these figures to provide some ranges for the effect of SWIS. It also includes the same measures for the impact of in-house IT capital on output as a comparison. The first row in Figure 7.9 gives the range of gross marginal products suggested by the elasticity estimates. Even for the most conservative estimates, these are substantially larger than Rs. 1 crore, suggesting that SWIS outsourcing offers supernormal returns. Also, when the gross marginal product of SWIS outsourcing is compared to that of in-house IT capital, it is clear that, on average, an additional Rs. 1 crore would be better spent on outsourced SWIS.

Figure 7.9: In Sample Effects of IT and SWIS investment

	Lower Limit (IV-FE)	Upper Limit (OLS)
Gross marginal product of SWIS outsourcing (Crore)	Rs. 11	Rs. 20
Growth in output per firm from investment into SWIS (%)	20%	40%
Growth in output per firm from investment into SWIS (Crore)	Rs. 35	Rs. 68
Share of total growth in output per firm attributable to SWIS (%)	10%	19%
Gross marginal product for in-house IT capital (Crore)	Rs. 8	Rs. 10
Growth in output per firm from investment into in-house IT (%)	11%	14%
Growth in output per firm from investment into in-house IT (Crore)	Rs. 20	Rs. 24
Share of total growth in output per firm attributable to in-house IT (%)	5%	7%

Source: Author calculations based on CMIE (2009).
Notes: Gross marginal products are calculated at the mean amongst those firms which have some spending on the IT type in question. All growth figures refer to growth between 2005 and 2008 in real terms. Rs.1 crore was equivalent to US$221,900 in 2005.

The other rows in the table are concerned with how much output growth in the sample firms can be attributed to investment into IT. Between 2005 and 2008, SWIS outsourcing per firm increased from Rs. 0.45 crore to Rs. 2.3 crore on average, giving a percentage growth rate of 420%. Applying the IV–FE elasticity to this growth rate gives a 20% increase in output per firm attributable to SWIS outsourcing. This amounts to an output increase per firm from Rs 180 crore to Rs. 215 crore, or 10% of a total 203% growth in output per firm over the period 2005-2008. Even with this, the most conservative estimate, it is a strong effect and an important driver of output growth. This becomes particularly clear when the effect of SWIS is compared to the impact of in-house IT. During the same period, the value of in-house IT per firm in the sample grew from Rs. 0.3 crore to Rs. 1.5 crore on average, a percentage increase of 381%. Even with the most optimistic (OLS) estimate, Figure 7.9 shows that this increase in in-house IT is responsible for only a 14% growth in output per firm, or 7% of all output growth in the period.

7.1.5 Results on productivity

The findings described in Section 7.1.4 show that the inclusion of SWIS into econometric models of equation (6) amongst the PROWESS sample did not substantially alter the elasticities of output to labour and capital. This suggests that the impact of SWIS on output came through an increase in total factor productivity rather than through changes in labour or capital productivity. This section provides more evidence to that effect. It examines in detail the response of one aspect of total factor productivity to SWIS expenditure: how technical efficiency changes when firms buy IT.

Figure 7.10 is the most important table of results arising from this investigation. It shows the results of estimating equation (8) to investigate how SWIS impacts technical efficiency. These results depend on a prior estimation of equation (7) which is detailed in Appendix A2.4. The model of equation (7) identified the production function for the most technically efficient firms in the sample, and estimates how distant in terms of output each firm is from what it would produce if it were as efficient as those superior performers. This output based measure of inefficiency was converted to a measure of efficiency, which was then used as the dependent variable in the estimation of equation (8) (described in Figure 7.11). Column 1 in figure 7.11 shows a regression of technical efficiency on SWIS outsourcing, and column 2 modifies this regression by including a set of other variables which might also be expected to affect efficiency. Both equations are estimated using a tobit specification to account for the fact that the dependent variable is bounded between zero and one. Both sets of estimates show that technical efficiency is significantly higher for firms which purchase SWIS[99].

[99] Kumbhakar and Lovell (2000: 262–265) provide a clear technical explanation of the two-step process which has been followed to reach the results here.

Figure 7.10: Estimates of the Impact of SWIS on Technical Efficiency

Dependent variable is technical efficiency	(1)	(2)
Log real outsourced SWIS	0.0021*** (0.0001)	0.0016*** (0.0001)
Age		0.0012*** (0.0001)
Log research and development		0.0035*** (0.0002)
Log expenditure on royalties and licences		0.0022*** (0.0002)
Banks		0.2002*** (0.0185)
Financial Institutions		0.2476*** (0.0279)
Finance - Securities		0.0522*** (0.0058)
Wholesalers		0.0684*** (0.0065)
Dummy for 2006	0.0053*** (0.013)	0.0046*** (0.013)
Dummy for 2007	0.0141*** (0.0017)	0.0110*** (0.0017)
Dummy for 2008	0.0368*** (0.0026)	0.0279*** (0.0025)
Constant	Yes	Yes
N	33,558	33,558

Source: Author calculations based on CMIE (2009).
Notes: Tobit models. Robust standard errors are in parentheses. The dependent variable is ln(E) as detailed in the methods section above, and estimated using the model in Appendix A2.4. *** Significantly different from zero at the 0.1% level.

This is an important result. It demonstrates that SWIS improves the technology with which firms convert inputs to outputs and moves them closer to the technical frontier. This verifies the earlier suggestion that a significant proportion of the output impact of SWIS comes from its ability to improve TFP in the firms that use it.

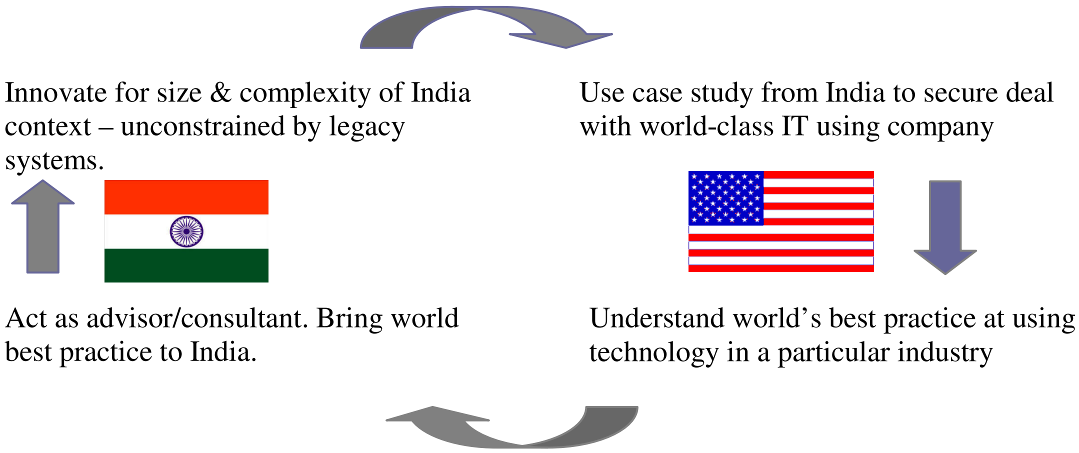
The next section returns to the qualitative data collected during the in-depth interviews. It provides the reasons for why SWIS outsourcing has such a strong impact on productivity, and why it outperforms in-house IT in its impact on output.

7.2 SWIS comes with learning from the west and new IT

The interviews in the 2009 fieldwork revealed two key contributions that SWIS projects uniquely bring to IT intensive firms: the application of knowledge from Western firms on how best to use IT in particular industries, and the use of innovative technologies. This section outlines these two contributions, explaining what benefits they bring to Indian firms. Before that though, the discussion provides a brief outline of sources of learning in IT firms. This is included here because it explains why the two benefits are uniquely associated with IT purchased from SWIS firms, and why they do not arise to the same extent when firms purchase their own in-house IT.

Successful IT firms are engaged in a conscious effort to learn in both domestic and export markets. IT professionals, during the in-depth interviews, reported that their firms acquired two distinct sets of knowledge and experience: one from India, and the other from Western countries. They then used the gained knowledge and experience from one market to create case studies that help them to sell more projects in the other. Figure 7.11 illustrates this process. In the right-hand panel, which is concerned with IT companies' undertaking projects in export markets, IT firms learn how leading firms in a particular industry use IT to benefit their specific businesses. To put this in the language of the experts, they accumulate "domain expertise". This domain expertise is then bought back to India where domestic clients expect, and insist on, the IT firm being able to advise on how best to use IT.

Figure 7.11: A Virtuous Cycle of Learning for IT Firms in Export and Domestic Markets



Source: Author's summary of in-depth interviews.

IT specialists in the in-depth interviews were quite clear that domestic market contracts, represented by the left-hand panel in Figure 7.12, also offer important lessons. In India, client firms are typically installing their first IT system; therefore the operation of any new system is not constrained by pre-existing or out-of-date "legacy" systems with which the new system must work. According to the interviewees, many Indian clients are also much more tolerant of a process of trial and error than export clients. These two factors, together with the proximity to the IT firms' staff and base, make India an ideal place to trial new technologies.

All of this learning and movement of knowledge means that Indian clients get both the benefits of Western domain expertise and the benefits of the latest IT innovation. These benefits are incredibly valuable to an Indian company buying IT. Domain expertise is important because, in many cases, the established firms that comprise the sector's clients in developed countries have been using IT for longer than Indian firms. These established firms have far more experience using IT successfully and using complicated applications that have arisen over years of experimentation. A senior a vice president at NASSCOM put it this way:

> “We brought in a lot of experiences from our work with British Telecom, from our work with General Electric, our work with all the banks in the world, and now we are saying [to Indian firms], ‘Look guys, its time for you to pull up your socks.’” [Rajdeep Sarawat, 22 January 2009, Delhi]

In the context of the literature on development, this opportunity to “pull up your socks” or, to put it another way, to gain parity with the technology used in Western firms, is both rare and precious (Chang, 2008). As with knowledge on other advanced uses of technology, domain expertise is context-specific, with decisions on how to use IT often being heavily dependent on the particular processes that a client follows. This means that it is difficult to codify the knowledge, and learning it requires experience in the client’s industry; or, at the very least, extensive face-to-face training from someone with that experience. In general, developed-country firms cannot be expected to willingly offer these insights directly to potential competitors in India. The fact that they have been willing to share with IT companies, who in turn apply the lessons in India, is an important and rare conduit of this kind of tacit knowledge.

The value of Western domain expertise to Indian firms is further amplified by the fact that IT systems often have implications for processes throughout a firm’s operation, so that implementation of a new system can often mean pervasive restructuring (Bresnahan, Brynjolfsson, and Hitt, 2002: 342; Perez, 1985: 9). In this context, applying developed-country domain expertise not only involves IT itself, but possibly improvements in a great many of the firm’s processes. According to interviewees, this kind of restructuring can be difficult, but Indian IT firms are aware of both what to do in particular client industries and how to manage the process:

> "Organisation change management…those kind of issues will be impediments in successful implementation of IT programmes in this country. Over the past 20 years, these are issues we have seen in the Western world, and we know how to manage it; we have gone through this cycle." [Rajesh Varrier, 24 February 2009, Bangalore]

Application of appropriate Western domain knowledge into IT and surrounding processes is not the only reason why SWIS projects are so successful in improving productivity and output. The other reason is the technological innovations being applied in India. It is worth paraphrasing here the evidence from Chapter 6 on the competitive advantages that Indian firms have enjoyed as a result of innovation for economies of scale initiated by SWIS companies working in the domestic market. On Indian mobile telephone companies, Kiran Karnik (Mumbai, 13 February 2009) said that SWIS innovations have already been responsible for Indian firms being able to charge lower prices than many of their competitors worldwide. He said that even with these low prices, Indian firms have been "incredibly profitable" because of the vast numbers of customers they provide call services to and economies of scale in their SWIS systems. The same low price, large scale business model has been adopted in Indian banking and Arindam Banerjii (Mumbai, 4 February 2009) said that it poses a significant threat to large multinational banks. He said that the threat arises because Indian banks already have millions of customers and their systems allow them to add a million more very easily. He also said that Indian banks can charge their customers a much lower price for banking services than Western banks because they have a lower cost of servicing customers as a result of more advanced technology.

But the benefits available from installing the latest versions of SWIS do not end there. Indian firms, by coming late to IT, have been able to take advantage of a whole range of other improvements in the technology too. Both IT consultants and clients of the IT sector agree that this has led to superior technologies being used in India versus the West:

> "India did not go through the same cycle of adoption that the UK and US did. India went from being a very low usage, fixed-line telephony environment straight into wireless, the same thing happened in television and it's true of cars as well. We went from some very dirty cars to some very decent cars very quickly…. [I]n IT the same thing is happening; we didn't go through mainframe as much as the West did. Everyone is on Java, everyone is aware of it. The technology is very modern." [Vasu Rao, CEO of IT Company, 1 March 2009, Bangalore]

> "India has skipped everything. If you are a late adopter, you can skip everything…. Late adopters can use the best technology." [Sanjay Jain, Head of Process Improvement at an ITES-BPO firm, 23 January 2009, Gurgaon]

The potential to overtake Western firms in terms of the quality of IT in use arises because investment choices in IT are path dependent. As adoption occurs, it influences the costs and benefits of subsequent purchases. The more accustomed a firm is to using a particular system, the higher is the cost of changing it: Employees have to be retrained and given time to become familiar with the new system, and, any processes or systems which depend on the one that is being changed also have to be re-designed. On the other hand, the benefits of not changing the IT system, but expanding the existing system are higher when the firm is already familiar with it

(Arthur, 1994). If path dependence like this is accompanied by fast technical change, as is the case with IT, it is problematic for early adopters and advantageous for late adopters. Early adopters become familiar with an early, inferior, version of the technology and so find it costly to replace that inferior version with a later and better type. Later adopters on the other hand go straight for the best version available. The president for the domestic market business for one of India's biggest IT firms gave the example of the Bombay Stock Exchange to illustrate how this situation benefits late adopters of IT in India:

> "This is the third biggest stock market in the world…. The Bombay stock market does a higher throughput of transactions with one-third of [the] infrastructure [of] the New York Stock Exchange…. When the people from NASDAQ came in, we shared our best practices." [S. Venkatramani, 17 February 2009, Mumbai]

To some extent, the benefits of having a blank slate upon which to build new IT systems are also available to Indian firms who buy IT without outsourcing it. However, it was clear from the interviewee comments that experimentation with new technologies is a costly and risky affair, and the sort that Indian companies rarely feel comfortable undertaking without advice. Mr Venkatramani said that his firm often undertakes projects in the domestic market using new technologies, at a great cost in terms of effort and expense. This is justified because knowledge of the new technology, and the demonstrated ability to use it successfully, is valuable in securing lucrative export market contracts which use the same, cutting edge, technologies:

> “ [Digitising the Bombay Stock Exchange] was very complex, and we really worked hard on it, [and] we must have got at least 20 to 30 projects using that as a case study. It was a big learning experience, but we can proudly say [that] we did it, with customers saying ‘What a wonderful job you’ve done.’” [S. Venkatramani, 17 February 2009, Mumbai]

According to these experts then, firms in India that purchase outsourced SWIS from the sector get two clear benefits over those that only purchase in-house IT: learning industry-specific uses of the technology from their competitors in the West, and using the newest technologies. Together, these two considerations explain why purchasing outsourced SWIS gives such a strong impact on output in the econometric estimates in Section 7.1. They also verify the finding there that rupee for rupee, SWIS outsourcing has a bigger impact on output in Indian IT intensive firms than in-house IT. The next section moves on from describing the processes by which SWIS impacts output to quantify the total impact of SWIS in different Indian sectors and in the economy as a whole.

