Research Article

Using Competitive Advantage Theory to Analyze IT Sectors in Developing Countries: *A Software Industry Case Analysis*

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Abstract

The purpose of this paper is to provide guidance for researchers and analysts on when, why, and how to apply Porter's competitive advantage theory to analysis of IT sectors in developing countries. To date, this theory has been rather poorly applied in such analysis, yet the question of how developing countries—as latecomers—can create competitive advantage in IT industries remains one of critical interest to policy makers, entrepreneurs, and international agencies. Understanding of IT sector growth is particularly important, in light of its significant potential contribution to economic development. From the five IT sectors—goods, software, infrastructure, services, and content—this paper focuses on software. Having provided a thorough explanation of competitive advantage theory, it applies this theory to the case of India's software industry, which it finds does have a competitive advantage, based on variables such as ever-increasing advanced skills, domestic rivalry, clustering, and government policy/vision.

To assist researchers, the paper identifies emergent challenges to Porter's theory that can be resolved relatively easily but also some less tractable problems around the issues of government policy, processes of upgrading/innovation, and local/global linkages. All these require some identified amendments to Porter's original ideas. Nonetheless, Porter's theory is seen to be a valuable tool for development informatics/ICT4D research, applicable to a variety of IT sectors—not just software—and offering answers to questions about whether sectors are competitive, why they are or are not competitive, and what should be done to improve or sustain competitive advantage.

This paper focuses on application of Michael Porter's theory of competitive advantage, based around his well-known "diamond" of determinants. Finding that Porter's ideas have yet to be fully and critically applied to issues of ICTs for development (ICT4D), it provides researchers and analysts with a guide to their application.

Porter's theory can help analyze a number of ICT4D issues but the first section concentrates on the IT sectors in developing countries, looking specifically at researching the software industry. Having explained Porter's theory in its second section, the paper therefore goes on to apply it to a software sector case study, choosing the example of India as one of the developing world's best-known software industries. The paper's final section reflects on this application of Porter's theory. It identifies a number of critiques and challenges that require some amendments to the theory if it is to be effectively applied to analysis of IT sectors in developing countries.

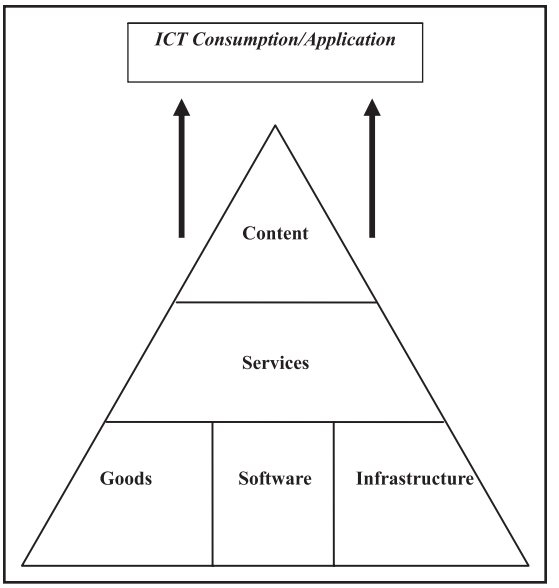

Figure 1. Typology of the IT sectors.

IT Sectors, the Software Industry, and Economic Development

"Development" can mean many different things; hence, the relationship between ICTs and development can be cast in many different ways. In this paper, the core interest is in economic development; defined largely in terms of increasing national and per capita incomes. Economic development is typically seen to be predicated on key elements such as growth and development in the primary, secondary, and tertiary sectors and (rather more contentiously) growth and development in trade (Thirlwall 2005). Given this focus, the central ICT4D issue framing this paper will be the relation of the technology to the productive sectors and also, perhaps, to trade.

One major way in which this relation occurs is through what is typically called the "IT sector" or "IT industry." More accurately, we should probably talk of "IT sectors," because the production of information and communication technologies can be broken down into five overlapping sectors (adapted from Wong 1998 and Molla 2000; Figure 1):

- *Goods:* production of ICT consumer goods such as computer hardware and digital telecommunications, plus ICT producer goods: both capital goods (e.g., automated machinery for manufacturing PCs) and intermediate goods (chips, motherboards, hard disk drives, DVD drives, etc. used in computer manufacture).
- *Software:* design, production, and marketing of packaged and customized software.
- *Infrastructure:* "development and operation of enabling network infrastructure" (Wong 1998, 325); both foundational telecommunications plus value-added networking services.
- *Services:* professional services not covered in other categories such as consulting, training, and technical services.
- *Content:* production and distribution of data content, including back-office processing and digitization.

The analytical approach used in this paper is usable in all these sectors, but here we have space to focus on only one. The IT sector chosen is the software industry. Impact studies show a variety of developmental impacts arising from the presence of an active software sector in a developing country, including impacts making a direct contribution to economic development (Arora and Athreye 2002; Kambhampati 2002; Carmel 2003a; Athreye 2005):

- *Economic impacts:* employment creation, income generation through wages, income generation through returns on capital investments, export earnings, human capital formation through skill development, and contributions to productivity improvement.[1]
- *Economic externalities:* induced growth in supply institutions (such as hardware firms and educational establishments), related sectors (such as IT-enabled services), and consumer sectors (e.g., via developments in e-government and e-commerce).
- *Social/organizational externalities:* demonstration effects of the benefits of entrepreneurship and operation of new organizational structures

1. For example, by the early part of the twenty-first century, the Indian software industry contributed 2.5% of GDP, 5% of all private sector employment, and 10% of exports (Kambhampati 2002; Arora and Gambardella 2004; Heeks and Nicholson 2004).

(such as flatter hierarchies) and processes (such as international standards of accounting or human resources management).

If the software sector in development thus deserves to be the focus of research, what kind of research issues should we be investigating? Some illustrations include

- *Information systems-in-development:* analyzing why information systems-in-development projects fail and seeking ways to improve the process of software development to reduce the failure rate and, hence, improve the contribution that both software production and related consumption can make to development. See, for example, Heeks (2002), which draws on concepts from the sociology of technology.
- *Management-in-development:* analyzing the particular structures and processes by which software production in developing countries is managed. Given the importance of software exports via offshore outsourcing, this would include a focus on analyzing and seeking to improve offshore software projects. See, for example, Heeks et al. (2001), which draws from contingency theory to develop the "COCPIT" framework of client-developer relations.
- *Development impact:* analyzing the range of economic, social and political impacts of software sector development. See, for example, Kambhampati (2002), which uses a checklist of impacts.
- *Business-in-development:* analyzing the government policies, business strategies, and other factors underlying growth and development of the software sector in developing countries. See, for example, Carmel (2003b), which uses a checklist of success factors induced from case data.

This paper follows the last research agenda—understanding why and how the software sector can grow—reflecting real-world outcomes and interests of policy makers, industry associations, and others with a strategic perspective. There has been very strong and continuous growth of the software industry in some developing countries, such as India and China, that many other countries would like to understand and replicate. The central research question here has thus been "Why and how does the software sector grow in a particular developing country?" It is this question that will be addressed below.

More generally there is a perceived need to understand the very varied performance of the software industry in different countries with the experience of India and China contrasting with that of other developing countries that have seen outcomes ranging from steady but ordinary growth through slow growth to contraction of the software industry (see, e.g., UNCTAD 2004). This would require a somewhat different research question—one discussed later in this paper, though not directly—"Why and how does the software sector develop differently in different developing countries?"

Competitive Advantage Theory

A number of different frameworks could be used to research software industry growth. Heeks (1996), for example, uses a development policy model of the continuum from structuralist to neoliberal policy. However, questions about sectoral growth more commonly draw frameworks from the literature on competitiveness and competitive advantage.

Wignaraja (2003, 15) characterizes that literature into three perspectives:

1. "a *macroeconomic* perspective which deals with internal and external balance at country-level and focuses on real exchange rate management as the principal tool for competitiveness;
2. a *business strategy* perspective which is concerned with rivalries between firms and countries and a limited role for public policies in fostering competitiveness;
3. a *technology and innovation* perspective that emphasises innovation and learning at the enterprise and national-levels and active public policies for creating competitiveness."