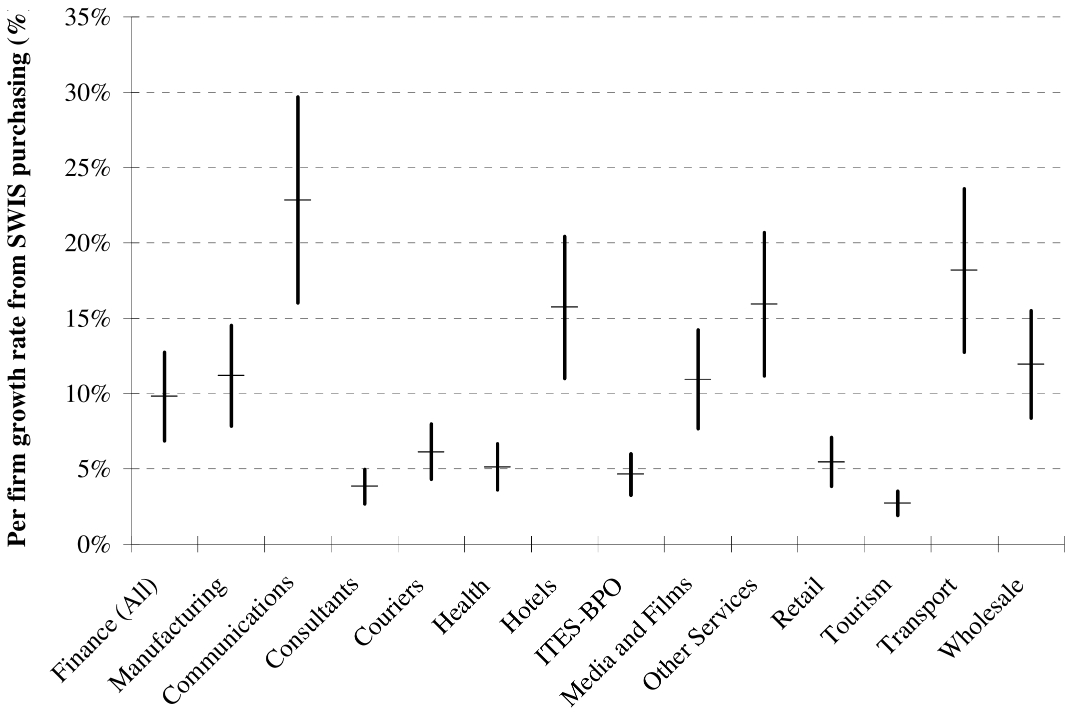
7.3 SWIS use is responsible for significant services-led economic growth

This section reports the results of using the elasticity estimates from Section 7.1 to identify the impact of SWIS outsourcing in the different sectors that purchase SWIS and on India's economic growth. The work in this part of the project used a simple methodology. Growth rates of real expenditures on SWIS were calculated for each year that the econometric study covered. These growth rates were then multiplied by the two estimated elasticities (OLS and IV-FE) from the study to give a range for the total number of percentage points of economic growth[100] or growth in per-firm output by sector attributable to investment into SWIS.

Figure 7.12 begins by applying this methodology to growth rates of per-firm expenditure on SWIS between 2005 and 2008 for each of the major sectors in the PROWESS sample. For each sector plotted along the x-axis, the vertical line shows the range of average per firm output growth implied by the estimates. The top of each line stops at the growth rate implied by the OLS elasticity estimate, and the bottom of each line stops at the rate implied by the IV-FE estimate. It is firms in services sectors that have expanded their purchases of SWIS the most during this period, and so it is in these sectors that the strongest per-firm growth from SWIS purchasing has been experienced. The sectors in the sample with the highest average per-firm growth rates attributable to SWIS purchasing are communications, hotels, media and films, transport, wholesale and other services.

[100] To get a true contribution to GDP growth rates, the estimates also have to be converted to growth in value-added. This is accomplished using the value-added percentage from the PROWESS data.

Figure 7.12: Estimated Per Firm Growth by Sector in PROWESS Sample



Source: Author calculations based on CMIE (2009).

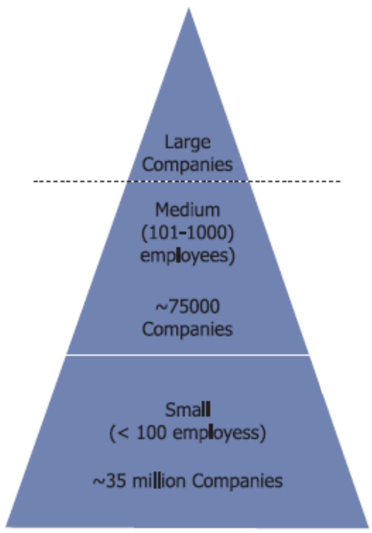
For an estimate of the impact of SWIS use on GDP, it is possible to use the OLS and IV-FE elasticities in tandem with data on macro-level expenditure on SWIS provided by NASSCOM (and graphed in Figure 5.15). The NASSCOM data on SWIS spending is not a measure of *all* expenditure on outsourced IT in India, because it only covers the revenues of NASSCOM's own members. Chapter 4 provided a detailed discussion of this dataset which concluded that it is a strong measure of forward linkages from large, registered IT firms but excludes all activity by informal[101] and small IT firms. What this means is that estimating the aggregate impact of forward linkages using NASSCOM spending data specifically limits attention to the impact of forward linkages from large and registered IT firms. It is a restriction that is unfortunate in one way, but not in another. On the one hand it means the resulting estimate completely ignores the informal sector which may well be both big and

[101] Informal refers to firms that are unregistered with the Government of India for the purposes of paying taxation. Formal refers to firms which are registered with the Government.

important. On the other hand though, it helps in alleviating any concern that the elasticity in the rest of the economy might be different to that measured in the PROWESS sample: Restricting attention to estimating the macro-level impact of NASSCOM members' forward linkages means it is possible to use NASSCOM's knowledge to identify characteristics of their members' clients. It turns out that this matches the profile of firms in the PROWESS dataset, so that there is some justification for applying the elasticities estimated in Section 7.1 to the national level NASSCOM spending figures.

The PROWESS dataset covers a large sample drawn from a subset of Indian firms which are listed on stock markets and publish financial reports. As mentioned above, these are predominantly large- and middle-size firms and together they produce a large proportion of the output of the formal, tax-paying, sector. It is reasonable to apply the elasticity estimated from the PROWESS dataset to the NASSCOM figures if NASSCOM's members' clients are also mainly large- or medium-size firms and are formally registered with the taxation authorities in India.

Figure 7.13: Firm-size Structure of NASSCOM members' clients



Source: NASSCOM (2009a: 87)

During the in-depth interviews Rajdeep Sarawat, a vice-president of NASSCOM, sketched a diagram of a pyramid which was later published in NASSCOM's 2009 strategic review, and which is reproduced in Figure 7.13. Based on knowing the make-up of NASSCOM members' clients, he made it clear that, so far, the majority of these clients are large, and the minority are of medium-size.

> "At the end of 1990s to the middle of the 2000s, this class of firms [pointing at the top of pyramid], this enterprise class… the Tata Steels, the Reliances of the world, and all, these guys went into overdrive of getting into productivity improvements. Firms…started looking at IT as a big lever to transform…. As we go down this pyramid, the IT adoption starts dropping. [Interview question: Does it drop quite quickly?] Very radically. Forget about quickly; it's a steep drop, and today the medium- and the small-firms, the "SME's". I call it MSME, micro-small and medium-size enterprises [which] do not have IT. There is this entire set of millions of small firms…employing 10 people, 20 people, who are just doing something like producing widgets with one or two machines…. So the challenge for our industry in India is how do I get IT here?" [Pointing to the lower half of the pyramid.] (22 January 2009, Delhi)

Dennis Rajakumar, another expert with experience of research amongst small, informal sector firms, agreed with this sentiment. He said that it is a well-known fact that smaller and, in particular, unregistered firms do not usually work with NASSCOM members because deals with formal sector IT firms are one way of being discovered by authorities, something that unregistered firms seek to avoid:

> "The problem in our country is…people are scared of registering their firms, because the moment you are registered, you [come] under this kind of taxman; you [come] under the scam of this type, that type, and so on. Each firm ex-post has to face the provisions related to a number of parliamentary acts [and] nobody wants to take that risk…. These small guys will also not work with NASSCOM members. This is an obvious place for the taxman to start looking…. They [small unregistered firms] will work with unregistered IT firms. There are a number of guys catering to this market, and this market is not small… it is a huge market, a huge market [stressing the word huge], but there are huge number of [unregistered IT company] players, and their revenues are not at all large."

Another reason is that NASSCOM members offer SWIS at a price point too high for many small firms. Dennis Rajakumar continued:

> "If they [small informal firms] want to have some IT solution, why should they go to some big companies…their pricing is very high… For them, the best thing is when a small guy says, 'I will develop some product, I've got something special for you, and I am going to charge 50-60 thousand rupees.' Larger companies would not care to get into this kind of segment… [Interview question: For the small unregistered IT company, it is a better business prospect?] Sure. Some of their friends…introduce them… [and then they] do the pilot testing, and they know that this is the requirement, but [the] product is not meeting their [the client's] requirements…so they keep improving, improving, and they don't have big overheads, and they don't have a number of clients to attend to simultaneously, they only have this one client….so they

struggle, struggle, struggle and come out with the perfect fit model that takes care of the requirements of that client. If they are successful, then what happens is word keeps spreading." [25 February 2009, Bangalore]

Taken at face value, Rajdeep Sarawat and Dennis Rajakumar's comments suggest that the type of firms in the PROWESS database are a reasonable match for the type of firms which become NASSCOM members' clients in India. It is therefore appropriate to apply the elasticity from the analysis above to the NASSCOM data. Figure 7.14 performs this exercise.

Figure 7.14: Estimating the Macro-level of Impact of Forward Linkages

			Implied GDP Percentage Points	
	Real aggregate spend on SWIS*	**Growth in SWIS Spending**	**Lower Limit (IV-FE)**	**Upper Limit (OLS)**
2005	Rs. 25,600	35%	1.6%	3.1%
2006	Rs. 34,390	34%	1.6%	3.1%
2007	Rs. 44,438	29%	1.4%	2.6%
2008	Rs. 48,885	10%	0.5%	0.9%
2005-2008 (Average)		27%	1.3%	2.4%

Source: Author calculations based on CMIE (2009). Athreye (2005: 34); Hanna (1994: 100); Heeks (1999b:2); Kenney and Dossani (2002: 237); Kumar & Joseph (2005: 94); NASSCOM (2008a:1), NASSCOM (2009a: 6,203), NASSCOM (2011:7,8); Sridharan (2004b: 34,37).
Notes: *Spending on SWIS is measured using revenues for NASSCOM members in the domestic market and are published in US dollars. These have been converted to Rs. Crore using exchange rates published by RBI (2011) and deflated as described in Appendix A2.

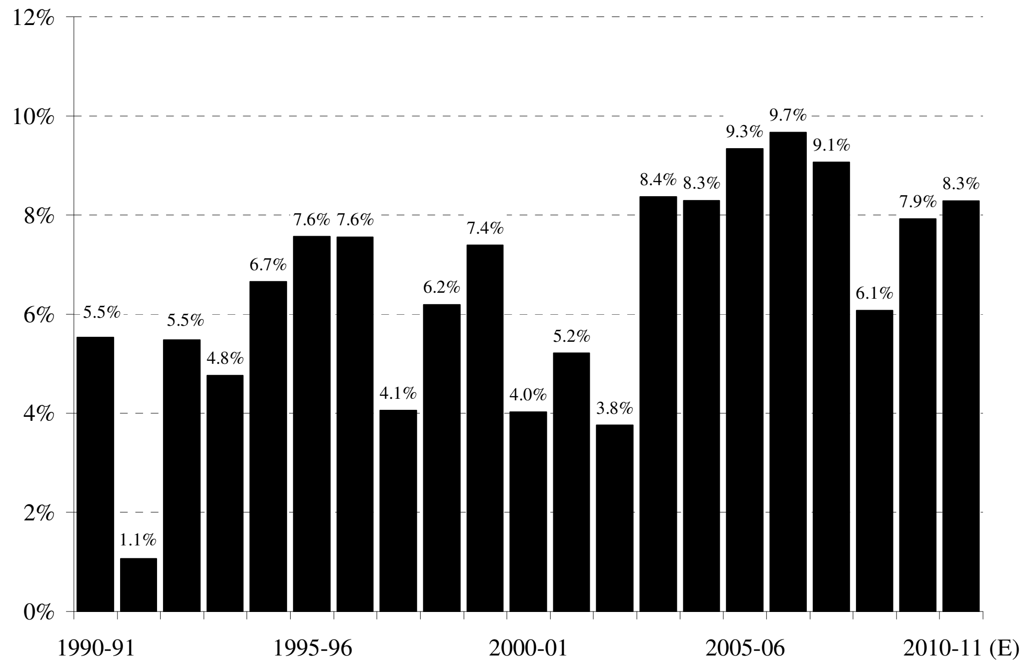
The second column in Figure 7.14 reproduces the figures for macro-level forward linkages from the formal SWIS sector from Figure 5.15. The third column shows percentage growth rates in these figures and the two columns on the right then apply the elasticities from Section 7.1 to these growth rates to obtain estimates of the implied contribution to GDP[102]. What these final two columns show is that between 2005 and 2008 forward linkages from the SWIS sector contributed an average of

[102] The GDP growth rates are the implied growth rates for gross output scaled down to reflect value added.

between 1.3 and 2.4 percentage points, or between 10% and 20%, of total GDP growth.

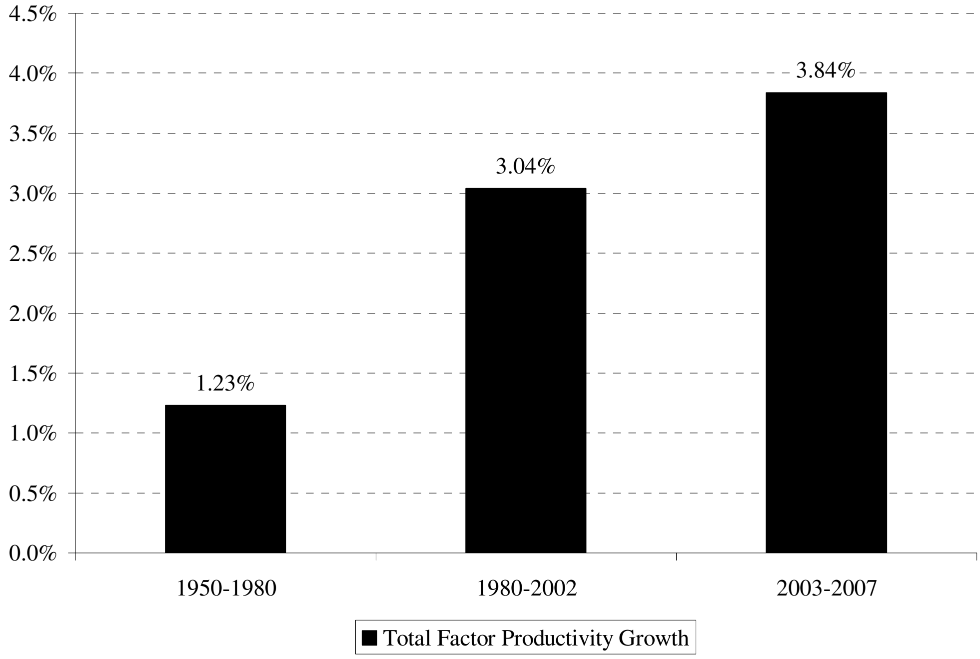
To put this contribution into context, Figures 7.15 and 7.16 graph macro-level real GDP growth rates and TFP growth. It is clear from both charts that starting in the mid-2000s, around the same time as the acceleration in forward linkages noted in Chapter 5, both measures have shown consistently improved performance. What the findings of this section suggest is that at least some of this improvement in macroeconomic outcomes can be attributed to the rise in domestic forward linkages from the SWIS sector.

Figure 7.15: GDP Growth Rates 1990-91 to 2010-11 in Constant 1999–00 Prices



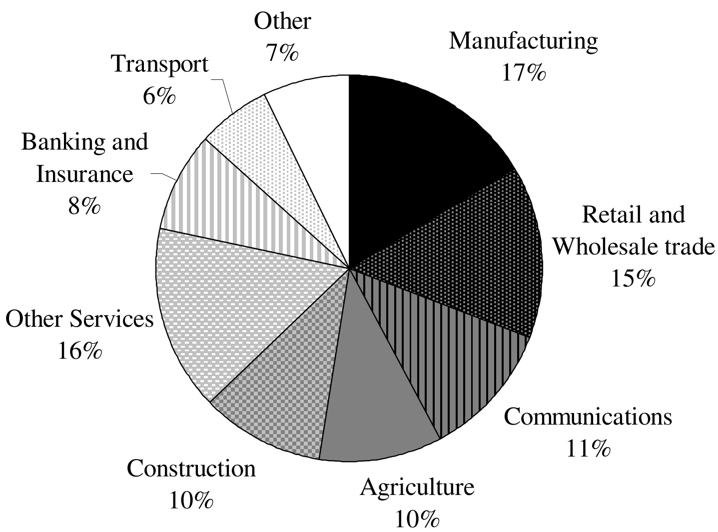
Source: MOSPI (2010).
Notes: Financial years run April to April. Market prices.

Figure 7.16: Total Factor Productivity Growth, 1950–2007



Source: Bhalla (2009: 37)

Figure 7.17: Breakdown of Economic Growth by Sector, 2002–03 to 2007–08



Source: Virmani (2008: 20)

The set of data in Figure 7.17 verifies this. It shows the sector-wise breakdown of economic growth during the period from 2002-03 to 2007-08. A large proportion of economic growth has come from the sectors identified in figure 5.21 (for 2003-04) and figure 5.22 (for 2006-07) using both NASSCOM and GOI data as being large purchasers of SWIS in India (in particular, manufacturing, financial services, communications and retail). In conclusion, it seems evident that the purchasing and usage of SWIS has made an important contribution to accelerated economic growth at the macro-level since 2005-06.

7.4 Conclusion: Important findings and a rich vein of new research

This chapter has found a strong impact of forward linkages from the SWIS sector into India's domestic economy. Even using the most conservative estimates from the econometric modelling exercise in Section 7.1, the results find that amongst large- and medium-size firms listed on India's stock markets outsourcing was responsible for a 20% increase in output per firm between 2005 and 2008. In aggregate, the analysis in Section 7.3 also finds that forward linkages from the formal SWIS sector have been responsible for between 1.3 and 2.4 percentage points of GDP growth. These estimated returns are large, relative to several different benchmarks. The most obvious of these is that the return is large relative to the cost of purchasing SWIS. The gross marginal product arising from the estimated elasticity of SWIS to output is Rs.11 crore for an additional Rs. 1 crore spent. This is a significantly higher return than the same firms achieve from purchasing in-house IT. At the margin, an additional Rs. 1 crore of in-house hardware and/or software assets returns a very respectable, but significantly lower, Rs. 8 crore. Relative to benchmarks in the literature, the same themes emerge. The elasticity for in-house IT is below the mean in a meta-study of developed country studies by Stiroh (2002). This suggests that Indian firms achieve less return with in-house IT than do their developed country competitors. The elasticity on SWIS outsourcing, on the other hand, is much higher than Stiroh's mean, suggesting that amongst the firms in the study, SWIS outsourcing may be instrumental in bringing parity between Indian and Western firms' technology use. This hypothesis is supported by the qualitative data outlined in Section 7.2. The in-depth interviewing found that purchasing SWIS from the sector enables Indian firms to significantly gain from the years of knowledge of Western firms about how to use IT in particular industries. Equally important, it also enables Indian firms to utilise the newest technologies.

The work contained in this chapter contributes to the two strands of literature introduced in Chapter 2. To the literature on output and productivity effects of outsourcing, it contributes the first developing-country study and the first study of IT outsourcing separated from other services. Perhaps because of this latter difference, the explanation for the productivity improvements measured is different here to that given in the rest of the literature on outsourcing. Where it refers to outsourcing of components, materials or non-IT related services, qualitative explanations of productivity improvements in the literature usually focus on re-structuring and the removal of low productivity work from the firm. In the current research, learning from partners seems to be much more important. In this respect, IT outsourcing has revealed itself to be different from normal outsourcing, suggesting that, in future studies of outsourcing, it needs to be divided from, not combined with, outsourcing of components or other services.

To the literature on the impact of IT, this chapter contributes one of the few pieces of research focussed on developing countries, and contributes the first research with a large sample size and with complementary qualitative research. Perhaps more importantly, it investigated the role of SWIS outsourcing and identified problems that arise if it is not included in studies of in-house IT. In Section 7.1, a significant bias was found in the elasticity of in-house IT when SWIS outsourcing was excluded. It may be that this issue is also relevant in other countries and contexts, particularly in other developing countries, and that there is a need to re-evaluate or re-design research methodologies in these cases.

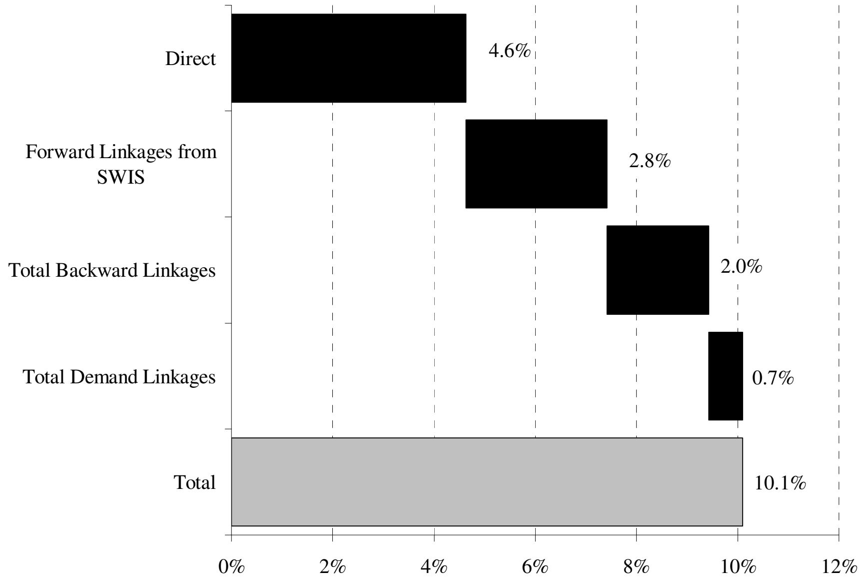
This chapter has touched on several other avenues for further research worth mentioning here. In Section 7.3, IT firms' learning in export markets and how that learning is dispersed in India is discussed. This topic is worthy of further investigation because the learning activities of IT companies are a rare and important avenue for tacit learning to cross borders. There are also several interesting avenues for further research using the PROWESS database. A fuller investigation of productivity in Indian firms is one of these, as is a more granular investigation of returns to IT and SWIS outsourcing at the sector level. These other avenues for future research are discussed in detail in Chapter 8. The chapter also includes a summary of the role of the SWIS sector in India's economy as a synthesis of the themes and research discussed so far, and some thoughts on the future for IT in India.

8. Discussion and Conclusions

8.1 In conclusion, IT is a leading sector in India

This thesis has demonstrated that, despite all the pessimism, the Indian IT industry is a leading sector in India. The research project identified and quantified the size and strength of different linkage mechanisms. Chapter 5 found that backwards linkages from IT firms' purchases were worth 2% of 2005-06 GDP and that IT workers' purchasing patterns contributed a further 0.6-0.75%. Chapter 7 discussed forward linkages from SWIS, and estimated that because of their strong impact on output, these linkages contributed 1.3 to 2.4 percentage points (or 10% to 20%) of GDP growth in the years between 2005 and 2007.

Figure 8.1: Conservative Estimate of the Total Contribution of the IT Sector to GDP in 2005–06



Source: "Direct" is from Figure 3.2. Total backwards and demand linkages are from Figures 5.4 and 5.7. Forward linkages have been calculated using the results in Figure 7.14.
Notes: Hardware manufacture is excluded. Estimate of the impact of forward linkages is only from SWIS and excludes indirect linkages. When a range of different values was suggested by previous chapters, the midpoint of this range is plotted here.

There are several reasons why these estimates may understate the impact of the IT industry in India's economy. The first reason is that for backwards and demand linkages, the estimates are five years old (the most recent estimates in Chapter 5 are from 2005-06), and for the last five years (2005-06 to 2010-11), the sector has continued to increase rapidly in size. The second is that for reasons laid out in Chapter 4, these estimates ignore the informal IT sector (that is, firms not registered with the GOI). Finally, the estimate of the impact of forward linkages, taken from the econometric work in Chapter 7, does not include any impact arising from indirect linkages. This is important because indirect forward linkages may have a substantial impact. When IT is used to deliver, for example, health advice or education, it is a conduit of investment into human capital (UNGAID, 2006). Similarly, familiarity with communications tools can lead to improved political debate and participation, and can be a driver of good governance and better decision making at national level (United Nations, 2010). In non-democratic countries this kind of debate can even lead to the emergence of democracy itself (Sen, 1999). Notwithstanding these considerations, Figure 8.1 collates the different contributions of the IT sector to GDP for 2005-06. It shows that in that year, the total impact of the sector on GDP (at 10.1%) was over double the size of the sector's own output (at 4.6%). It also shows that even in that early year, and even using conservative estimates, a total of 10.1% of GDP was attributable to the IT sector.

Of all the parts that comprise this substantial contribution, forward linkages from SWIS are the most likely to lead to sustainable growth. Chapter 7 showed that installing SWIS in firms leads to improvements in productivity. This produces a more sustainable pattern of growth because, as argued in Chapter 1, productivity improvements can put industries on to the 'high road': Firms that compete through improving productivity, rather than through low costs and slim margins, earn profits that can be reinvested into their business. If they do this, they can embark on a virtuous circle of further upgrading, which in turn secures and improves their competitive position on an on-going basis. As long as there is sufficient demand for the firm's products, expansion can continue. Demand is likely to be strong for India's SWIS-buying industries, at least in the medium-term. Both IT itself and many of India's SWIS-buying sectors are income elastic, and continue to have a large and growing share in world trade (Portugal-Perez, Reyes, and Wilson, 2010: 1).

If growth arising from the SWIS sector's forward linkages is both substantial and sustainable, then the question of how and why these forward linkages arose is paramount. The thesis answered this question by documenting and explaining how the technology became appropriate for India. Chapter 6 gave a detailed analysis of how SWIS is used in Indian firms and, in particular, the returns to scale of software systems. It found a match between attributes of the technology and recently emerged attributes of India's economy and society. This match meant SWIS was appropriate for India because it enabled companies to provide low-cost, quality products to price-conscious consumers on a large scale. This not only allowed Indian companies to find more demand for their products, it also, in many cases, led to price cuts that were beneficial for Indian consumers. In uncovering and explaining this process, Chapter 6 provided an empirical demonstration of a widespread appropriateness of IT in a developing country, therefore making a significant contribution to the literature on IT and development reviewed in Chapter 2.

These main conclusions of the research project, combined with other themes threaded through the preceding chapters, have several important implications for economic principles and policy. These are covered in Section 8.2, while Section 8.3 lays out an agenda for future research, and Section 8.4 brings the thesis to a close.

8.2 Implications for Economic Principles and Policy

Software, services and the pattern of India's economic growth

This thesis is supportive of the idea that services sectors such as finance, communications, hotels, transport, wholesale and retail trade, and IT can be the engine of India's economic growth both now and in the future. Chapter 5 included data that demonstrated that it is the services sectors which are the main buyers of outsourced SWIS. Chapter 7 went on to demonstrate that because of this large investment, it is these sectors which experience the biggest per firm improvements in output and productivity. In a supplementary analysis, Chapter 7 also included separate models of the production functions in services and in manufacturing. These identified significantly higher output elasticities for both SWIS outsourcing and in-house IT in services firms versus manufacturers. Finally, the case study on one services industry, SWIS, in this thesis has found evidence of many linkages which have positive effects on other industries. This adds to the evidence of Hansda (2001) and Dasgupta and Singh (2005) who both also found that services sectors have strong growth enhancing externalities.

This evidence points to an optimistic prognosis for ongoing expansion in India's services industries. It is these sectors who, as a result of purchasing SWIS, can compete on the basis of a technological lead. In turn it is they who have the opportunity to enter into a 'high road' pattern of growth and a virtuous circle of investment and upgrading (Guiliani, Pietrobeli and Rabelotti, 2005: 550; Humphrey and Schmitz, 2000: 4). If they capitalise on this opportunity, India's services firms will not only be more profitable, they will also have a more sustainable business than firms in other sectors which compete on the basis of low wages and slim margins.

Demand for services is also likely to be strong over the coming years. Services continue to be the fastest growing sector of the world economy (McCartney, 2010:108) and empirical studies have confirmed that demand in many service sectors is income elastic (Falvey and Gemmell, 2005). If the neo-Schumpeterian authors introduced in Section 2.1.1 are correct, future demand for services can be relied upon for many years to come. They predict that a global restructuring of economic activity in favour of exactly the type of activity that takes place in IT-intensive services sectors is underway, and is set to last for forty to sixty years.