In this paper, the selected framework for analysis is a well-known theory from within the second category of literature: Michael Porter's theory of competitive advantage, as described in *The Competitive Advantage of Nations* (1990). This is selected for a number of reasons. First, it is well known and fairly well established. There is thus an important hinterland of work explaining, critiquing, developing, and

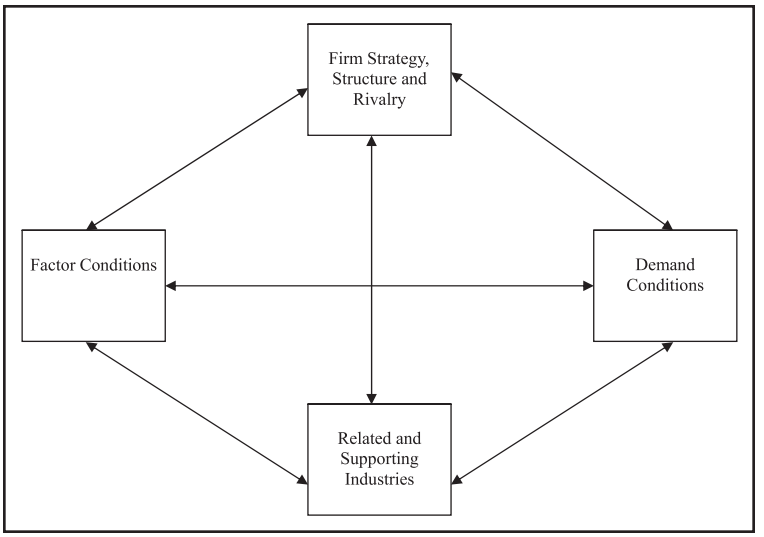

Figure 2. Determinants of competitive advantage.

applying the theory, including application to the software sector in developing countries. Second, it is relatively accessible, particularly thanks to the "diamond model" that can be seen as the core of the theory. Third, it has been comparatively stable, with later presentations (e.g., Porter 2001, 2002) differing relatively little from the original theory, probably because the theory is "owned" by a single person. Fourth, it overcomes some important limitations of the macroeconomic perspective on competitiveness while, at the same time, incorporating aspects of the technology and innovation perspective.[2]

Porter's theory will now be summarized. In presenting such work, it would be the norm to start with a definition of key terms, particularly "competitiveness" and "competitive advantage." Bizarrely and frustratingly, Porter seems unable or unwilling to pin himself down to a straightforward definition; nor does he clearly distinguish between the two concepts except to leave some general sense that the latter is a somewhat more comparative concept than the former.

Instead, both initial and later presentations break the "competitiveness/competitive advantage" concept into two parts: a dependent variable that measures the outcome of competitive advantage and a set of independent variables that are the source of competitive advantage. Each of these will be discussed in turn.

Measuring Competitive Advantage

When discussing the competitiveness of nations, Porter's focus is on productivity—"The only meaningful concept of competitiveness at the national level is national productivity" (Porter 1990, 6)—measured in terms of GDP per capita: "the best single, summary measure of microeconomic competitiveness available across all countries" (Porter 2002, 8).

However, when operationalizing his ideas to give country case studies, he recognizes that it is not nations that compete but firms, more particularly firms within *"specific industries and industry segments."* (Porter 1990, 9). Instead, though, of building up his cases on the basis of measures of productivity within industries, "We chose as the best measures of international competitive advantage either (1) the presence of substantial and sustained exports to a wide array of other nations and/or (2) significant outbound foreign investment based on skills and assets created in the home country" (Porter 1990, 25). For those assessing competitive performance, Porter, therefore, offers a choice of one or more of: productivity, exports, and outbound investment.

Explaining Competitive Advantage

Determinants of Competitive Advantage

Porter feels that one must look for the independent variables—the determinants of competitive advantage—at industry or even segment level. His ideas are therefore quite appropriate for those seeking to study at the level of an IT sector. These determinants, in part, can be summed up by a "diamond" of four main determinant categories (Figure 2; Porter 1990, 72).

2. Wignaraja's contention that the latter perspective is distinct from the business strategy perspective is, therefore, debatable. Porter developed his model to make "improvement and innovation in methods and technology a central element" (1990, 20) and sees government policy, while one element among others, as being "vital" and "essential" (681).

Each of these will now be discussed in some further detail.

Factor Conditions

Factors of production are "the inputs necessary to compete in any industry" (Porter 1990, 76), which Porter classifies into human resources, physical resources (including natural resources but also location and time zone), knowledge resources, capital resources, and infrastructure (including transport, communications, and power). He moves beyond the simple factor approaches of other models (such as some used in economics) in a number of ways:

- *The richness of categorization* (Grant 1991): where simple factor models might use just "labor," "capital," and "land," Porter provides a much richer perspective on production inputs. He identifies "*basic factors* . . . natural resources, climate, location, unskilled and semi-skilled labor, and debt capital" and "*advanced factors* . . . modern digital data communications infrastructure, highly educated personnel . . . and university research institutes" (Porter 1990, 77) as well as "*generalized* factors . . . the highway system, a supply of debt capital . . . [that] can be deployed in a wide range of industries" and "*specialized* factors [that] involve narrowly skilled personnel, infrastructure with specific properties" and that have limited applicability (78). Echoing the ideas of resource-based theory, he finds that the latter in each category—i.e., the advanced and the specialized factors—are those that are more significant for competitive advantage, partly because they are hardest to imitate. This applies especially in services where "less-skilled labor is usually unimportant" while "a nation's stock of specialized, skilled professional and technical personnel is frequently vital" (256).
- *Deployment and creation:* for Porter, it is not simply a question of a factor existing in an economy; what is more important to competitive advantage is the way in which factors are "created, upgraded and made more specialized . . . [and] . . . *how efficiently and effectively they are deployed*" (76). He thus takes both a dynamic and process-oriented perspective on factors (although his own studies tend to say relatively little about how factors are actually deployed within firms).
- *Factor disadvantages:* from his field data, Porter notes that some national industries succeed despite the absence or weakness of a production factor. This he attributes to the pressures for innovation that such a factor disadvantage creates.

Demand Conditions

One theme of this determinant category is once again that of moving beyond the assumptions of simple economic models, which would concern themselves mainly with market size. For Porter, market size is of relatively limited importance: he allows that a large local market can encourage scale economies, and also that it may hinder export drive. Instead, what matters is the composition of demand, specifically of domestic demand because, "where foreign and home market needs diverge, signals from the home market usually dominate" (1990, 87). The composition of domestic demand can be factored in terms of

- The nature of the market such as its growth rate, number of buyers, and the particular segments that dominate.
- How sophisticated and demanding local buyers are.
- The relation of those buyers to global trends and markets, with competitive advantage accruing if local buyers anticipate global demands and/or if they can provide channels for internationalizing local demand (for example, if they are multinationals).

The overall message is that the more innovative pressure local buyers place on firms, which they do more through qualitative than quantitative factors, the greater the competitive advantage.

Related and Supporting Industries

As with demand, there is a domestic focus in this determinant, which looks at "the presence in the nation" of suppliers and others who are internationally competitive (Porter 1990, 100). Suppliers to the focal industry are particularly important: if they are competitive, they can supply the focal industry with low-cost and/or high-quality and/or early-access inputs but they can also act in a less formal way by giving new ideas, through joint problem-solving, and generally by stimulating innovation.

Related industries (for any of the IT sectors one could probably count most of the other IT sectors

and also professional services such as management consulting) can also help if they are competitive. They can provide "information flow and technical interchange." In addition, international demand for what a related and competitive industry provides can "pull through" demand for what the focal industry produces (e.g., a globally competitive consulting services industry could help pull through demand for software services). In both cases, because of their proximity, lower transactions costs, and "cultural similarity" (Porter 1990, 106), local supply/related industries are more important than foreign ones.

Firm Strategy, Structure, and Rivalry

Retitled in later works "context for firm strategy and rivalry," in the original, this covers not just context but also a number of other factors. Three main elements are identified:

1. *Domestic firm strategy and structure:* this begins with some clarity in arguing that "nations will tend to succeed in industries where the management practices and mode of organization favored by the national environment are well suited to the industries' sources of competitive advantage" (Porter 1990, 108). For example, the Italian "national environment" seems to favor fragmented structures and niche strategies. The elements that constitute the national environment are quite broad, though they would be readily recognizable to those working from a new institutionalist perspective. They include "attitudes towards authority, norms of interpersonal interaction, attitudes of workers towards management and vice versa, social norms of individualistic or group behavior, and professional standards. These in turn grow out of the educational system, social and religious history, family structures, and many other often intangible but unique national conditions" (1990, 109). "Language skills," "government policy," and "a nation's political stance" are also seen to play a role.
2. *Goals:* "Nations will succeed in industries where . . . goals and motivations are aligned with the sources of competitive advantage" (1990, 110). For company goals, this alignment will be determined by "ownership structure, the motivation of owners and holders of debt, the nature of the corporate governance, and the incentive processes that shape the motivation of senior managers" (110). Incentive systems but also national attitudes toward things like money, success, and risk will similarly influence alignment of individual goals. Both will be affected by a sector's national prestige and priority and by the ability of sectoral actors to show sustained commitment to building up the sector.
3. *Domestic rivalry:* where the other two elements are rather broad and loose, this is rather clearer: "Among the strongest empirical findings from our research is the association between vigorous domestic rivalry and the creation and persistence of competitive advantage in an industry" (117). Where there are several strongly-competing domestic rivals—which support for new business formation will foster—they push each other to seek out new markets (often overseas), to compete on cost and quality, to develop new products, and to look for higher-order factors of production.