The new findings also shed light on two mysteries that were introduced in Chapter 2. The first was data by Poddar and Yi (2007:8) which showed Indian services sectors experiencing stronger total factor productivity (TFP) growth than manufacturing despite both Smith (1776) and Marx (1887) having predicted that for fundamental reasons manufacturing should be the more productive of the two. What the new evidence in this thesis adds to this debate is an explanation of why TFP growth is so strong in these Indian service industries - it is because of investment into IT. The thesis also contributes an understanding of why Smith and Marx were unable to predict India's recent pattern of growth. IT simply hadn't been invented when they were writing. The second mystery surrounded India's experience of structural change. Evidence was presented in Chapter 2 which showed that as the share of agriculture in India's GDP has diminished, it is services sectors which have grown to fill the gap and not manufacturing. It was noted that this stood out in stark contrast to the experience of the now developed countries (Rostow, 1960), and the question was posed as to whether this could possibly be as successful as the usual, manufacturing based, route. On this possibility, the current research gives reasons for optimism. In turn it is suggestive of a general policy implication for developing countries:

Development based on services rather than manufacturing may well offer an alternative, and in some cases preferable, route to prosperity.

The next section moves on from the implications for India and begins to discuss some implications of the current research for economic theory.

Not all production is equal: some sectors are better than others

The most obvious implication for economic theory is the thesis' finding that particular leading sectors are important. The research project has found that the expansion of the IT sector in India has successfully transmitted growth to other sectors through linkage effects. It has provided a case study which demonstrates, just as Hirschman (1958) predicted, that leading sectors can bring about growth. The thesis has also shown that in India, the IT sector and its forward linkages are bringing to the Indian economy a totally new and highly technical type of production. Prior to the sector's inception, and in accordance with the profile of India's endowments[103], India had very little expertise in IT and, therefore, carried out very little production in an IT intensive way. Thirty years later, India has strong companies which compete successfully in world markets in both IT production and production using IT. It is a compelling confirmation of the power of leading sectors and linkages. If the leading sector strategy can bring growth using a new and demanding technology in a country with no experience of using that technology, and with the wrong endowments, it will surely be useful in less demanding scenarios.

In providing support to the idea that growth in leading, highly linked sectors is superior to growth in other sectors, the thesis has implications for an idea which

[103] Mayer and Wood (1999) find that India's endowments are suitable for labour-intensive manufacturing.

pervades the modern practice of macroeconomics. This is the belief that it is possible to simply add up all economic activity in a country, and to treat the aggregate quantity (GDP) as one thing to be explained and perhaps targeted through use of policy. What leading sectors tell us is that applications of this idea will give misleading results. For example, econometric models that link macro-level growth to macro-level causal variables over time treat output increases in every period as equally valuable. When leading sectors are important, this is an invalid assumption. Expansion in a leading sector, which might occur in only a subset of the time periods under consideration, may bring more expansion in the future, whilst expansion in another sector at another time does not. A similar criticism can be levelled at the use of theoretical models that use linear aggregations of micro-foundations to understand the macro economy. In assuming that a group of firms, individuals, or sectors will all do the same thing in reaction to a particular stimulus, these models effectively rule out the possibility that one firm, individual, or sector may react to the actions of another. When linkage effects are important in driving macro-outcomes, this can only be described as a disastrous thinking (Hausman 2009; Kirman 1997).

Another implication of the leading sector strategy concerns the relationship between growth and inequality. Leading sectors drive spurts in economic growth that are concentrated in particular linked sectors and, hence, amongst particular types of workers and in particular geographies. In the current case study the leading sector and the other sectors that buy from it either produce or use IT. Therefore, there is a need for skilled workers, which means that poor, uneducated people are effectively excluded[104]. If this pattern turns out to be relevant more generally, it can constitute

[104] Section 2.2.2 explains why IT-intensive firms need more highly skilled workers; this is also documented in Bresnahan, Brynjolfsson and Hitt (2002).

one explanation for an empirical regularity which has become increasingly visible in recent years: starting in the 1980s, growth has come with rising inequality (Cornia and Addison, 2003; Palma, 2011) and the world is now more unequal than it once was (Figure 8.2).

Figure 8.2: Gini coefficient (y-axis) versus inequality ranking (x-axis) in 1985 and 2005

Source: Palma (2011: 90).
Note: Ma is Malaysia; US is USA; Br is Brazil.

If leading sector growth is important to the stories behind these figures, then the current case study could add an important strand to the global debate. Not only would India's experience provide a new explanation for rising inequality, but the country's relatively long history with an IT related leading sector might offer lessons to other countries on how inequality associated with leading sectors evolves. Over the medium- to long-term, the IT sector in India has begun to locate in disadvantaged areas. It has also seen the emergence of substantial domestic backwards linkages which, as the discussion in Chapter 5 showed, predominantly benefit low-skilled workers. In other words, because of backwards linkages, unequal growth in India has begun to "trickle down," as Kuznets (1955) predicted.

What all of these considerations have in common is that they suggest a much larger role for the meso-level both in the theory and the practice of economics. This sub-section has argued that if leading sectors are important, meso-level analysis is likely to provide a good understanding of macro-level quantities like growth and inequality. Meso-analysis is also likely to be helpful for policymakers, particularly in identifying potential leading sectors and providing the right kind of policy to support them. The next sub-section discusses what policymakers should do to encourage leading sector growth, and highlights the implications of the current meso-level case study on this issue.

Government versus markets is a false dichotomy: both must play a part

This thesis provides a case study not only of the importance of SWIS as a leading sector, but also of how expansion in that leading sector came about. In this latter respect it is a case study that sheds light on a controversy which still exists between the two authors who advocate leading sectors introduced in Chapter 1. Hirschman (1958) and Hausmann along (with various coauthors) disagree on (1) how leading sectors should be chosen and (2) who should provide the investment that leads to expansion in them. On both counts, Hirschman points to the government. He says that the state should choose leading sectors by reference to statistical analysis (of the kind included in Chapter 5) and then provide investment directly to them (1958:203). He also says that the government should ensure that growth in the leading sector can continue by investing into sector-specific complementary public goods (such as ports, highways and electricity) (p. 83-97). Rodrick and Hausmann's (2006) position is very different. They argue that governments have neither the information nor the incentives to choose the correct leading sectors, or to identify and implement the right types of investments into them (p. 29). Aside from providing general, multipurpose, public goods, governments should do nothing more than initiate a period of consultation with private sector actors. This consultation should have the objective of identifying opportunities for investment and finding private sector volunteers willing to make those investments (p. 31). The process is expected to elicit superior information by identifying investment opportunities in which private sector entrepreneurs see potential profit (p. 31). It is also expected to excuse the government from making the kinds of investments that Rodrik and Hausmann think are outside of any government's purview to implement and manage.

Section 3.3 addressed this government versus market controversy by providing a critical review of the literature on the emergence and growth of the IT sector in India. The discussion found that despite most of the literature agreeing with either Hirschman or Hausman (and coauthors) in this debate neither of the two positions can explain the sector's trajectory on its own. The position of this research is that there was a particular chain of events which led to the IT sector establishing itself in India. To begin, starting in the 1950s, the Government of India provided substantial investment in education in engineering and related subjects. This created a later comparative advantage in SWIS at a time when, because of the nature and life stage of the technology, global demand was outstripping the ability of the developed countries to supply it. These two circumstances—historical government investment into engineering education and global demand for SWIS—created a market opportunity in exporting IT services and it was this opportunity, exploited by the private sector, which led to the SWIS sector's emergence and early success. As for the government's later involvement, this was generally unhelpful or neutral in the early days of the industry because the aim of policy was to support a hardware manufacturing sector and SWIS was largely ignored. Once the SWIS industry was clearly more viable than hardware, the direction of policy switched to being helpful to SWIS rather than hardware and this was generally successful in helping to build the sector.

The current case study cannot, therefore, support either side of the divide between Hirschman (1958) and Hausman and Rodrik (2006) on policy implications. In accordance with Hausman and Rodrik's predictions, the GOI did not actually select the correct leading sector (SWIS) to target with policy, but it was close in picking hardware. On the other hand, and in line with Hirschman's proscribed role, the government did later take several important actions which supported the sector. A similarly contingent story applies to the role of the market and private sector actors. Without private entrepreneurs, India's comparative advantage in SWIS would not have been sufficiently exploited to provide such impressive growth in exports. Then again, there would have been no opportunity for the private sector to exploit if a comparative advantage for SWIS had not been created as a result of the historical GOI investment in education. In summary, then, this case study is one in which development has been supported by a successful interplay of government intervention and market forces, with both working in the same direction. It has also occurred in the context of some special circumstances relating to the nature and life-stage of the technology which ensured strong and growing demand. The existing debate on the emergence of the SWIS sector, arguing strongly for either government or market is, therefore, misleading. There is a need for a more balanced and nuanced approach to the question of how this leading sector came to be so successful both in export markets and at home.

The tendency of the literature to focus on government versus market is not limited to discussions on leading sectors, and it doesn't arise from any particular features of them. The controversy between Hirschman and Hausman and Rodrik (2006) on policy can be explained by an understanding of wider trends in thinking about economics. In the 1950s, when Hirschman wrote his book, the prevailing wisdom was that postcolonial governments in developing countries were both capable of and interested in enacting successful development-oriented policy. More recently, and because of the perceived failure in that earlier period, mainstream economics moved to the other, pro-market, extreme. Hausman and Rodrik (2006) is simply one example of this extreme thinking: that governments are for several endemic reasons incapable of identifying and successfully carrying out sector-specific industrial policy. A full consideration of this thinking, and the reasons given to support it, falls outside of the scope of the current work. However, in showing that the government intentionally and successfully played a role in the SWIS sector's success, the current case study suggests that the swing to a pro-market ideology in mainstream economics went too far.

"It's the demand side, stupid"

Contributions in the literature on the emergence and growth of the IT sector are not the only ones which have been queried during the research project. The new research in Chapters 5, 6, and 7 made it clear that the accepted literature on the sector's linkages, reviewed in Chapter 3, also has serious shortcomings. This sub-section takes another look at both of these two literatures in the light of all the data collected and analysed in this project. In the case of the literature on the emergence and growth of the sector it asks 'In focussing on governments versus markets, which important drivers did this literature miss? And, in the literature on linkages, why did the two most influential analyses of forward linkages, Dahlman & Utz (2005) and D'Costa (2003) get their predictions so wrong? The answer to both of these questions is demand. IT is relatively new, and has several unique and valuable characteristics, and there is a great demand for it and for the products which embody it.

The literature on the IT sector's emergence misses this point because it pays little if any attention to the importance of demand for IT workers in the developed world and why that demand was so strong. Section 2.1.1 discussed in detail the trajectory of investment in the United States and Europe in IT in the late 1980s and 1990s. The literature review there found that the speed of uptake in that period was dramatic: technological advances and improvements in semi-conductor technology meant that what was achievable with IT for a given expenditure was improving very quickly. Additionally, IT could be used in myriad ways, including raising productivity in many industries. These attributes of IT and of that period in its lifecycle meant there were a great number of firms and consumers in Western economies wanting to purchase it. Chapter 2 concluded that the resulting speed of uptake was too fast to be matched by output of suitably qualified staff in developed countries, thus leading to a shortage of IT workers. In India, by coincidence, historical government policy (which set out to create heavy industry in the country) had created a pool of English speaking university educated engineers. The beginning of the IT industry in India was sparked when it became clear that there was profit in sending these engineers to Western countries for work, or having them work remotely on Western IT problems. True, India had a comparative advantage in providing IT workers to developed countries, but this would not have been enough if IT had not been so new, fast-changing, and pervasive. Without the large, worldwide demand for IT, there would have been no urgency for it in developed countries, and India's engineers would not have been deployed.

A similar criticism can be levelled at the literature on forward linkages. Chapter 3 introduced two influential contributions which provided explanations for the lack of forward linkages from the IT sector into India (Dahlman and Utz, 2005; D'Costa, 2003). These publications led to a gloomy prognosis that it was unlikely that forward linkages would emerge in the near future. These two contributions were re-evaluated in Chapter 6 in the light of the findings of the project. The research found that despite these two analyses resting on very different methods and ideologies, they both concentrated almost exclusively on the supply side. For this reason, neither was able to explain the actual trajectory of forward linkages. The market-oriented model of Dahlman and Utz (2005), and the Marxist model of D'Costa (2003), both analysed the most likely location for the supply of SWIS and IT-intensive products and services for world markets. Both analyses had the implication that this was, and would likely continue to be, the developed world. In paying scant attention to the special features of the technology, in particular its attributes when deployed over scale, both missed the possibility that IT might become appropriate for India and, therefore, demand for IT-intensive products might arise there. In turn, both missed the possibility that Indian firms producing for domestic markets might begin to install SWIS in large volumes.

The omission of the decisive role of demand in the existing literature on Indian IT is important for three reasons. The first is that there are clear theoretical reasons why demand is more important than supply for the location and growth of IT-intensive sectors, and as argued in chapter 6, this case study when properly understood offers empirical validation of these theories. The second is that there are lessons for other developing countries. If analyses of which sectors developing countries can and cannot succeed in do not consider demand, they risk ruling out as improbable or unlikely, trajectories which could offer a beneficial pattern of growth, and even structural change. Finally, as explored in more detail in the next section, it is through an examination of the demand side that the features of the technology, which made it a good leading sector, are revealed.

Pervasive, new, and productivity-boosting products make leading sectors

This sub-section details the characteristics of IT, as a product and as a technology for production, which contributed to it being a successful leading sector in India. Some of these have already been highlighted in this chapter. The sub-section directly above found that two characteristics of IT were important for the early demand in the West and, therefore, for bringing the Indian sector into being: *innovation* and *myriad uses*. Together, these factors led to a vigorous uptake of IT in the West, which directly led to a demand for India's educated workers. Another two important characteristics were highlighted in Section 8.1. The first arose from the discussion of why forward linkages have expanded so quickly in India. There it was found that without *economies of scale* resulting from software code being free for its owners to copy, very fast growth in domestic forward linkages would not have occurred. The second was the *productivity-enhancing* capabilities of SWIS. These are the main reason why forward linkages from the sector are successful at expanding output in SWIS-buying sectors. They have also been essential in putting India's SWIS-buying industries onto the 'high road', or in other words, bringing about a desirable, and sustainable, pattern of growth.