Influences on Competitive Advantage

The complete systemic map of determinants of competitive advantage must add in two further elements that sit outside the diamond (Figure 3), chance and government:

- Chance describes elements outside the control of firms or sectors, such as wars or surges in demand or major technological changes. Chance is seen as lying outside the diamond because it is the core determinants that decide which nations or sectors gain or lose from chance.
- Porter takes a similar line on government policy. It is an "important influence on competitive advantage" (1990, 128) but lies outside the diamond because its role is as a positive or negative influence on the four determinants. Of itself, he argues, government cannot create competitive advantage.

Competitive Advantage System Dynamics

As will be noted below, some applications of Porter's work do not seem to get beyond the diamond; in particular, do not seem to get beyond applying the diamond in a reductionist manner, ticking off each of the four categories one by one. Porter, how-

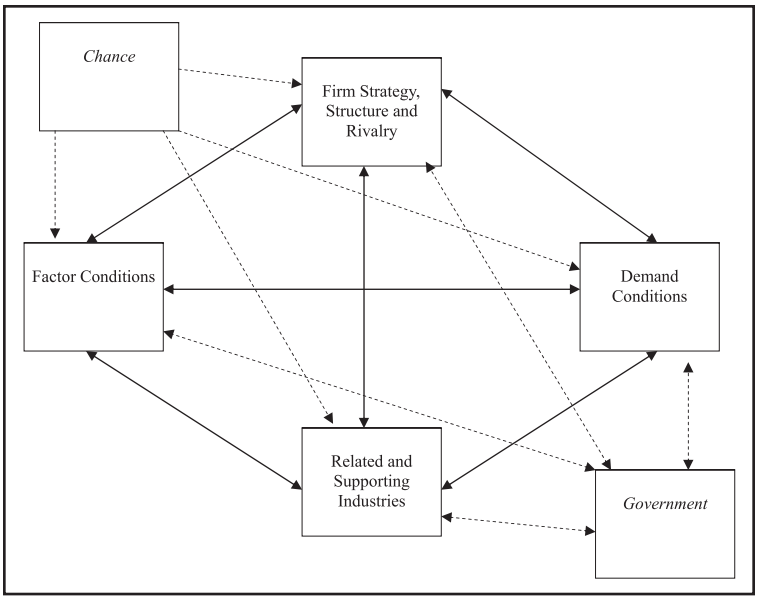

Figure 3. System of competitive advantage.

ever, takes a holistic and systemic view of the diamond as "a mutually reinforcing system." This adds at least three further aspects to his theory.

Inter-relationship of Determinants

As denoted by the diamond's arrows, each one of the determinant categories impacts and is affected by all of the other three categories. A full analysis of competitive advantage in an industrial sector would therefore take this into account possibly, as Porter does (1990, 132–43), by systematically analyzing all twelve of the possible inter-relations.

Clustering

Because of the importance of local related/supporting industries and of domestic rivalry, competitive advantage is supported by clustering in both senses of the word. First, as Porter uses the term, by the development of a network of firms—suppliers, buyers, competitors, and collaborators—who stimulate each other through rivalry but who also exchange information and labor; build attention and reputation with investors, government, and customers; and act as the catalyst for new entrants. Second, for similar reasons, by the development of geographic concentrations of firms that can thrive on the way in which proximity fuels both determinants and their interactions. Indeed, it is one of Porter's key points that "the local" becomes more, not less, important as globalization proceeds because proximity is that which is resistant to globalization.

Chronological Dynamics

For Porter, a cross-sectional perspective on competitive advantage will be of some value, but a longitudinal perspective will be better because "the system is . . . constantly in motion. The national industry continually evolves" (1990, 144). From this, Porter then builds to the notion of stages of competitive development. As with other ideas, he himself applies this at the level of nation but it may well fit more comfortably at the analysis level of interest here—the industrial sector (see Figure 4, adapted from WEF 2004).

There are three main stages:

1. *Factor-driven,* where an industry would draw its advantage "almost solely from *basic* factors of production" (Porter 1990, 547) such as natural resources or semiskilled labor. In this stage, factor conditions are the only determinants that matter: domestic demand is modest or nonexistent and, with foreign firms providing the source of technology and market access, issues of supporting/related industries do not apply. Porter sees such industries as vulnerable and as a poor foundation for sustained productivity growth. Most nations—particularly developing countries—have factor-driven development as the genesis of most of their competitive industries (either that or "unusually heavy local demand" (160)) but they then remain stuck in the factor-driven stage.
2. *Investment-driven:* "In this stage, national competitive advantage is based on the willingness and ability of a nation and its firms to invest aggressively" (Porter 1990, 548). Investments are made in new technology (particularly foreign technology); in developing the higher-skilled workers who can absorb, use, and improve that technology; and in modern infrastructure. Domestic rivalry helps drive this on, but factor conditions—particularly more

Figure 4. Stages of economic development.

advanced/specialized factors and the means for creating them domestically—remain important. Home demand conditions may still be relatively unimportant, but Porter sees best prospects in those industries where home demand is supportive. Related/supporting industries remain relatively unimportant, with continued reliance on foreign sources. Government may well play a substantial role in creating/upgrading factors, in temporary protection to promote domestic competition, and in helping with technology acquisition. Porter sees this as most likely to occur in relatively mature sectors with high labor costs, fairly standardized products, and technology that is readily transferable. At least from the perspective of 1990, he saw few signs of developing nations having reached this stage.

3. *Innovation-driven:* now the full diamond is in place—advanced factors are created and deployed, and there are strong supporting industries, sophisticated and internationalizing demand, global strategies, and strong competition. Firms are innovating new product/process technologies and drawing in foreign investment. Government's role has changed to a more indirect one that helps improve the quality of domestic demand and that encourages local start-ups and other competitive pressures. This is not a stage that Porter associates with any developing countries.[3]

Progress relies on elements such as factor creation mechanisms (e.g., good universities), the motivation of managers and staff to make money, vigorous domestic rivalry, upgrading of demand in the domestic market, selective factor disadvantages that give an impetus to innovation, and the capacity for new business formation.

Analyzing India's Software Sector by Using Competitive Advantage Theory

Having identified competitive advantage as an important analytical issue for software industry research and having identified Porter's theory as a relevant model for researching competitive advantage, we now move on to apply the model to a national case: India. Specifically, then, we address the issues of whether India's software industry exhibits a competitive advantage (the "how" question posed earlier) and of what explains its competitive position (the "why" question posed earlier).

This is by no means the first time Porter's theory has been applied to the analysis of software industries in "follower" nations, defined as those attempting to build a software sector after the first-movers like the United States, United Kingdom, France, and so on, which built a competitive position in software in the 1970s.[4] Examination of these previous studies suggests they could be plotted somewhere on the field summarized in Figure 5.

Each axis will be explained in turn, starting with application:

- *Naïve application* of Porter's theory covers descriptive work that tends to merely use the four diamond category headings as dump bins into which to allocate points, with little engagement with the content of those categories, with determinant elements missed out, and potentially with misunderstanding of the determinants. There is no engagement with—i.e., acknowledgement or use of—any of the systemic or dynamic elements of the theory.
- *Basic application* covers somewhat more analytical work that goes through the four determinant categories fairly systematically, using them to characterize or understand a software

3. There is a fourth stage—wealth-driven—that represents the seeds of decline rather than progress. It occurs when firms in an already-wealthy country stop focusing on innovation and instead try to preserve the status quo. It is of little relevance to developing countries.

4. The "follower" terminology is temporarily adopted here rather than "developing country" to encompass some studies of the Irish software industry that have used Porter's model.

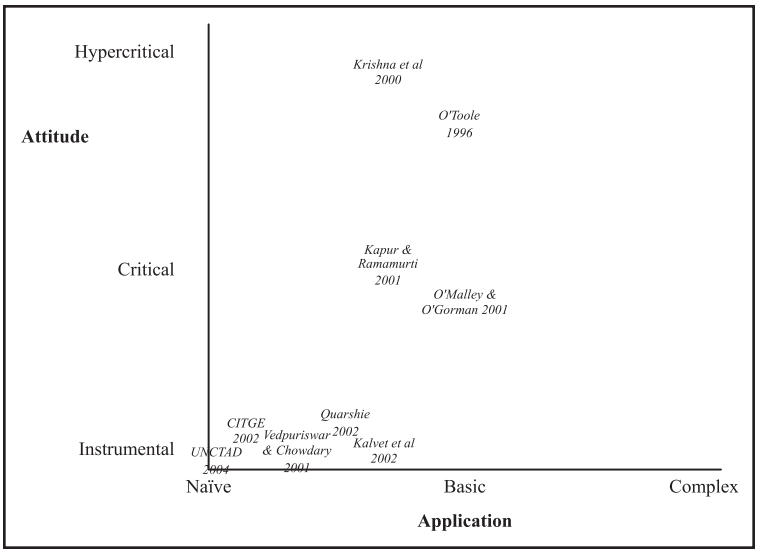

Figure 5: Researcher usage of Porter's theory.

industry. There again tends to be no engagement with any of the systemic or dynamic elements of the theory.

- *Complex application* is analytical work that encompasses the four diamond and two extra-diamond categories and that engages with the systemic and dynamic aspects of Porter's theory.

Attitude is more difficult to induce from the research outputs analyzed because one can interpret the appearance of that attitude only subjectively:

- *Instrumental work* is that which sees Porter's theory as a tool to achieve a descriptive or analytical end. It is unquestioning of the theory and assumes it to be valid.
- *Critical work* uses Porter's theory for instrumental purposes but is also reflective on that tool and does not take it as an accepted truth.
- *Hypercritical work* seems to use Porter as an Aunt Sally, setting out to prove that his theory is wrong, sometimes with possibly limited regard for the evidence.

This paper lies somewhere between the basic and the complex in its application and attempts to be critical in its attitude. Before operationalizing these ideas, though, a background on India's software industry must first be provided.

Overview of the Indian Software Industry

During the 1950s and 1960s, there was no Indian software industry.[5] Software came bundled with hardware provided by multinational hardware companies like IBM and ICL. IBM's unbundling of software from hardware in the late 1960s is seen as a generic global catalyst for the existence of independent software firms (*Financial Times* 1989). Indian firms—notably Tata Consultancy Services, which was a professional consulting firm and is now the country's largest software firm—did make some tentative software exports from 1974, but, in general, software development remained the in-house preserve of large user organizations or of the emergent indigenous hardware manufacturers.

The late 1970s and early 1980s saw a number of developments that mark the true emergence of an Indian software industry. A U.S. multinational—Burroughs—set up the first software-related joint venture when it saw an opportunity to combine sales of its hardware products into the growing Indian market with use of Indian staff to produce software (almost entirely working at the U.S. sites of Burroughs' clients). In-house software groups began trying to sell their products in the Indian marketplace, sometimes leading to their being spun off as software firms. At the same time, IBM withdrew from India, catalyzing the creation of a number of computer services/software firms by its former employees, mainly seeking to serve the domestic market.

The 1980s saw very strong growth in the domestic hardware base, partly because of the advent of the personal computer, partly because of the—

5. Unless otherwise indicated, data presented here are drawn from fieldwork (including interviews with more than 150 Indian software sector managers, programmers, policy makers, analysts, and local/overseas customers) undertaken between 1988 and 2005 by the author and by Brian Nicholson. These data have been extensively reported elsewhere (e.g., Heeks 1996; Sahay et al. 2003; Heeks and Nicholson 2004).

related—liberalization of hardware policy in 1984. Despite this—or perhaps because of the growth in software piracy associated with standard PC software—the domestic market began to lose its significance with more and more firms seeing greater opportunities in software exports.

There have been continuous exports of software products since the early 1980s. These include enterprise systems, design software, and database management tools. However, products have never formed more than 5% of total exports and, in 2005–06, they made up 2% of the total (Heeks 1999a, Das 2006). Indian software exports have been, and remain, dominated by services.

Within the overall segment of software services exports, though, trends of change are detectable. Indian firms began with a strong emphasis on "bodyshopping": the transportation of software staff to work overseas at the client's site. In the late 1980s, around 75% of export earnings came from bodyshopping. By 2000, this had dropped to nearer 60% (*Dataquest* 2001) and by 2006 it had fallen just over 50% (Das 2006), indicating a slow but steady trend towards offshore working.

This has been paralleled by a second trend: that of moving from supply of individual programmers to complete turnkey programming project services. As with offshore work, the trend of change has been greater within individual client–vendor relationships than in the industry overall. Nor has the industry overall diversified much from its main market: the United States. Figures from the early 1990s until 2005–06 consistently show around two-thirds of software exports going to the United States, one-fifth going to Europe (mainly the United Kingdom, Germany and France), and about 5% going to other English-speaking OECD nations (e.g., Australia, Canada) (Heeks 1996b; Nasscom 2004; Das 2006).

Although it faded into the background during the 1980s and 1990s, the domestic market has continued to grow, bolstered in recent years by strong private and public sector investment in e-commerce and e-government applications, respectively. As a result, by 2005–06, software sales to the local market were US$3.8 billion (Das 2006).

Nevertheless, exports remain the "jewel in the crown," representing more than 80% of industry revenues. India exported US$17.5 billion worth of software in 2005–06, reflecting average annual growth of more than 35% over two decades (Heeks 2006). The total number of software firms (domestic and export) could be as high as 7,000 though probably less than 1,000 of these are actively engaged in exports (Kublanov and Satyaprasad 2004; Nirjar and Tylecote 2005). Software employment figures also vary, with estimates of those working in software exports ranging from 100,000 (KPMG/Nasscom 2004) to 350,000 (Menon 2005) to 450,000 (Kublanov and Satyaprasad 2004).[6]

Does the Indian Software Industry Demonstrate a Competitive Advantage?

As noted above, Porter's work offers at least three possible measures of competitive advantage in a sector: productivity, exports, and outbound investment. As discussed below, only exports seems to be usefully operationalizable for software industries generally and for the Indian software industry specifically. Here, the data used are McKinsey's figures for global trade in software packages and services (see, e.g., ACM 2006) and figures from Dataquest (India) for software exports reported in its annual DQ top 20 (see Heeks 2006, for a summary time series). This suggests that, in 2005–06, Indian software exports represented 3.4% of the US$510 billion world trade in software up from 0.17% in 1992–1993.

In terms of competitive advantage, then, in relation to both global trade share and trade share growth, India rates as the developing world's most successful—i.e., most competitive in Porterian terms—software industry.[7] In global terms, some of the shine comes off because a 3.4% share is not particularly "substantial" and because—despite the fact that it does export to a "wide array" of nations—two-thirds of its exports go to the United States. Nevertheless, it seems reasonable to say that India's software industry is competitive and does demonstrate some global competitive advantage. From this, we therefore move on to look at the sources of this competitive advantage.

6. Interview data suggest variation depends partly on whether figures include software activity in nonsoftware firms and partly on whether they include nonsoftware staff working in software firms.

7. Though possibly challenged by Singapore's software sector, about which relatively little seems to have researched or written (see IDA 2005).

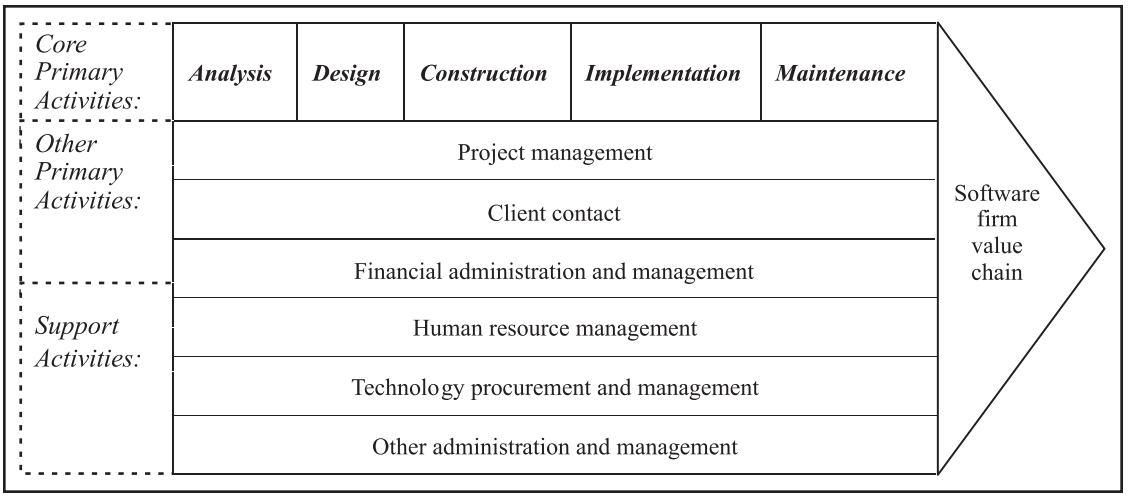

Figure 6. Software firm value chain.