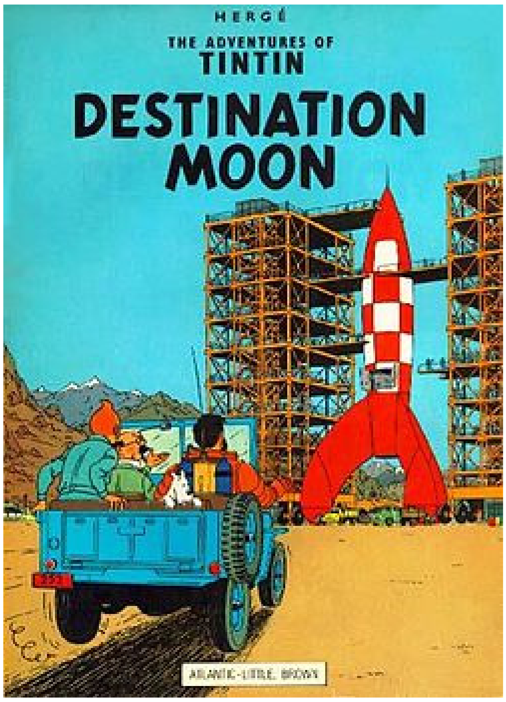
These are not the only features of the technology which have been important, however. Chapter 7 found that the impact of forward linkages on productivity and output in Indian firms was stronger than the impact of in-house IT either in India or in Western countries. Section 7.3 explained this finding, and the two reasons given rest heavily on two particular attributes of the technology: that *IT is constantly improving* and that *it is appropriate for outsourcing*. In India, the SWIS sector often installs IT into firms that previously have not experienced IT. Unlike in developed countries, there are no compromises or changes needed to make the new system compatible with legacy or dated systems already in place, because there are no systems in place. For this reason, IT systems installed in India are often superior to those in used in the West. This over-taking in terms of the technical quality of systems comes about because of a process which has long been observed with new technologies experiencing continuing innovation and improvement in IT (Abramovitz, 1986). That is, because the technology continues to be improved, newer systems implemented later are better than the older ones which are in use amongst early adopters. The second reason for superior returns from SWIS arises from IT being an ideal service for successful Western companies to outsource. Section 7.3 found that Indian firms that buy IT from the sector have the opportunity to learn about how best to implement IT from their IT outsourcing partners. Because these firms also undertake SWIS outsourcing projects in western economies, these lessons are very valuable. IT firms are experts on how IT should and should not be used in particular industries. They have accumulated “domain knowledge” through export projects in Western countries, and they regularly apply this knowledge in Indian companies.

If features of the product are important in explaining why IT makes a good leading sector, then this is an important implication for other developing countries. IT, as a product or as a production technology, will have these same features in other developing countries. This means that an IT sector may well be able to play a similar role there to the role that which the thesis has documented in India. If so, this case study adds an important strand to the literature on IT and development. That literature, perhaps not surprisingly, given its paucity of meso- or macro-level empirical evidence (as documented in Chapter 2), is far from any consensus on what IT can or will do in developing countries. Section 2.2.2 documented that some authors believe that IT may not be appropriate for developing countries (Miller, 2001; Mody and Dahlman, 1992). Even amongst those that reject this position there is a wide divergence of opinion on how IT can help. On the one hand, the mainstream literature holds that IT helps development because it complements free markets and trade liberalisation (International Monetary Fund 2001: 136; Miller, 2001; Mody and Dahlman 1992: 1706). On the other hand, specialist literature, such as *Information Technology for Development*, rejects this position on the grounds that it is a-contextual and includes little about the processes that actually take place in developing countries (Avgerou, 2003: 383). This latter literature, instead, focuses on contextual case-study evidence which, whilst rich, has a narrow geographical and empirical scope and rarely makes conclusions about the economy-wide impact of IT (Avgerou, 2008). Against this uncertainty, the current research is important because it documents a clear process by which IT can affect growth in developing countries. IT technology is appropriate because it is amenable to use in automating and upgrading production in developing countries with large middle classes. A leading IT-producing sector is a reliable mechanism by which to start and maintain the processes which bring this outcome about.

Another implication of the special features of IT identified in this section is that other products, with some or all of these same special features, may also make a good leading sector. This suggests the creation of a checklist of attributes against which to judge any potential leading sector. If the research is a good guide, one attribute of such a product or technology is that it be relatively new, so that demand is strong and growing. If innovation means falling prices at the same time as increasing quality, so much the better. The product or technology should be pervasive, or at least multi-purpose, so that it has many potential buyers, and so that forward linkages can be numerous. Finally, if the product or technology is productivity-enhancing and undergoing rapid technical change, it may be able to put its linked sectors onto the high road. In this case, the sector's linkages can lead to sustainable growth and catching-up with technologies in use in developed countries. This is not a short list, and it is not easy to find products or technologies that completely fit these attributes. Perhaps leading sectors can be found in products or technologies with only some of these attributes. If, however, all are needed, it suggests the need for developing countries to focus on products or technologies, like IT, which can be described as "revolutionary" (David, 1990; International Monetary Fund, 2001; Nolan, 2001: 134; Perez, 1985). Citing Britain for steam, America for oil, and South East Asia for IT hardware, Perez (2001) argues these historical "revolutionary" technologies did, in fact, carry at least one developing country to a much wealthier status. Although Perez does not use the terminology of leading sectors, she sums up that developing countries that make an early entrance into production of a "revolutionary" technology gain a rare chance to leap forward, development-wise.

Taking this idea to its natural conclusion leads to a policy recommendation for developing countries to now begin to plant the seeds of a comparative advantage in whatever the next “revolutionary” technology will be. A recent article by Kuper (2011) suggests a novel strategy. Citing the proliferation of models of Tintin’s rocket in the offices of astronauts whose work got us to the moon and the accuracy with which Orwell’s 1984 imagined Korea under communism, he suggests looking to science fiction as a guide to the future. In 2011, this might lead to building capabilities in nano-technology, or at least investing in the education of physicists or biologists who might play a similar role to India’s engineers in the next nano-enabled “revolution”.

Figure 8.3: Herge, Destination moon. A predictor of the first moon landing?



Source: Herge (1950)

While not as adventurous as Kuper’s suggestion to look toward science fiction, the next section sets out avenues for useful research arising from the research project.

8.3 An agenda for further research

Addressing the limitations of this study

Understanding the role of all the linkages between one particular sector and all possible other sectors throughout an extremely large developing country like India is a considerable endeavour and one which will only be fully completed through on-going research. This section identifies several areas in which the current work's conclusions would be strengthened by further attention. The most significant of these is a consideration of the informal IT sector and its impact on small- and medium-size client firms throughout India. As quoted in Chapter 7, Dennis Rajakumar (25 February 2009, Bangalore) suggested that the informal (i.e., unregistered with the GOI) IT sector does important work for these particular firms, including researching the firms' needs and developing software designed specifically for them. If this assertion is verified by further research, it could show that informal IT firms are having an important additional effect on macro-level outcomes. On the other hand, the informal sector may display different attributes, and may be more or less effective, than the official IT sector researched in this thesis. These are issues worthy of investigation, if estimates of the percent of informal employment in India's economy are a guide to the share of the informal IT sector. Naik (2009:9) estimates that in 2004-05, 86% of employment in the country took place in unregistered firms.

Another set of avenues to explore for extensions of the current work arise from a paucity of official data on some of the issues covered in the thesis. The most important of these is the weakness of official data on the size, growth, and activities of the IT sector itself. The thesis has relied heavily on NASSCOM's data on the size of the sector and on its activities. Chapter 4 provided verification of its data and a discussion of the methods used; however, it is clear that NASSCOM's remit is to be persuasive in particular directions. How much this affects what is contained in NASSCOM's research and publications remains unclear because there is no comprehensive official source for comparison. A related issue concerns the analysis in Chapter 5 of India's input–output tables. The discussion in that chapter revealed what appeared to be serious concerns regarding the official estimates of where output from the SWIS and ITES-BPO sectors was used. This uncertainty is compounded by the frustratingly slow speed at which additional years are published by the GOI. At the time of this writing, the most recent input–output tables available are five years old. This not only makes it difficult to verify the earlier figures or to match trends with other data sources, it also renders the estimates of direct and indirect linkages arising from the tables as already out of date.

There are also areas which merit further attention but which were not fully investigated during the project because of its limited size and, so, necessarily its limited scope. The first of these is on backwards linkages. It would be beneficial to undertake newer research on these linkages. The discussion on this issue in Chapter 5 relied heavily on NASSCOM and CRISIL (2007). Their research, in turn, relied on a single survey of SWIS+ITES-BPO spending patterns and India's 1997-98 input–output tables. The second is that there is little consideration within the thesis of Hirschman's third type of linkage: entrained wants. Chapter 6 argued that the middle class in India are desirous of IT-intensive products, which may be a result of using and seeing SWIS from the sector. However, it was not possible to research this linkage in any meaningful way during the timeframe of this thesis. The third limitation is that ITES-BPO is also an under-researched area. It was argued in Chapter 4 that this is often misclassified as an IT-producing sector, when, in fact, it is better thought of as an IT-buying sector. However, many of the processes documented in Chapter 6 as being important in the expansion of Indian IT-intensive industries do not apply to ITES-BPO, because it is significantly more export-oriented. This means that the rise of large middle-class markets in India is less important to their IT use than the needs of Western clients.

Research that would extend the boundaries of the current project is not the only next step suggested by this thesis. Throughout the preceding chapters, there were questions which arose but were not fully investigated. The remainder of this section sets out a plan to rectify these omissions. It re-visits where this project intersected with other pertinent themes, and it outlines an agenda for further research. This begins with a discussion of the implications of increasing returns to scale arising from the use of IT.

Big is bountiful? IT, increasing returns, and growth

For all the investment into and interest in IT over the past 30 years, the nature of the technology and, in particular, how IT works in production is under-studied in the literature on economics. The "productivity paradox" literature, reviewed in Chapter 2, includes a large number of publications interested in the impact of IT in production, but very few delve into what is different in the production methods and capabilities of firms that install it. Instead, these contributions generally treat "the firm" as a black box. In goes IT and other inputs, and out comes telephone services or online banking. This thesis has demonstrated that this is an area worthy of more investigation. Even in the limited timeframe available for this project, striking findings have arisen from studying what happens to the process of production when Indian firms use IT. Chapter 6 showed that economies of scale arise from the use of software in production as firms grow. It also highlighted two other beneficial scale effects within the firm:

conscious learning by doing in systems, and improved co-ordination to postpone decreasing returns to scale as firms grow. These beneficial scale effects may be the first of many important generalities that can be drawn from study of the economic properties of IT as a production technology. Increasing returns to scale may also be important in more ways than those documented here so far.

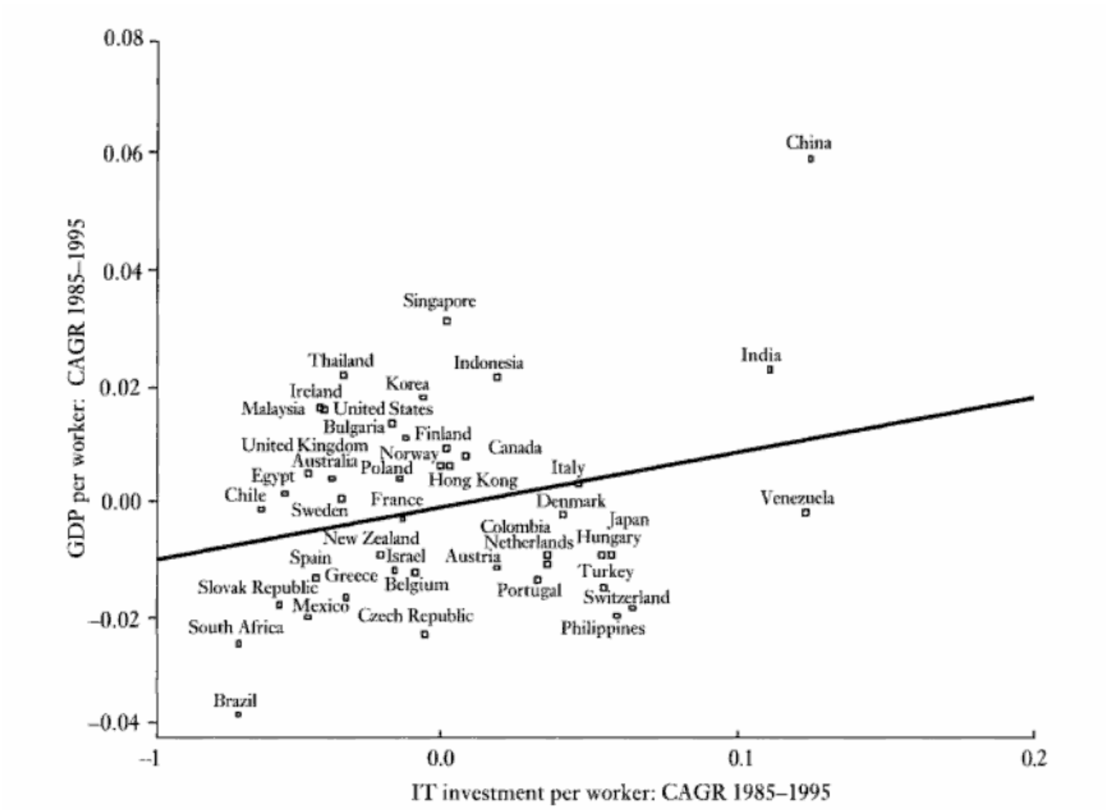
One possibility in this latter direction is the prospect that the features of software, and how it is used in firms, can lead to a form of endogenous growth. De (2007) has begun work which revolves around this insight. He set up an endogenous-growth model with the important feature that software acts a special type of capital, alongside traditional and human capital. In it, the "free copy" property of software code (see Chapter 6) generates endogenous growth because software companies can sell the software they produce to other industries whilst keeping a copy for themselves at no additional cost. This increases output but still allows software firms to re-use a proportion of the software. It means that in the next period, the software industry can produce and sell more software than in the first, without having to increase its input needs. De applies his theoretical model to India, and argues that his mechanism may be able to explain both macro-level economic growth and differential growth rates amongst states. There are some serious problems with this conclusion, however, not the least of which is that domestic consumption of software from the sector was too small during period he analyses to be the main driver of the whole economy's pattern of growth. However, the central insight of De's model is important. If IT-producing firms, and those that use IT, can use free, copied, software to give themselves more or better knowledge (or inputs) during the following period, this is a valid source of endogenous growth. This idea may be able to explain the trajectory of productivity and output growth at the micro- or meso-level in India and elsewhere.

Another, perhaps even more, interesting possibility arises from a different theoretical model of how increasing returns to scale in the production technology matters. The "Big Push" theories of development, introduced by Rosenstein-Rodan (1943) and formalised by Murphy, Schleiffer, and Vishny (1989a, 1989b), postulate that if the technology of modern industry displays increasing returns to scale, insufficient domestic demand may prevent developing countries from experiencing industrialisation. The problem is that until large domestic markets for firms' final products are in place, increasing returns technologies are not viable for use as production technologies. This means that modern industry which relies on these technologies cannot emerge, and so it cannot hire the workers which could otherwise make up the so far lacking domestic markets. The end result is that industrialisation does not occur. Murphy, Schleiffer, and Vishny (1989a) say that one way out of this trap is for one or several industries to be successful enough to escape the trap, perhaps by finding markets for their products abroad. Workers in these industries then constitute a source of domestic demand, which then enables other industries to invest in technologies requiring a large scale to be viable. These other sectors then also escape the trap. They can add more workers to the pool of domestic demand, so that more and more industries invest, and a launch into industrialised growth can occur.