Basic Analysis of Competitive Advantage

This section considers both determinants of and influences on competitive advantage in India's software industry.

Determinants of Competitive Advantage

Factor Conditions I: Labor/Skills

There is a general analysis that labor is *a* key factor underlying competitive advantage in software and, at least according to some analyses, *the* key factor (Correa 1996). It is certainly mentioned as a critical factor in every one of a range of analyses of India's software sector development (Balasubramanyam and Balasubramanyam 1997; Tessler and Barr 1997; Krishna et al. 2000; Kapur and Ramamurti 2001; Dayasindhu 2002; Kambhampati 2002; Athreye 2005).

Software work requires a range of different skills[8] that can be characterized through a variation on Porter's (1985) notion of the value chain (Figure 6):

- *Core operational skills:* these are typically characterized in terms of the software lifecycle (analysis—design—construction—implementation—maintenance), with a particular differentiation being made between relatively lower-skilled downstream skills (required for the programming work within construction and maintenance) and relatively higher-skilled upstream skills associated with analysis and design.
- *Other primary skills:* these relate particularly to project management skills (required for the internal management of software development) and what we might call "contact" skills (ranging from rather lower-skilled sales/marketing to higher-skilled client account/contract management).
- *Support activity skills:* the range of skills required to administer the finance, human resources, and technology management within the software firm, plus the higher-level skills needed for senior/strategic management.

India has had a tradition of strong scientific and technical institutions and skills that pre-dates but was significantly strengthened after Independence (Lema and Hesbjerg 2003). It is this that laid the foundation for development of the hardware, consulting and in-house software activity that, in turn, was the foundation for India's relatively early (by "follower" standards) development of a software industry. The initial foundation for growth was a large supply of graduates (often from engineering colleges) who either had programming skills or who could rapidly develop them through company train-

8. The terms "skills" is used here for simplicity rather than the more thorough notion of "competencies" which covers the knowledge, skills and attitudes that constitute human capital. In Porter's terms they are all advanced rather than basic factors but range from less advanced and more generalized (e.g., programming skills) to more advanced and more specialized (e.g., managing software projects for niche customers).

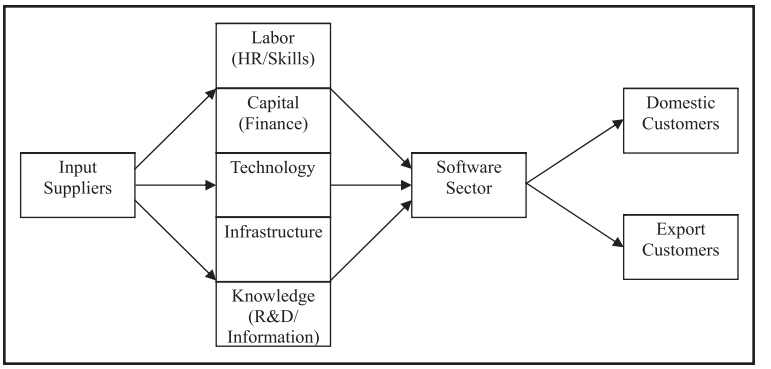

Figure 7: Software industry value chain.

ing. Though swimming in the shallow end of the skills pool in software terms, these are an advanced factor in Porter's terms, albeit one that is somewhat generalized, in being utilizable in a wide range of industries, not just software.

This factor source in itself is a created not inherited source of competitive advantage, but India made ongoing attempts to strengthen this factor further. The supply-side response to growing demand for skilled software labor has come partly from government, partly from the private sector, and has seen strong growth in generic technical education at tertiary level and also growth in software-specific training (Patibandla and Petersen 2002). Largely because of learning-by-doing, there has also been a development of more advanced, more specialized skills: a growth in the number of experienced programmers; a growth in the number of staff with expertise in developing software for particular niche markets (such as financial institutions); and a growth in project management expertise which, as noted above, has been a prerequisite for the move in exports from onsite to offshore working, which has tended to produce higher revenues. There has also been a development of knowledge: about software markets, business norms, and specific customer needs and values both at home and, more particularly, abroad (Lema and Hesbjerg 2003).

What Indian firms do not seem to have done in any major way, despite the cost and profit advantages this would bring, is move up the value chain to more highly skilled software work, such as that involved with analyzing client requirements or design program specifications (Arora and Gambardella 2004). There are limited amounts of product development, research and development work, and other high-skill activity.

From a simple economics perspective, labor costs would be seen as an important source of Indian advantage: annual programming wages are US$5,000–10,000 as compared to more than US$50,000 in the United States (Nasscom 2003; ACM 2006; BLS 2006), though this is eroded somewhat because, at least in export and product work, labor costs make up only a minority of total production costs (Heeks 1996; neoIT 2004). Further, and echoing Porter's attempts to push consideration of factors beyond simple economics, interview and other evidence (Robb 2000) shows that clients and investors rate labor skills and motivation and the ability to close their labor demand-supply gap as more important than costs.

One final skill-related source of competitive advantage must be acknowledged: the pervasive presence of English—the global business and IT language—in Indian higher education and business, including the software business. As with India's development of more advanced and specialized skills and knowledge, this has provided a competitive factor that—despite potentially lower labor costs—software industries in competing developing countries have found difficult to imitate.

Factor Conditions II: Other Factors

As summarized in Figure 7, other important input factors for software production include a base of hardware and software systems/tools, finance, telecommunications infrastructure, other infrastructure such as utilities and transportation, and—at least for software products—a sound R&D knowledge innovation base. All of these follow a fairly similar trajectory in India. In the initial days of the industry, in the 1980s, they were a source of competitive weakness rather than strength: the ICT infrastructure was very limited and outdated, financial institutions did not understand software financing, power cuts affected firms, and so on (Schware 1992).

For domestic-oriented production, this constrained the competitive performance of the software sector. For export-oriented production—as per Porter's formula—these were factor disadvantages

that catalyzed innovation: the development of bodyshopping which, at the time, was a new model for international trade in services (and one, incidentally, not included by Porter in his own typology of service trade models). The supply-led need for this new model was matched by a demand-led need: the uncertainty and lack of trust from export customers, which meant they preferred Indian staff to be working at their home sites rather than working offshore in India.

Gradually, during the 1980s and building pace during the 1990s, though, these factors improved. Restrictive policies were liberalized, software firms imported more IT, there were heavy public and private investments in telecommunications and other business infrastructure, and India's venture capital industry became operational; much of this was induced by the growth of the software industry and related IT sectors. There has also been a build-up in software R&D work, especially by multinational firms (Patibandla and Petersen 2002), though the true depth of this work and its spillover effects are debatable.

Despite the improvements, it is not clear that these other factors are sources of competitive advantage. They remain significantly concentrated in a few cluster locations rather than being generally diffused, and they only bring India up to—or close to—what might be seen as international standards. Save perhaps the development of software-friendly financing, most of the nonlabor factors are relatively easily replicable and, indeed, *are* being replicated in other developing countries. This build-up, however, has allowed in India the gradual development of domestic-oriented software production and, in exports, a gradual change of dominant business model from *bodyshopping* to *offshore management,* with creation of "offshore development centers" (ODCs). This—which as noted above is also significantly predicated on skill build-up—has enabled India to keep ahead of new entrants.

Physical resources seem to play little role in software. There is the issue of location, but it relates only to exports and its true importance is uncertain. In one sense, India is at a locational disadvantage because of its significant distance from all major export markets. This is something that developing countries located close to major markets (such as Central American or Central European nations) are trying to exploit through the development of "nearshoring" (Sahay et al. 2003). Beyond its catchy label, though, it is not clear how significant nearshoring is in software. Even if it does represent a factor disadvantage for India, it is one that the innovation of offshore development centers may partly neutralize. ODC-based models do still require some physical interchange of client and vendor staff, and some synchronous communication. Both of these are hampered by India's location. ODCs, however, can run significantly in virtual/asynchronous mode. Not only should this mode neutralize issues of physical location, but it might also bring some advantage. Because of time zone differences, Indian staff can in theory work "overnight" on problems posted by North American and European clients, returning solutions in time for their clients' arrival to work next day. Again, though, beyond the striking "elves and the shoemaker" image this conjures up, the true extent and value of this activity is not really clear and may be overstated.

Demand Conditions

According to Porter, domestic demand is "perhaps the single most powerful determinant of national competitive advantage in services today" (1990, 258). One might try to argue this for India's software industry. Since the late 1990s, there have been strong investments in e-commerce and e-government, and a market of US$3.8 billion in 2005–06 is sizeable. There are also cases in which activities in domestic niches have helped form the basis for exports of a software product or services; local multinational customers have been used as a conduit from the domestic to the export market; and domestic work is used as the basis for development of software expertise.

But, overall, trying to sell India's domestic market for software as a factor advantage will not work. Market size has been continually constrained by low spending on ICTs generally and by high rates of piracy. Sociocultural, as well as economic, factors may also play a part: developing countries often have protected local niche markets due to requirements for software to be customized to local laws, customs, or languages. India certainly has this, but opportunities may be smaller because of linguistic and other institutional legacies of colonialism (some of which can be seen as competitive strengths in other ways), which allow some of these niches to be more readily penetrated by standard foreign packages. As a comparative example, then, India spent less than

US$2 per capita on software in 2004, whereas China spent more than US$7 (Xi 2004; Menon 2005). Likewise, whatever its absolute size, domestic market revenue as a proportion of total revenue has fallen from around 40% in 1991–92 to less than 20% in 2005–06.

Beyond size, interview and other evidence (Kapur and Ramamurti 2001) suggest that local consumers are generally neither sophisticated nor demanding and that market trends lag rather than lead global trends, all this partly due to the general lack of global orientation among most of India's business sectors.

The story of domestic demand that fits far better, then, is that of its role as a factor disadvantage, rather than advantage. As described in the overview above, it is the constraints of the domestic market—its small size and low profitability—that have driven entrepreneurs into exports. Alongside this push has been the pull of global demand: the computer software and services market rose roughly 20% per annum on average from 1983–2006 creating, among other things, a demand-supply gap for hundreds of thousands of software professionals in the world's leading economies by the early years of the twenty-first century (KPMG/Nasscom 2004; ACM 2006).

Related and Supporting Industries

Software's most important input is skilled labor, so the most important "supply industry" for India will be the educational establishments already mentioned in the section on factor conditions. The size and, in part, quality and relevance of their human capital output has been continuously upgraded with some quite strong interactions between software companies and education providers. This has included private investments in equipment, teacher training and curriculum development as well as public–private partnerships like the Indian Institutes of IT (Patibandla and Petersen 2002).

These quite strong and competitively beneficial synergies (which arguably fall into the "factor conditions" heading rather than here) do not really find a parallel in software's relations to other domestic industrial sectors. There have been relationships with suppliers of input factors, such as telecommunications and finance, but there are no signs that these have provided any particular competitive edge for software firms. Hardware is an important supply input, and there are certainly links to India's sizeable hardware sector. However, those links are not about the hardware sector providing particularly low-cost or high-quality or innovative computers on which software is written. Instead, the links mainly relate to the software work of hardware companies; especially their systems integration activities, which can provide a (small) market for domestically produced products, and which also form a development pool for software labor.

If anything, the qualitative—if not quantitative—nature of software–hardware industry links has cooled over time (Heeks 2004). In the 1980s, India's hardware industry was independent, had a strong R&D function, and developed or purchased its own locally innovated operating systems and applications software. Liberalization and the dominance of global standards then drew hardware firms into alliances with multinational corporations (MNCs). This created channels that encouraged those firms to diversify into software exports, but it reduced the extent of local innovation in both hardware and systems/applications software.

As with Indian hardware firms, so with software firms, the more significant relationships have been with foreign not local IT firms: the MNCs, starting with Burroughs, who have set up everything from informal partnerships with Indian software firms to wholely-owned Indian subsidiaries. Within these relationships the IT MNCs have provided the IT (hardware and software systems/tools) on which software is produced, have invested in training and other infrastructure, and have acted as both customer and source of customers for Indian software.

If we turn, lastly, to "related industries," the most obvious candidate is IT-enabled services both inside the IT sector, such as back–office processing, and outside, such as call centers. There is a definite relationship: software's offshore development center model particularly has fostered a build-up of management skills, client contact skills, reputation and ICT infrastructure, all of which have had a strong pull-through that has helped establish IT-enabled services as a fast-growing sector in India (KPMG/Nasscom 2004). The presence of a local software sector has therefore been a strong source of competitive advantage for development of IT-enabled services. There are, though, few signs as yet of any

reverse flow that could act as a source of advantage for software.

Firm Strategy, Structure and Rivalry

The extent and impact of domestic rivalry in India's software industry is difficult to pin down. On the one hand, there is evidence of competition: the industry is dominated by privately owned players; barriers to entry and exit are relatively low, and there are dozens if not hundreds of new entrants each year. As a result, thousands of firms jostle for a place in the software market and to these must be added the pressure imposed by growing numbers of other developing country locations for software development, something that Indian managers seem well aware of (KPMG/Nasscom 2004).

In domestic-oriented work, it seems reasonable to conclude that there are strong competitive pressures: there is always someone willing to undercut, and profitability is low (Kumar 2001). Other than encouraging entry into export markets, though, there seem to be few signs that this competition has fostered the kind of factor/quality improvements or new product/process developments that Porter hopes for.

Competitive pressures in exports may be more mixed. Concentration is quite high (the top ten firms earned 60% of revenues in 2005–06 (Das 2006)) and the continuing strong growth of demand can leave Indian firms feeling they are "pushing at an open door" (Krishna et al. 2000). There may also be some segmentation with MNC subsidiaries serving the captive markets of their parent organization, isolated from competition with other Indian firms (Athreye 2004). Company strategies can therefore be read as ones of imitation rather than innovation with all seeking to copy first bodyshopping and then the offshore management model.

There is another side, though. Some MNC subsidiaries branch out to serve their parent company's clients: a more competitive market; new entrants are continually arriving and sometimes try to undercut going rates; and the IT slowdown of 2001–03 encouraged emergence of cost cutting as a competitive tactic particularly given perceived cost threats from locations such as Russia and Vietnam (Field 2001). Firms have also been driven to differentiate or innovate in a number of ways—adopting certifications like the capability maturity model (CMM), building specialized skills in market niches or project management, and developing new HR practices and incentive structures in the competition to recruit and retain skilled labor (Arora and Athreye 2002). Despite the inevitable imitation of such tactics,[9] they do quite strongly resemble the kind of outcomes of competition that Porter predicts: probably a combination of competition for labor and competition for market.

We can analyze the remaining grab bag of factors that fall under this heading by looking at two levels: the sectoral and the national. Sectorally, there are contextual factors that have enabled the software industry to represent something of a paradigm shift from the "traditional" model of Indian business. These factors include a core vision—held by government officials and private entrepreneurs alike—of what software (especially exports) could achieve for the nation; financing and ownership models that supported entrepreneurship; and a government policy regime—interpreted by some as "hands-off" and by others as supportive—that contrasted with the more direct regulatory intervention seen in other sectors. These, plus the direct and indirect influence of links to U.S. and European firms, led software firms to have organizational structures and processes that—while still incorporating Indian elements—were different from those in other industries: flatter hierarchies, greater linkage between reward and performance, and a more participative and less paternalistic style (Krishna et al. 2000).

Some commentators go beyond the proximate institutions of the sector to find competitive advantage for software in deeper national institutions or supposed characteristics: the "natural propensity for Indians to succeed in activities that require mental rather than physical skills, and flexible rather than standardised behaviour" and their "natural liking for sciences and mathematics" (Krishna et al. 2000, 188, 190). There are tensions here, though: how can a common set of institutional foundations be simultaneously responsible for, and supportive of, both traditional Indian sectors and the very different structures and processes seen in software? The na-

9. For example, by 2004, of 80 companies worldwide audited at CMM level 5 (the highest level), 60 were Indian software firms (DoC 2004).

ture of work on this issue is also problematic, too easily giving the appearance of empty stereotypes and assertions without a convincing chain of evidence.[10] As yet, then, the case for deep historical and cultural sources of national competitive advantage remains "not proven."

Influences on Competitive Advantage

Chance

Porter seems to attribute the term "chance" to most factors other than government that are exogenous to the national diamond. For Indian software, one such could be the Y2K problem and the advent of the Euro currency. Though hardly chance events, both affected overseas demand conditions and provided significant opportunities for Indian firms to grow in the export market.