It is possible that a similar narrative around software and automation, not machinery and factories, applies to India in the modern era. The pattern of economic growth since the 1980s in India has, as described in Chapter 1, predominantly benefited the middle class. This segment of society has now become a large domestic market for IT-intensive products. As described in Chapter 6, this, in turn, has enabled many IT-intensive sectors to invest in the technology for the first time, particularly because IT firms have assisted their clients by sharing the risks. As demonstrated in Chapter 7, it has also meant that many IT-intensive sectors have experienced an expansion. Where the need for more research arises is in understanding whether these sectors actually hire more workers as a result of their IT-enabled expansions. If so, the Big Push model may apply, and India might witness a growth take-off, accompanied by a restructuring of the economy in favour of IT-intensive sectors. This would validate the ideas of authors, primarily in the business press, who put forward the idea that the Indian middle class will be central to a consumption-led economic growth take-off (Banerjee and Duflo, 2008: 1; Deutsche Bank, 2010). On the other hand, though, in the 1990s, there were concerns in the literature about a low-employment elasticity of IT- and services-led growth in India (Joshi, 2004). If anaemic employment growth remains the norm, then even the important addition to a Big Push narrative made here—an enabling technology with increasing returns to scale—will not turn it into a compelling bet.

These issues around increasing returns in IT are not only relevant in India. The observation made in Chapter 6, that economies of scale, alongside large consumer markets, made the technology appropriate for India, might also be important in other large developing countries. Even if this is not the case, one or both of the two applications of increasing returns to scale in IT introduced in this sub-section may be relevant. More research is needed, particularly in China and Brazil, which each have large and thriving domestic markets for SWIS (Arora and Gambardella, 2005). If increasing returns to IT are important in explaining investment in these countries, and if IT in these countries is as important in driving economic expansion as it is in India, this strand of research could yield important dividends. Existing cross-country research already reveals that these three countries (India, China and Brazil) are influential outliers without which the cross country relationship between IT investment per worker and GDP growth per worker would be much weaker (Figure 8.4). Going forward, it is conceivable that increasing returns to scale in the production technology may eventually be found to be part of the reason for these three countries' strong performance in the IT era (World Development Indicators, 2010).

Figure 8.4: IT investment Growth per worker and GDP Growth per worker



Source: Kraemer and Dedrick (2002: 264)

Of course, this relevance to other large developing countries depends on their implementations of IT being of equal quality as those studied in this thesis. The next section picks up on this issue by advocating further investigation around why Indian SWIS is so effective in producing productivity and output improvements. It focuses on how and why learning about the use of IT has been transferred from the West to India by the actions of the Indian IT sector.

SWIS outsourcing and knowledge transfer

Chapter 7 provided evidence that the SWIS sector is an important conduit of tacit knowledge about IT from developed countries to Indian firms. This knowledge was argued to be an important driver of success in IT projects in India. Because IT firms possess experience gained from the developed countries, they are able to replicate complicated and useful applications of the technologies which have emerged from years of experimentation by Western firms. This means that Indian firms do not have to repeat the experimentation phase or make the costly mistakes inevitably involved. In some cases, such as mobile telecommunications or banking, interviewees reported that Indian systems are better than those in place in developed countries. In these cases Indian firms have been able to learn from Western applications of IT, and then improve them by using more current versions of the technology itself. This parity, and even surpassing of Western technology, may have huge ramifications. When use of technology is an important determinant of competitive advantage, implementation of superior systems can lead to an opportunity to dominate in world markets. As an example of this type of effect, Chapter 6 noted the fast growth of Bharti–Airtel in supplying mobile telephones in many countries.

If India's catching-up or surpassing of Western technologies continues to occur as a result of the SWIS sector delivering Western learning to Indian firms, this case study will add significantly to the literature on development. Such success stories are rare, and always have been. Historically, there is a long list of publications which document how difficult it is to bring about technological catching-up in developing countries and question how and why successes can be brought about (Chang 2008; Gereffi, Humphrey, and Sturgeon, 2005; Kaplinsky, 2000; List, 1856). More recently, a new question on learning and technological catching-up specifically as a result of outsourcing relationships has spawned a new literature which reflects the same difficulties. This new literature, which takes the supply chain, or Global Value Chain (GVC), for a particular finished product as the unit of analysis, contains two different types of case study. On the one hand, there are rare cases in which developing-country firms supply products or services to Western firms, and then are able to learn from these buyers (e.g., Gereffi, 1999). On the other hand though, there are far more case studies which document developing-country firms joining global supply chains, only to find themselves unable to improve their processes (e.g., Dolan and Humphrey, 2000). The current case study, suitably extended, may be an important one because it has the potential to add interesting arguments to the debate which has arisen around what makes a particular case a success or failure, in terms of learning (e.g., Gereffi, Humphrey, and Sturgeon, 2005; Humphrey and Schmitz. 2000). If so, it may also contribute to the larger debate about when and how developing countries can catch up technologically with Western countries.

There is a need for caution here, though. Several of the interviewees in the 2009 fieldwork testified that, so far, Indian firms are only just beginning to work with the IT sector. Much could change as India's IT buying firms reach maturity, so it will be important to monitor whether later purchases are on the technological frontier. It will also be important to see whether other developing countries can surpass Western applications of IT, and perhaps even outperform their competitors in India. The subject explored in the next sub-section is of clear relevance to India's potential position in this conceivable future race, and argues for more research on the second cause of investment into SWIS: sector-specific reform.

Industrial policy by stealth? Reform in India's IT-intensive sectors

Chapter 6 introduced a role for sector-specific reform in prompting investment, and documented evidence which showed that liberal policies by the GOI were an underlying cause of slow growth in forward linkages both before and after 2005–06. It also delved into why government reform led to this investment. What emerged was a clear corroboration of the effects of reform expected by India's policymakers (Virmani, 2006). In the experience of the experts interviewed, the sequence and style of sector-by-sector reform led to investment and technology improvements as each sector was targeted. In a first wave of "pro-business" reforms, a targeted sector was helped to invest and upgrade with protective barriers. This particular approach to reform gave a window of opportunity for Indian firms to prepare prior to the introduction of competition from foreign companies. It was the forewarning that such competition was coming, combined with the opportunities presented by pro-business policies that prompted and, perhaps, compelled firms to invest. Without upgrades to the quality and value that they could offer consumers, the coming foreign competition might have eroded, or even eclipsed, incumbents' market share.

It was argued in Chapter 6 that this was a strange narrative to arise from a program of ostensibly liberal reforms. Usually, reforms have the intention of rolling back the influence of the state and ending interventionist industrial policy. Here though, the protectionist barriers allowed room for India's firms to upgrade and invest, and the GOI used the threat of international competition to compel firms to undertake these steps. In other words, the government managed to create successful infant industry-type policies, whilst ostensibly carrying out only a gradual scheme of liberal reform. This is an interpretation of India's liberalisation that is a far cry from that of Jenkins (1999). He argued that India's reform process was a introduced suddenly, was initiated by the bureaucracy and occurred as a result of many behind the scenes activities and decision-making processes, and he famously labelled the process 'liberalisation by stealth'. If a closer inspection of reforms in sectors using IT, instead verifies the chain of events which have been identified here as the cause of investment in IT-intensive industries, a better description would be 'intervention by stealth'.

If this process can indeed be verified it could be very useful knowledge for other developing countries. The gradual and carefully sequenced reform in India took place in a period during which policy makers had committed not to intervene in particular sectors (Pederson, 2000: 276). This is a commitment that has also been made in many other developing countries around the world. Intervention by stealth, according to the research here, may be feasible for other countries; in particular, "pro-business" deregulations, privatisations, and reductions in the share of government firms, in particular sectors, are aligned with the wider liberalisation agenda. The threat and eventual enactment of "pro-market", or trade liberalisation policies, are exactly those that international or domestic constituencies for neo-liberalism require.

There is a possibility that the PROWESS database introduced in Chapter 7 could be used to provide a wider exploration of these issues than was possible from the limited experiences of the experts who took part in this project. For example, it is possible to perform a similar analysis to that found in Aghion et al. (2005), which focussed on the impact of reform in manufacturing industries in the 1980s. A new analysis using the PROWESS data could look for significant increases in investment, both into SWIS and into other forms of capital, as reform is enacted. A finding that the response to "pro-business" reform was stronger than the response to "pro-market" reform might verify the chain of events explained. Other, alternative hypotheses about the effect of reform, should also be investigated.

Using collected data in new ways

An investigation of reform in IT-intensive sectors is not the only possible use of the PROWESS database, which could well yield interesting results, given more time and attention. The most obvious additional investigation is suggested in Chapter 7. The size and scope of the PROWESS database means that it is possible to look at the impact of IT, including outsourced SWIS, in a much more disaggregated way than that included here. In particular, it seems that services sectors and manufacturing sectors get different returns from their purchases of IT, and there may also be differences between sectors within these wider divisions. The stochastic frontier modelling in chapter 7 also opens up additional avenues for investigation. In particular it would be interesting to identify other factors, apart from SWIS use, that improve the technical efficiency of Indian firms. Another possibility arises from the fact that PROWESS includes measures of outsourcing of components and/or business services. This enables an analysis of the impact of non-IT outsourcing in the same vein as those reviewed in Section 2.2.3. What this analysis would add to that literature is the second ever investigation of outsourcing from developing country firms rather than from the United States or Europe[105].

Apart from the collation of the PROWESS dataset, the research project included the production of a large number of charts illustrating the data that describes the current case study. In many cases, these charts were put together through detailed collation of

[105] According to a fairly extensive literature review, and with the understanding that Banga and Goldar (2004) is the only other publication that would fall into this category.

data in disparate publications. In at least one case this effort in creating a more complete picture illuminated something which had been missed by the literature. This is the long time series of the size of the domestic market for SWIS (see Figure 5.15). This chart illustrated for the first time that the sector has been growing very quickly since 2005-06. An added bonus to the production of these charts is that the data collated in this thesis may be used elsewhere, without other researchers needing to sift through the individual sources.

8.4 Epilogue: On happy endings

> “About midnight in they came, dancing and skipping, hopped round the room, and then went to sit down to their work as usual; but when they saw the clothes lying for them, they laughed and chuckled, and seemed mightily delighted.
>
> “Then they dressed themselves in the twinkling of an eye, and danced and capered and sprang about, as merry as could be; till at last they danced out at the door, and away over the green.”
>
> Brothers Grimm, *The Elves and the Shoemaker*, (1912)

Fairytales like the *Elves and the Shoemaker* always have a ”happy ever after”, and here at the end of the thesis is the time to assess whether the story of the IT sector in India might also have one. The thesis has found that progress so far has been strong. The volume and nature of purchasing by the IT industry and its employees is such that it creates jobs and improves opportunities, even amongst the most disadvantaged. More importantly, like the Grimm’s elves, some of India’s firms have begun to use the sector to clothe themselves with top quality IT. So far the firms that have been done so also have reason to be “mightily delighted”. The IT that they have purchased is bringing strong productivity and output improvements. In 2011, though, it is still too early to write ‘happy ever after’ and close the book. Many Indian firms have not yet bought IT from the sector, and those that have still have many processes yet to be automated. There continue to be possible events that could thwart the continuation of the current IT trend in India. However, there also continue to be possible developments that could accelerate its processes and expand the benefits.

If India is to experience a continuation or acceleration of the current narrative towards a happy conclusion, a host of factors identified as important will need to persist. The intrinsic characteristics of the technology, its pervasiveness, its capacity to bring increasing returns to scale, and its tradable nature will remain, regardless. As time goes on though, the scope for continued innovation in the technology and, consequently, for its continued ability to raise productivity may turn out to be limited. This might lead to a diminution in the strong demand both abroad and at home that have bought the sector to where it is today. The continuation of the current success story relies on the on-going successful interplay between government policies and private sector actions. Unfortunately, this includes controversial policies on the part of the government. The actions which supported the IT sector, both before its inception and in its early years, are more difficult to justify now that the sector is both large and profitable. Nevertheless, the promotion of tertiary, rather than primary, education, and the continuation of sector tax breaks and infrastructure provision will continue to be important for its future growth. On the prospects for maintaining and expanding forward linkages, private sector firms in potential IT-using industries will need to continue to play their part. This will in turn depend on both the GOI and firms that hire workers continuing to act in ways that favour the middle classes and lead to expansions in their numbers. IT firms also need to remain willing to invest in their clients businesses by paying the up-front costs of systems in pay-per-use deals. Before long, it will also become important for IT firms to find a way to get economies of scale across small and medium companies, or, at a minimum, outside of large ones.

If enough of these things come to pass in the coming years, India's IT sector will continue to contribute to the country's economic expansion, and the story which has been begun here may well have a happy ending.

Appendix 1: Source Data for Selected Charts

This appendix accompanies Chapters 2 to 8 and contains the source data used in the figures, in particular where the numbers are not immediately transparent in the main text. The tables included in this appendix are intended as an accompaniment to the figures in the main body of the thesis. Please see the respective sources and notes in each chapter.

Table A1, for Figure 2.6: GDP Growth Per Annum Attributed to IT in the United States

Source	Sample	Percentage Points of GDP Growth Attributed to IT Use
Oliner and Sichel, 1994	1970-1979	0.0
Oliner and Sichel, 1994	1980-1992	0.2
Jorgensen and Stiroh, 1995	1985-1992	0.2
Sichel, 1997	1987-1993	0.3
Crafts, 2001	1991-1995	0.6
Daveri, 2001	1991-1999	0.9
Oliner and Sichel, 2000	1996-1999	1.1
Crafts, 2001	1996-2000	1.4

Table A2, for Figure 2.7: The Effect of IT on US Labour Productivity Growth, Percentage Points

Source	Sample	Percentage Points of Labour Productivity Growth Attributed to IT Use
Oliner and Sichel, 1994	1980-1992	0.0
Jorgenson and Stiroh, 2000	1995-1998	0.7
Jorgenson, Ho, and Stiroh, 2007	1995-2000	1.0
Jorgenson, Ho, and Stiroh, 2002	1995-2000	0.8
Oliner and Sichel, 2000	1996-1999	1.0
Oliner and Sichel, 2002	1996-2001	1.0
Jorgenson, Ho, and Stiroh, 2007	2001-2005	0.6

Table A3, for Figure 2.8: Share of Total GDP Growth Attributed to IT Use in Developed Countries

Source	Country	Sample	% of Total GDP Growth Attributed to IT Use
Colecchia, 2001	Canada	1995-99	10.4%
Daveri, 2001	France	1991-99	21.5%
Colecchia, 2001	France	1995-99	13.8%
Daveri, 2001	Germany	1991-99	31.3%
Colecchia, 2001	Germany	1995-99	17.6%
Daveri, 2001	Italy	1991-99	22.5%
Colecchia, 2001	Italy	1995-99	20.6%
Daveri, 2001	UK	1991-99	29.1%
Colecchia, 2001; Roeger, 2001	UK	1995-99	21.2%
Daveri, 2001	US	1991-99	24.3%
Roeger, 2001	US	1995-99	16.5%

Table A4, for Figure 2.11: Real GDP for India, 1951–52 to 2010–11 (in 1999–00 prices)