Going still further back, many initial software export contracts and partnerships in the 1980s and 1990s arose because an expatriate Indian manager working in a U.S.- or Europe-based multinational was able to suggest and/or facilitate the process. This too has nothing much to do with chance and much more to do with the ongoing diaspora of Indian professionals to Western nations. These linkages have brought more than just trade contacts; they also impact factor conditions by providing market information and money. Saxenian's (2002) study, for example, found that half of Silicon Valley's India-born population had business contacts in India, while a quarter had invested in an Indian start-up. The value of the diaspora—their knowledge, skills, and social and financial capital—has been further enhanced through reverse migration (Kapur and McHale 2005). Returnees have come home to invest in software start-ups, especially since the mid-1990s.

Finally, into this category we might mention factors external to any national diamond that, though not a source of specific competitive advantage for India (and certainly not chance events), do affect the sectoral context and help explain why countries like India have been able to enter the software trade (Sahay et al. 2003, 6–9):

- The divisibility and separability of elements of the software production process, which has allowed certain lower-cost, lower-skill elements (notably coding and testing) to be outsourced with relative ease;
- The relative separability of software production from consumption (unlike some services such as health care, which can only be produced at the point of consumption);
- The standardization and accessibility of production tools (e.g., programming languages) so that, despite ongoing technological change, it is relatively easy for software firms to train staff to use these tools and then to have some longevity of return on that investment; and
- The intangibility of software, which has facilitated globalization of production, including to locations far from main markets.

Government Intervention

Government intervention in the Indian software industry has been a mix of pulling back and pushing forward. On the one hand, less government (such as liberalizations in telecommunications and finance) and absence of government (such as exemption of software from regulations covering other sectors, and absence of significant public ownership in software) have both contributed to growth of India's software sector (Arora et al. 2001).

On the other hand, technocrat public servants created both the educational infrastructure and science-based industries (related/supporting industries) that were software's ultimate foundation in India, particularly the original foundation for its skill base (factor conditions), and they largely created the vision for software exports (firm structure, strategy, and rivalry). Key public sector ICT projects in the early 1980s—computerizations of the Asian Games and the Indian Railways—provided visible public demonstrations of Indian competence in software and influenced local demand. Government followed these up by continuous subsidies for overseas marketing, provision of market information, and organization of trade visits that created some of the original momentum for exports. There has also been continuous government investment in factor bases such as ICT infrastructure and education.[11]

10. Not to mention the (contentious) argument that "India" is an imperial creation that brings together a very disparate array of cultures and institutions.

11. The public sector has also always been a major consumer in the domestic software market; however, given the lack of clear competitiveness in domestic-oriented software production, procurement cannot be seen as a clear source of competitive advantage.

There is continuing debate about the importance of government intervention in Indian software success. Some see the glass as half-empty, attributing success to the relative lack of intervention compared with other industrial sectors (Singh 2003). Others see the glass as half-full, noting government interventions played a key role in development of all Western software industries, and seeing India as no different (Tessler et al. 2003). One partial resolution to this is to see that interventions were greater in scale and significance from the 1950s to the 1980s in the prehistory and early history of the industry but that they have played a lesser role as private sector capacity to intervene has grown during the 1990s and 2000s.

Advanced Analysis of Competitive Advantage

This takes in higher-level analysis based on the system dynamics view of competitive advantage within Porter's work.

Systemic Analysis of Competitive Advantage

Some of the determinant inter-relations have already been identified. These can be summarized as follows:

- *Factor conditions:* these have been positively impacted by domestic rivalry as firms have competed and invested to improve creation and deployment of skills (and, to a lesser extent, other factors such as ICT infrastructure). Except for the notion of educational establishments as a supply industry, there seems little impact from related/supporting industries or from domestic demand. Global demand has pressurized India to improve local factor conditions.
- *Demand conditions:* domestic demand, as noted, hardly seems a source of competitive advantage and has been little impacted by other determinants. Again, export demand has been affected—for example, through creation of a national image for Indian software services and through attraction of multinationals to access local factors (i.e., labor) that then create further channels of demand for exports.
- *Related/supporting industries:* as noted, this has largely been an outbound not inbound effect with certain of software's factor conditions (and perhaps competitive pressures) supporting the development of IT-enabled services.
- *Domestic rivalry:*[12] the impact of both domestic and global demand on competition is unclear, but new firms have entered, presumably increasing competitive pressures, from the ranks of hardware suppliers, educational institution staff, and customer organizations.

This has not, perhaps, added very much to the earlier reductionist analysis in its elements, but it does bring home the conclusion that India's software industry does not have a fully functioning diamond; a system of mutually reinforcing determinants. Instead, it has only some partial sources of competitive advantage around factors and, perhaps, rivalry.

A systemic view also incorporates the idea of clusters which—in their geographical sense—have been important in India. Most software firms cluster around a few locations: Bangalore, Mumbai, Chennai, Delhi and Hyderabad (Sahay et al. 2003). There is evidence of locational economies in the more efficient provision of physical infrastructure and labor/capital supply inputs to a cluster of software firms than to the same number of firms that are dispersed (de Fontenay and Carmel 2003). Government has supported this by helping deliver infrastructure to the clusters. It has also been assumed that clusters enabled rapid interchange of information and knowledge, for example, about best practices and about market opportunities. Other than through the circulation of labor between firms, however, clear evidence of this has not yet been forthcoming (Dayasindhu 2002; Lema and Hesbjerg 2003). Nevertheless, it is clear that the locational clustering of India's software firms has supported the competitiveness of this sector.

Dynamic Analysis of Competitive Advantage

The evolution described above from the body-shopping to the offshore management model matches Porter's ideas quite well (see Figure 8). The Indian software industry began in a factor-driven stage of competitive development in which one main factor (advanced rather than basic skills) was the source of advantage. Other factors were more a source of disadvantage needing to be overcome by

12. Porter (1990, 140) lists this rather than "firm strategy, structure, and rivalry" in his discussion of inter-relations.

Figure 8. Indian software sector development.

a new business model than a source of advantage. Other determinants played little or no role.

Through sustained investment, most of the factor disadvantages have been transformed into factors that are either advantageous or neutral to competitive advantage. The main advantage—human capital—has been significantly upgraded. All of this has permitted the strategic innovation of a move to offshore management, and there are at least some signs of domestic rivalry. Domestic demand for software and related/supporting industries remain relatively unimportant. All of this fits Porter's description of the investment-driven stage, perhaps because software fits the description (1990, 551) of sectors in which this stage is likely to emerge, having large labor cost components and technology that is readily transferable.

There are no real signs of an innovation-driven stage emerging in India given that the full diamond is not (yet) in place. One must also be careful about characterizing the Indian software sector as having moved from a factor-driven to an investment-driven stage. These changes are seen in the more mature export-focused firms, especially those with strong client-developer relationships that have allowed trust to build. In the sector overall, though, domestic-oriented work could not be described as investment-driven and, in exports, there is still a lot of onsite work (bodyshopping). One gets an image of a vacuum effect as if, for every large firm that upgrades from a factor-driven to an investment-driven model, five new small firms enter the industry using the low-barrier bodyshopping approach.

Findings: the Contribution of Porter's Theory

What contribution, then, has this analysis using Porter's competitive advantage theory made to questions about software sector competitiveness? It has helped to show that the Indian software industry *is* globally competitive, and it has charted the development of competitive advantage, starting from a factor-driven stage and partially moving to the investment-driven stage. Secondly, application of this theory has helped to identify the sources of competitive advantage (and factors that do not contribute to specific competitive advantage), as summarized in Table 1. Finally, use of Porter's theory has helped to address issues of what actions to take to sustain the competitiveness of this sector. In looking at the system of diamond determinants, for instance, one can see that government has been doing as Porter would recommend (see Porter 1990, chap. 12) in a number of ways:

- *Factor conditions:* upgrading both the general education and specific training that underpins advanced skills in software; investing or enabling investment in all aspects of infrastructure; facilitating readier access to capital; generating and disseminating market information.
- *Firm strategy, structure, and rivalry:* enabling and sustaining competition by facilitating entry of new firms and multinationals and by avoiding barriers to internal or trade competition.
- *Clustering:* supporting locational clusters through infrastructure investments (though this has been carried out as much by state governments as by the national government).

Firms, too, have been trying to push themselves away from the low-cost, factor-driven strategy of bodyshopping and toward higher-skill, offshore, niche-oriented software development through their investments and innovations in management strategies, structures, and processes. They have been building advantages that are more difficult to imitate such as reputation and strong customer relations. They are also internationalizing their own operations: investing significantly in offices and subsidiaries in main markets such as the United States, and investing in software development operations in other low-cost locations such as China (Heeks and Nicholson 2004). Again, this is much as Porter (1990, chap. 11) would recommend.