Year	Real GDP Growth	Year	Real GDP Growth	Year	Real GDP Growth
1951-52	2.9%	1971-72	1.6%	1991-92	1.1%
1952-53	2.6%	1972-73	-0.5%	1992-93	5.5%
1953-54	6.1%	1973-74	3.3%	1993-94	4.8%
1954-55	4.8%	1974-75	1.2%	1994-95	6.7%
1955-56	3.2%	1975-76	9.1%	1995-96	7.6%
1956-57	5.6%	1976-77	1.7%	1996-97	7.6%
1957-58	-0.4%	1977-78	7.3%	1997-98	4.1%
1958-59	7.4%	1978-79	5.7%	1998-99	6.2%
1959-60	2.6%	1979-80	-5.2%	1999-00	7.4%
1960-61	5.5%	1980-81	6.7%	2000-01	4.0%
1961-62	3.7%	1981-82	6.0%	2001-02	5.2%
1962-63	2.9%	1982-83	3.5%	2002-03	3.8%
1963-64	6.0%	1983-84	7.3%	2003-04	8.4%
1964-65	7.5%	1984-85	3.8%	2004-05	8.3%
1965-66	-2.7%	1985-86	5.2%	2005-06	9.3%
1966-67	0.0%	1986-87	4.8%	2006-07	9.7%
1967-68	7.8%	1987-88	4.0%	2007-08	9.1%
1968-69	3.4%	1988-89	9.6%	2008-09	6.1%
1969-70	6.5%	1989-90	6.0%	2009-10	7.9%
1970-71	5.2%	1990-91	5.5%	2010-11	8.3%

Table A5, for Figure 2.13: Sector-wise Composition of Real GDP in India (1999–00 prices)

Year	% of GDP for Primary Sector	% of GDP for Secondary Sector	% of GDP for Tertiary Sector
1980-81	39.9%	22.0%	38.0%
1981-82	39.8%	22.5%	38.0%
1982-83	38.8%	21.8%	39.5%
1983-84	39.3%	22.0%	38.6%
1984-85	38.5%	22.2%	39.4%
1985-86	37.2%	22.2%	40.6%
1986-87	35.8%	22.4%	41.9%
1987-88	34.1%	22.9%	43.0%
1988-89	35.8%	22.4%	41.8%
1989-90	34.4%	22.9%	42.8%
1990-91	34.1%	23.2%	42.8%
1991-92	33.0%	23.0%	44.1%
1992-93	33.3%	22.5%	44.2%
1993-94	32.5%	22.7%	44.9%
1994-95	32.1%	23.3%	44.6%
1995-96	29.8%	24.3%	45.8%
1996-97	30.2%	24.1%	45.6%
1997-98	28.5%	23.9%	47.7%
1998-99	28.3%	23.3%	48.2%
1999-00	27.3%	23.0%	49.7%
2000-01	26.2%	23.5%	50.3%
2001-02	26.2%	22.8%	51.0%
2002-03	23.7%	23.5%	52.8%
2003-04	23.9%	23.4%	52.7%
2004-05	22.4%	24.0%	53.4%
2005-06	21.6%	24.3%	54.0%
2006-07	20.6%	24.6%	54.8%
2007-08	19.8%	24.4%	55.7%
2008-09	18.9%	23.9%	57.3%
2009-10	16.9%	25.8%	57.3%
2010-11	16.6%	25.7%	57.7%

Table A6, for Figure 2.17: Income Distribution of Indian Households 1989–90 and 1998–99

	1989-90	1998-99
Up to US$850	58.8%	47.9%
US$850 - US$1,700	26.9%	41.7%
US$1,700 - US$2,500	10.1%	16.8%
US$2,500 - US$3,400	2.7%	7.5%
Above US$3,400	1.4%	6.9%

Table A7, for Figure 2.18: Income Distribution of Indian Households 2002 and 2010

	2002	2010
< US$2,000	72.0%	61.4%
US$2,000 - US$4,200	22.0%	40.1%
US$4,200 - US$10,500	5.0%	11.8%
> US$10,500	1.0%	4.7%

Table A8, for Figure 3.1: Revenue of Indian IT Sector (HW, SWIS, ITES-BPO)

Year	Total Revenue of IT Sector (US$m)	Year	Total Revenue of IT Sector (US$m)
1985-86	$234	1998-99	$5,041
1986-87	$302	1999-00	$7,679
1987-88	$394	2000-01	$11,675
1988-89	$547	2001-02	$14,744
1989-90	$720	2002-03	$18,864
1990-91	$784	2003-04	$21,500
1991-92	$924	2004-05	$28,000
1992-93	$1,064	2005-06	$37,408
1993-94	$1,269	2006-07	$47,883
1994-95	$1,602	2007-08	$64,119
1995-96	$2,296	2008-09	$71,669
1996-97	$3,091	2009-10	$77,643
1997-98	$4,342	2010-11(E)	$92,322

Table A9, for Figure 3.2: India's GDP with IT Sector Output (Current US$, millions)

Year	Remainder of the Economy (US$ Millions)	IT Sector (US$ Millions)	Share of GDP
1985-86	$227,306	$234	0.1%
1986-87	$249,447	$302	0.1%
1987-88	$275,836	$394	0.1%
1988-89	$304,548	$547	0.2%
1989-90	$299,878	$720	0.2%
1990-91	$324,730	$784	0.2%
1991-92	$287,643	$924	0.3%
1992-93	$289,281	$1,064	0.4%
1993-94	$274,081	$1,269	0.5%
1994-95	$322,156	$1,602	0.5%
1995-96	$365,323	$2,296	0.6%
1996-97	$386,041	$3,091	0.8%
1997-98	$416,137	$4,342	1.0%
1998-99	$419,322	$5,041	1.2%
1999-00	$445,701	$7,679	1.7%
2000-01	$456,128	$11,675	2.5%
2001-02	$468,231	$14,744	3.1%
2002-03	$486,197	$18,864	3.7%
2003-04	$569,851	$21,500	3.6%
2004-05	$666,980	$28,000	4.0%
2005-06	$775,913	$37,408	4.6%
2006-07	$862,981	$47,883	5.3%
2007-08	$1,079,766	$64,119	5.6%
2008-09	$1,212,050	$71,669	5.6%
2009-10	$1,295,531	$77,643	5.7%
2010-11(E)	$1,394,825	$92,322	6.2%

Table A10, for Figure 3.3: IT Sector's Contribution to GDP Growth (%)

Year	GDP Growth ($US, m)	IT Growth ($US, m)	IT's Share of GDP Growth
1995-96	$43,861	$694	1.6%
1996-97	$21,513	$795	3.7%
1997-98	$31,347	$1,251	4.0%
1998-99	$3,885	$699	18.0%
1999-00	$29,017	$2,638	9.1%
2000-01	$14,424	$3,996	27.7%
2001-02	$15,172	$3,069	20.2%
2002-03	$22,086	$4,120	18.7%
2003-04	$86,290	$2,636	3.1%
2004-05	$103,629	$6,500	6.3%
2005-06	$118,340	$9,408	7.9%
2006-07	$97,543	$10,475	10.7%
2007-08	$233,022	$16,236	7.0%
2008-09	$139,834	$7,550	5.4%
2009-10	$89,454	$5,974	6.7%
2010-11(E)	$113,973	$14,679	12.9%

Table A11, for Figure 3.4: Employment in the IT Sector 1993-94 to 2008-09

Year	IT Professionals Employed
1992-93	71,300
1993-94	93,040
1994-95	114,780
1995-96	136,520
1996-97	158,260
1997-98	180,000
1998-99	230,000
1999-00	284,000
2000-01	430,114
2001-02	622,250
2002-03	670,000
2003-04	880,000
2004-05	1,068,000
2005-06	1,283,000
2006-07	1,621,000
2007-08	2,010,000
2008-09	2,236,614
2009-10	2,300,000
2010-11(E)	2,540,000

Table A12, for Figure 3.5: India's Exports with IT Sector Exports

Year	Total IT Sector Exports	All Other Exports	IT's Share
1985-86	$52	$8,853	0.6%
1986-87	$73	$9,672	0.7%
1987-88	$91	$11,998	0.8%
1988-89	$167	$13,803	1.2%
1989-90	$243	$16,370	1.5%
1990-91	$233	$17,912	1.3%
1991-92	$297	$17,569	1.7%
1992-93	$361	$18,176	1.9%
1993-94	$489	$21,749	2.2%
1994-95	$662	$25,669	2.5%
1995-96	$769	$31,026	2.4%
1996-97	$1,371	$32,099	4.1%
1997-98	$1,960	$33,046	5.6%
1998-99	$2,604	$30,615	7.8%
1999-00	$4,613	$32,209	12.5%
2000-01	$7,337	$37,224	16.5%
2001-02	$9,435	$34,392	21.5%
2002-03	$12,239	$40,480	23.2%
2003-04	$13,400	$50,443	21.0%
2004-05	$18,100	$65,436	21.7%
2005-06	$24,189	$78,902	23.5%
2006-07	$31,677	$94,737	25.1%
2007-08	$40,930	$121,974	25.1%
2008-09	$47,339	$137,956	25.5%
2009-10	$50,118	$128,545	28.1%
2010-11	$59,380	$186,220	24.2%

Table A13, for Figure 3.8: The Indian IT Sector by Its Component Industries

Year	SWIS	Hardware	ITES-BPO
1985-86	$81	$153	
1986-87	$108	$194	
1987-88	$130	$264	
1988-89	$160	$387	
1989-90	$191	$529	
1990-91	$243	$541	
1991-92	$327	$598	
1992-93	$410	$654	
1993-94	$558	$711	
1994-95	$835	$767	
1995-96	$1,224	$1,072	
1996-97	$1,755	$1,336	
1997-98	$2,936	$1,406	
1998-99	$4,011	$1,030	
1999-00	$5,539	$1,536	$604
2000-01	$8,298	$2,377	$1,000
2001-02	$9,958	$3,218	$1,568
2002-03	$12,455	$4,059	$2,350
2003-04	$13,200	$4,900	$3,400
2004-05	$17,200	$5,600	$5,200
2005-06	$23,110	$7,084	$7,214
2006-07	$29,921	$8,455	$9,507
2007-08	$39,616	$11,997	$12,506
2008-09	$44,778	$12,107	$14,784
2009-10	$49,066	$13,923	$14,654
2010-11(E)	$59,401	$16,012	$16,910

Table A14, for Figure 3.9: Software and IT Services Revenue, Domestic vs. Exports, 1985-86 to 2003-04

Year	SWIS Revenue ($m)	Domestic Share (%)
1985-86	$81	70.4%
1986-87	$108	63.9%
1987-88	$130	60.0%
1988-89	$160	58.1%
1989-90	$191	47.6%
1990-91	$243	47.3%
1991-92	$348	44.1%
1992-93	$453	40.9%
1993-94	$558	40.9%
1994-95	$835	41.9%
1995-96	$1,224	40.0%
1996-97	$1,755	38.2%
1997-98	$2,936	40.1%
1998-99	$4,011	35.2%
1999-00	$5,539	28.5%
2000-01	$8,298	25.1%
2001-02	$9,958	23.2%
2002-03	$12,455	22.2%

Table A15, for Figure 3.10: Cost of IT Labour in India, the US and the UK in 1995

	US	UK	India
Project Leader	$54,000	$39,000	$23,000
Systems Designer	$55,000	$34,000	$11,000
Development Programmer	$41,000	$29,000	$8,000
Quality Assurance Specialist	$50,000	$33,000	$14,000

Table A16, for Figure 4.6: Comparison of NASSCOM and IDC Figures on the IT Sector for 2006

	NASSCOM 2005-06	IDC 2006	NASSCOM 2006-07
Domestic	$13,219	$15,462	$16,206
Exports	$24,189	$29,397	$31,677
Total	$37,408	$44,859	$47,883

Table A16, for Figure 5.1: Private Equity & Venture Capital Funding in India

	Value of Deals ($USm)	Number of Deals
1996	$20	5
1997	$80	18
1998	$250	60
1999	$500	107
2000	$1,160	280

Table A17, for Figure 5.5: Enrolments in Higher Education in Engineering

Year	Enrolment in Higher Education in Engineering	Year	Enrolment in Higher Education in Engineering
1970-71	87,257	1988-89	201,289
1971-72	82,804	1989-90	209,371
1972-73	82,674	1990-91	216,837
1973-74	86,665	1991-92	258,028
1974-75	90,685	1992-93	271,213
1975-76	96,067	1993-94	285,045
1976-77	100,040	1994-95	299,583
1977-78	103,706	1995-96	315,720
1978-79	111,659	1996-97	331,017
1979-80	118,607	1997-98	346,833
1980-81	128,937	1998-99	363,481
1981-82	130,189	1999-00	389,001
1982-83	142,440	2000-01	529,469
1983-84	153,131	2001-02	605,597
1984-85	159,046	2002-03	692,087
1985-86	176,540	2003-04	716,652
1986-87	183,966	2004-05	754,635
1987-88	192,148	2005-06	795,120

Table A18, for Figure 5.10: Domestic Output from IT Firms' and Workers' expenditures in 2005-06 (Rs. Bn)

	Indirect	Direct	Total
Via IT Firms' Operating Expenditures	Rs. 267.9	Rs. 309.9	Rs. 577.8
Via IT Firms' Capital Expenditures	Rs. 61.9	Rs. 63.9	Rs. 125.8
Via IT Workers' Consumption	Rs. 108.0	Rs. 96.0	Rs. 204.0
Total	Rs. 437.8	Rs. 469.8	Rs. 907.6

Table A19, for Figure 5.13: Software Exports from Orissa

	Software Exports from Orissa (Rs. Crore)
1996-97	Rs. 0.0
1997-98	Rs. 5.0
1998-99	Rs. 53.0
1999-00	Rs. 89.0
2000-01	Rs. 200.0
2001-02	Rs. 213.0
2002-03	Rs. 260.0
2003-04	Rs. 315.0
2004-05	Rs. 400.0
2005-06	Rs. 465.0
2006-07	Rs. 800.0

Table A20, for Figure 5.15: SWIS Revenue for Indian IT Sector from Domestic Market, Current Rs. Crore

	Domestic IT Services Revenue (Rs. Crore)	Growth (Rs. crore)
1985-86	Rs. 70.5	
1986-87	Rs. 87.0	Rs. 16.5
1987-88	Rs. 101.1	Rs. 14.1
1988-89	Rs. 129.4	Rs. 28.4
1989-90	Rs. 147.6	Rs. 18.2
1990-91	Rs. 201.2	Rs. 53.6
1991-92	Rs. 346.4	Rs. 145.1
1992-93	Rs. 493.4	Rs. 147.0
1993-94	Rs. 716.9	Rs. 223.6
1994-95	Rs. 1,098.1	Rs. 381.2
1995-96	Rs. 1,588.6	Rs. 490.5
1996-97	Rs. 2,373.7	Rs. 785.1
1997-98	Rs. 4,274.8	Rs. 1,901.1
1998-99	Rs. 5,822.7	Rs. 1,547.9
1999-00	Rs. 6,789.8	Rs. 967.1
2000-01	Rs. 9,352.0	Rs. 2,562.2
2001-02	Rs. 10,904.6	Rs. 1,552.6
2002-03	Rs. 13,457.1	Rs. 2,552.5
2003-04	Rs. 15,837.8	Rs. 2,380.7
2004-05	Rs. 19,032.9	Rs. 3,195.1
2005-06	Rs. 25,600.1	Rs. 6,567.1
2006-07	Rs. 32,326.6	Rs. 6,726.6
2007-08	Rs. 41,771.6	Rs. 9,445.0
2008-09	Rs. 45,951.5	Rs. 4,179.9
2009-10	Rs. 56,891.7	Rs. 10,940.2
2010-11 E	Rs. 65,543.9	Rs. 8,652.2

Table A21, for Figure 5.19: SWIS Revenue for Indian IT Sector and Share Accounted by Domestic Contracts, 1985-86 to 2010-11

	Exports	Domestic	Domestic Market Share %
1985-86	Rs. 24.0	Rs. 57.0	70.4%
1986-87	Rs. 39.0	Rs. 69.0	63.9%
1987-88	Rs. 52.0	Rs. 78.0	60.0%
1988-89	Rs. 67.0	Rs. 93.0	58.1%
1989-90	Rs. 100.0	Rs. 91.0	47.6%
1990-91	Rs. 128.0	Rs. 115.0	47.3%
1991-92	Rs. 173.9	Rs. 152.7	44.1%
1992-93	Rs. 219.8	Rs. 190.3	40.9%
1993-94	Rs. 330.0	Rs. 228.0	40.9%
1994-95	Rs. 485.0	Rs. 350.0	41.9%
1995-96	Rs. 734.0	Rs. 490.0	40.0%
1996-97	Rs. 1,085.0	Rs. 670.0	38.2%
1997-98	Rs. 1,759.0	Rs. 1,177.0	40.1%
1998-99	Rs. 2,600.0	Rs. 1,411.0	35.2%
1999-00	Rs. 3,962.0	Rs. 1,577.0	28.5%
2000-01	Rs. 6,217.0	Rs. 2,081.0	25.1%
2001-02	Rs. 7,647.0	Rs. 2,311.0	23.2%
2002-03	Rs. 9,545.0	Rs. 2,769.0	22.2%
2003-04	Rs. 9,800.0	Rs. 3,400.0	25.8%
2004-05	Rs. 13,000.0	Rs. 4,200.0	24.4%
2005-06	Rs. 17,305.0	Rs. 5,805.0	25.1%
2006-07	Rs. 22,790.0	Rs. 7,131.0	23.8%
2007-08	Rs. 29,500.0	Rs. 10,116.0	25.5%
2008-09	Rs. 34,196.0	Rs. 10,582.0	23.6%
2009-10	Rs. 37,300.0	Rs. 11,765.0	24.0%
2010-11 E	Rs. 44,800.0	Rs. 14,601.0	24.6%

Table A22, for Figure 5.20: Growth in SWIS Revenue by Destination Market

	Export Growth	Domestic Growth
2001-02	23.0%	11.1%
2002-03	24.8%	19.8%
2003-04	2.7%	22.8%
2004-05	32.7%	23.5%
2005-06	33.1%	38.2%
2006-07	31.7%	22.8%
2007-08	29.4%	41.9%

Table A23, for Figure 5.21: Destination for Domestic SWIS and ITES-BPO in 2003-04, Current Rs Lakh

	2003/4 Input Output Flow Tables	2003/4 NASSCOM Member's Survey
Financial Services	Rs. 30,299.0	Rs. 545,527.5
Communications	Rs. 412,891.0	Rs. 296,569.6
Retail	Rs. 21,717.0	Rs. 15,505.7
Manufacturing	Rs. 405,559.0	Rs. 466,357.2
Others	Rs. 217,083.0	Rs. 363,563.4

Table A24, for Figure 5.22: Destination for Domestic SWIS and ITES-BPO in 2006-07, Current Rs Lakh

	2006/07 Input Output Flow Tables	2006/07 NASSCOM Member's Survey
Financial Services	Rs. 41,040.0	Rs. 1,487,518.5
Communications	Rs. 838,125.0	Rs. 689,337.8
Retail	Rs. 55,021.0	Rs. 290,247.5
Manufacturing	Rs. 946,159.0	Rs. 544,214.1
Others	Rs. 292,288.0	Rs. 616,776.0

Table A25, for Figure 6.6: Indian IT sector revenues from high value export projects, US$ millions

	2000-01	2001-02	2002-03	2003-04	2005-06
Project Based	$2,500	$3,200			$7,708
IT Consulting	$50	$50			$348
Systems Integration	$75	$150			$374
Network Testing and Integration	$125	$50			$167
	2006-07	2007-08	2008-09	2009-10 (E)	
Project Based	$9,860	$11,980	$13,327	$13,973	
IT Consulting	$600	$650	$737	$764	
Systems Integration	$580	$680	$778	$808	
Network Testing and Integration	$230	$280	$320	$332	

Table A26, for Figure 7.12: Estimated Growth from SWIS Purchasing by Sector in PROWESS Sample

	IV-BB	Midpoint	OLS
Finance (All)	6.9%	9.8%	12.7%
Manufacturing	7.8%	11.2%	14.6%
Communications	16.0%	22.8%	29.7%
Consultants	2.7%	3.8%	5.0%
Couriers	4.3%	6.1%	8.0%
Health	3.6%	5.1%	6.7%
Hotels	11.0%	15.7%	20.4%
ITES-BPO	3.3%	4.6%	6.0%
Media and Films	7.7%	10.9%	14.2%
Other Services	11.2%	15.9%	20.7%
Retail	3.8%	5.4%	7.1%
Tourism	1.9%	2.7%	3.5%
Transport	12.7%	18.2%	23.6%
Wholesale	8.4%	11.9%	15.5%

Table A21, for Figure 5.19: SWIS Revenue for Indian IT Sector from Domestic Market, Current Rs. Crore

	Exports	Domestic	Domestic Market Share %
1985-86	Rs. 24.0	Rs. 57.0	70.4%
1986-87	Rs. 39.0	Rs. 69.0	63.9%
1987-88	Rs. 52.0	Rs. 78.0	60.0%
1988-89	Rs. 67.0	Rs. 93.0	58.1%
1989-90	Rs. 100.0	Rs. 91.0	47.6%
1990-91	Rs. 128.0	Rs. 115.0	47.3%
1991-92	Rs. 173.9	Rs. 152.7	44.1%
1992-93	Rs. 219.8	Rs. 190.3	40.9%
1993-94	Rs. 330.0	Rs. 228.0	40.9%
1994-95	Rs. 485.0	Rs. 350.0	41.9%
1995-96	Rs. 734.0	Rs. 490.0	40.0%
1996-97	Rs. 1,085.0	Rs. 670.0	38.2%
1997-98	Rs. 1,759.0	Rs. 1,177.0	40.1%
1998-99	Rs. 2,600.0	Rs. 1,411.0	35.2%
1999-00	Rs. 3,962.0	Rs. 1,577.0	28.5%
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2004-05	Rs. 13,000.0	Rs. 4,200.0	24.4%
2005-06	Rs. 17,305.0	Rs. 5,805.0	25.1%
2006-07	Rs. 22,790.0	Rs. 7,131.0	23.8%
2007-08	Rs. 29,500.0	Rs. 10,116.0	25.5%
2008-09	Rs. 34,196.0	Rs. 10,582.0	23.6%
2009-10	Rs. 37,300.0	Rs. 11,765.0	24.0%
2010-11 E	Rs. 44,800.0	Rs. 14,601.0	24.6%

Appendix 2: Details from Econometric Modelling

This appendix accompanies Section 7.2 and contains additional details on the econometric estimates of the impact of SWIS outsourcing contained therein.

A2.1 Data Dictionary

Real Total Output

The basis of this measure is the PROWESS metric "Total Income" which has the following description in their online, context specific, documentation: "Total income is the sum of all kinds of incomes generated by an enterprise during an accounting period. It represents the sum of the sale of goods and services." This metric is deflated using the following indices: for manufacturing, Reserve Bank of India's wholesale price index for manufactured products; and for services and finance, the GDP deflator for those sectors implied in National Accounts Statistics (which are published both in real and nominal terms).

Real Net Capital Stock

The basis of this measure is the PROWESS metric "Net Fixed Assets" which has the following description in their documentation: "These are total fixed assets that are used for producing goods and services and are shown net of accumulated depreciation. These include movable and immovable assets as well as capital work in progress, i.e., assets which are in the process of being installed. Net fixed assets include capital work-in-progress and re-valued assets, if any." This metric is deflated using the Reserve Bank of India's wholesale price index for machinery and machine tools.

Real Net Stock of Computers

The basis of this measure is the PROWESS metric “Total Net Computers” which has the following description in their documentation: “This data field captures the value of computers and its peripherals owned by the company or leased by it and is shown net of accumulated depreciation.” This metric is deflated using the Reserve Bank of India’s wholesale price index for IT hardware.

Real Net Stock of Software Assets

The basis of this measure is the PROWESS metric “Total Net Software Assets” which has the following description in their documentation: “Software is a computer program, which provides the instructions which enable the computer hardware to work. Anything that is not tangible and cannot be touched like the operations, programs, and files on a computer is software. This data field captures the value software of a company on the last day of the accounting period and is shown net of accumulated depreciation.” This metric is deflated by 6% per year, as suggested Prud’homme, Sanga, and Yu, (2005)’s price index for software in Canada.

Labour

The basis of this measure is the PROWESS metric “Employees” which has the following description of workers included in their documentation: “Employees [include] all kinds of workers and management employees.” According to this metric, there are many firms in the PROWESS database with zero employees. It is assumed that these are firms with one working director or owner. For the purposes of the econometric modelling, 0 in this variable has been replaced with 1.

Real Intermediate Inputs

This is a composite variable which has been constructed as the sum of all intermediate inputs to the production process. These include:

- Real Expenditure on materials;
- Real Expenditure on energy;
- Real Expenditure on manufactured components produced outside the firm;
- and Real Expenditure on outsourced services.

Each of these components is based on an appropriate field in the PROWESS database and each has been deflated using an appropriate price index. For expenditures on materials, it is the Reserve Bank of India's wholesale price index for primary articles. For expenditures on energy, the field is the Reserve Bank of India's wholesale price index for fuel and power. For manufactured components, it is the Reserve Bank of India's wholesale price index for manufactured products. For outsourced services, the field is the GDP deflator for services sectors implied in MOSPI (2011) (which are published both in real and nominal terms).

Real SWIS Outsourcing

The basis of this measure is the PROWESS metric "Expenditure on Software and Other Professional Services". The software part of this metric is defined as "Expenses paid by the company to get a piece of software developed from an external professional agency. It also includes software maintenance fees, upgradation fees, etc. However, it excludes any data-entry work or data-processing work that may have been outsourced by the company. These are included separately in 'IT-enabled services charges.' The "Other Professional Services" part "captures all those expenses reported by a company on external professional services engaged by the company for services other than for audit, consultancy, software development, IT-enabled services, cost audit and legal services”. This metric is deflated by 6% per year, as suggested Prud’homme, Sanga, and Yu’s (2005) price index for software in Canada.

Total Factor Productivity (TFP) controls

Included in these controls is, for any given firm, the firm’s age; expenditures on research and development; and expenditures on royalties; other controls are sub-sector dummies for banks; financial institutions; providers of securities; and wholesalers. These measures were all extracted directly from the PROWESS database.

A2.2 SWIS and miscellaneous outsourcing by industry

Figure A2.1 shows the size of SWIS and miscellaneous outsourcing by industry in 2008 as measured by PROWESS's "Expenditure on Software and Other Professional Services". It shows the top ten industries by mean expenditures per firm on outsourcing. For these industries, the figure includes the number of firms in the sample that spend more than Rs 1 crore on outsourcing and the total expenditure by these firms in Rupees and US dollars.

Figure A2.1: SWIS and Misc. Outsourcing by Sector for 2008, Firms Spending> Rs 1 crore.

	Mean per firm (Rs Crore)	Number of firms included	Total in sample (Rs Crore)	Total in sample ($USm)
Communications	99.2	21	2,084	$529
Banks	16.8	50	841	$213
Chemical Manufacturers	16.1	99	1,590	$403
Misc Services	14.0	68	952	$241
Non-bank Financial Services	10.3	11	113	$29
Metals Manufacturers	9.8	53	521	$132
Transport Services	7.2	19	136	$35
Securities (Finance)	6.9	19	131	$33
Computer Manufacturers	6.4	4	26	$6
Brokers (Finance)	5.9	14	83	$21

Source: Author calculations based on CMIE (2009).

Of the top ten SWIS-buying sub-sectors, four are financial services; three are manufacturing; and one each are Communications, Transport Services, and Misc Services. This set of industries is very close to the set which is globally known to use IT intensively in production. In the United States during the 1990s, finance, telecommunications, and equipment manufacturing were widely reported as the most intensive users of IT (Baily and Lawrence, 2001: 309; Mann, 2003: 4; Stiroh, 2001: 19; Triplett, 1999: 318). Similarly, Hanna (1994: 40) shows that banking; finance and insurance; IT production; manufacturing; transport and other services were five of the nine industries that comprised between 68% and 94% of IT expenditures in seven Asian countries in 1992. It is also consistent with NASSCOM and GOI data on shares of the Indian SWIS sector's revenues in 2006-07 in figure 5.22, chapter 5.

A2.3 Summary statistics for key variables

Figure A2.2: Summary Statistics for Key Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Real Gross Output	33,564	Rs. 272.4	Rs. 3,106.2	0.0	Rs. 233,752.9
Employees	33,564	305	3,727	0	320,506
Real Net Capital	33,564	Rs. 100.1	Rs. 1,138.8	0.0	Rs. 74,924.5
Real Net Computer Capital	33,564	Rs. 0.4	Rs. 6.5	0.0	Rs. 520.1
Real Net Software Assets	33,564	Rs. 0.2	Rs. 3.2	0.0	Rs. 192.7
Real Intermediate Inputs	33,564	Rs. 91.7	Rs. 1,201.5	0.0	Rs. 77,427.6
Real SWIS outsourcing	33,564	Rs. 0.9	Rs. 12.2	0.0	Rs. 997.9

Source: Author calculations based on CMIE (2009).
Notes: Firm-level unweighted statistics over the whole pooled sample (2005–2008). All currency figures are in constant 2005 rupees crore. Quantities of capital are shown net of accumulated depreciation.

A2.4 Stochastic frontier model

Figure A2.3 shows the stochastic frontier model which provided the dependent variable in the regression which is the subject of Section 7.1.4. It was estimated using a pooled, rather than panel data formulation and under the assumption that -ln(E) (the measure of inefficiency) follows an exponential distribution[106]. The model uses a heteroscedasticity robust form for both the inefficiency term and the normal residual. The standard error of the inefficiency term is 1.17.

Figure A2.3: Stochastic Frontier Model for Output in the PROWESS Sample

Dependent Variable is Log of Real Output Stochastic Frontier estimates	**Coefficient**	**Standard Error**	**z**
Log real capital	0.053***	0.002	23.800
Log labour	0.235***	0.005	46.760
Log real intermediate Inputs	0.120***	0.002	78.900
Log real IT capital	0.018***	0.001	19.220
Constant	Yes		
N	33,558		
R-Squared	44.7%		

Source: Author calculations based on CMIE (2009).
Notes: Stochastic frontier model of equation (7) in section 7.1.1. *** Significantly different from zero at the 0.1% level.

[106] Other distributional assumptions were tested, and found to give similar estimates to those found here.

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