Table 1. Sources of Competitive Advantage for India's Software Industry

Category	Direct source	Not direct source
Factor conditions	Low-cost skills base (IT, management, English); skills and knowledge development	Other input factors: finance, technology, infrastructure
Demand conditions	Global demand	Domestic demand
Related and supporting industries	Skills development institutions	Other input factor institutions; other related sectors
Firm structure, strategy and rivalry	Competition between domestic players; vision for software	Cultural/institutional factors
Government	Supply interventions	Demand interventions
Systemic	Locational clustering	———
Dynamic	Innovations to address domestic factor and demand constraints	———
Other	International linkages	———

For the future, Porter's work would recommend to India that government and firms consolidate an investment-driven strategy across more of the software sector, thus affording greater protection from other low-cost developing country competitors. It would also, for the medium term, recommend development of a true diamond of competitive advantage. This will require work on the two determinants that have to date been rather dormant:

- *Demand conditions:* actions to drive up the size and level of sophistication of domestic demand. Government could do, and indeed is doing, this through measures to increase spending on e-government applications, create a much more pervasive ICT infrastructure, and facilitate development of e-commerce in India. To some extent, such policies may help create a competitive advantage in serving the software markets of other developing nations. Indirectly, the value of domestic demand will also be enhanced through policies in sectors other than software: that encourage more foreign multinationals to set up subsidiaries in India and through policies that encourage Indian firms to internationalize.
- *Relating/supporting industries:* India's software industry can be the nucleus for a successful collection of related industries. At least on the service side, this could take in IT-enabled services and management consulting/other professional services (such as accountancy). It may or may not include hardware production since hardware and software—though very much related—have very different sectoral profiles and implications. As firms diversify into the related industries, government can support this process through its standard menu of support, especially for factor development in the related industries.

In overall terms, application of Porter's theory does seem to score relatively well on some fairly obvious research tests. One may first ask whether it says anything new. This is a difficult test for the Indian software industry, in light of the plethora of research on the topic. All one can say is that it has at least put previous ideas into a new shape with new priorities. Second, one may ask if it says anything credible. Some questions about Porter's theory will be raised next but one of the main values of using a clear and well-known model such as the diamond is that it does make results more convincing than the simple listing of factors found in other analyses. It also provides the basis for further argument and debate framed around the model rather than simple assertion versus counter-assertion. Finally, does application of this model say anything useful? Although presented only briefly here, it does seem to, in giving industry and policy practitioners a clear sense of the forces at play in the sector, a sense of priorities, and a sense of what actions to take to maintain the sector's competitive position.

Reflection and Review of Competitive Advantage Theory

This section reflects on the application of Porter's theory of competitive advantage just undertaken, plus evidence from other applications of the theory. It suggests that some criticisms of Porter's theory—here labeled "more tractable"—could be addressed within the context of the existing model, whereas others—"more challenging"—may require modifications to that model.

More Tractable Criticisms of Porter's Theory

Falsifiability of Porter's Theory

Some work applying Porter's theory concludes that the theory is wrong, almost always because it finds a sector (or sometimes nation) that can be seen as competitive, yet does not have a "diamond" in place (Davies and Ellis 2000). This has been the case for at least two studies of India's software industry, which have found poor infrastructure, weak domestic demand, a lack of related/supporting industries, and low levels of competition (Krishna et al. 2000; Dayasindhu 2002). They therefore conclude that Porter's theory either does not fully explain the Indian software sector's success (Dayasindhu 2002) or that it is "unable to explain" the sector's success (Krishna et al. 2000, 195).

There are specific methodological criticisms one could level at these papers, such as lack of clarity about source of data (Dayasindhu 2002) and exclusion of elements such as high-quality software labor, ICT infrastructure, and national institutional/cultural factors from the Porterian analysis, only to introduce these later in support of an alternative model (Krishna et al. 2000). Alongside this, however, is the more general problem with attempted empirical criticisms of Porter's theory: that such work does not appear to have grasped two of Porter's key arguments. First, that certain determinant disadvantages (particularly factor disadvantages) can spur rather than constrain competitive advantage. Second, that one is only likely to find a fully functioning "diamond" at the innovation-driven stage of a sector's (or nation's) development, and this is not a stage that most sectors have reached, especially not in developing countries.

As described above, in the Indian case analysis, weaknesses of infrastructure, lack of domestic demand, and lack of related/supporting industries are thus entirely consistent, not contradictory, with Porter's theory. He explicitly identifies these as components of competitive industries in their early stage, of the type one would expect to find in developing countries.

The problem with Porter's theory, then, is not so much that it might be wrong when applied to software or other IT sector analysis but that it is difficult to falsify, thus weakening its credibility and value (Popper 1959). By including so many factors within his model—especially "dump bin" categories like "firm strategy, structure, and rivalry" and "chance"—plus adding further systemic and dynamic features plus allowing both factor absence or presence to have a positive impact on competitiveness, Porter makes it easy to fit the story of any sector or nation into his theory.

This is often a danger with wide-ranging, systemic models and does not negate their value. Despite its broad factoral scope, the theory is still quite good at identifying some key elements that are likely to underlie a successful software industry, and which can be tested to some extent: strong technical skills, some size or sophistication of demand, and competition between firms leading to process or other innovations. Porter is also relatively clear about what both firms and governments need to do at any particular stage of a software industry's development; again, providing a practical value that offsets philosophical weaknesses of his theory.

Operationalizing Porter's Theory

Although there is practical value from Porter's work, there are also practical challenges in operationalizing his theory for research purposes.

Type and Level of Research

As Ma (1999, 3) notes, "competitive advantage is a relational term," suggesting that rather than undertake the type of single-case analysis provided here and by most other applications of Porter's theory, it would be better to do comparative studies. Comparative studies of, say, one country's software sector with another, have the advantage of controlling for certain common (typically global) factors and of highlighting differences in determinants of competitive advantage that lead to differences in performance. In practical terms, too, each country gets to sense how much of a competitive threat the other is, and may learn lessons (though these may be

rather unidirectional if one country is more a leader and the other more a laggard in competitive terms).

In terms of the level of research focus, undertaking work at the level of the sector seems to be supported by relative strengths and weaknesses of Porter's theory. Although the main intention of the theory is to be applied at the level of the nation, it seems to work less well at that level. Porter himself points out that competitiveness resides at the sector/segment level and that it was difficult for him to write his country cases given "a theory that is aggressively industry (and cluster) specific" (Porter 1990, 283).

National-level work also suffers measurement problems. Porter tries to commensurate measures of competitive advantage at both national and sectoral level; measures that are not only different but also inconsistent since, for example, low labor costs or a favorable/depreciating exchange rate could encourage exports (his sectoral measure) while leaving productivity (his national measure) flat or falling (Grant 1991; Davies and Ellis 2000).

All this supports the notion that application of Porter's theory to individual IT sectors like software will be more appropriate than application to whole countries. However, is "software sector" itself too broad? The Indian case analysis questions whether a combined analysis of both export- and domestic-oriented work is viable given the latter may not be competitive whereas the former is. India's may be an extreme case but there are other software industries in which firms have been "born global" and partly compete in different contexts to domestic-oriented firms (Heeks and Nicholson 2004). Likewise, software products and software services can operate according to very different business models. Thus, following the model of strategic positioning in software (Figure 9; Heeks 1999b), should we divide competitive analysis of software into at least four different segments?

The answer seems to be "probably not." Despite the complexities of trying to cover different segments in a single narrative, Figure 9 is a reminder that sector—rather than segment—level work may still be appropriate: because some software firms (indicated as "E" in the diagram) straddle the intersections between segments. Such firms may use domestic market work as the basis for a move into exports, or they may produce "semipackages" and then packages from an individual services/customization contract. A more reductionist, segment-wise analysis would not encompass such firms, yet they are found to be significant in the development of many developing country software industries (Heeks 1999b).

Dependent Variable Measurement

Once the particular focus has been chosen—comparative or not, software sector or segment—the next operational step is to assess the dependent variable of competitiveness through some measure of performance. As noted above, Porter offers productivity, exports, and outbound investment as possible measures. In seeking to operationalize these for the Indian software industry, a number of points arose, some of which are generic, some of which are specific.

The first generic point is the static nature of the measures proposed and used by Porter, who—despite his emphasis on change, innovation, and dynamism—relies on cross-sectional statistics. Although static measures are helpful and easily available, they are surely not as good a representation of competitiveness as dynamic measures such as productivity growth or export growth.

Given the point about the relative nature of competitive advantage, one should arguably prefer comparative measures that help understand the performance of a sector relative to that of other countries. This is additionally relevant in software because the global market has averaged double-digit growth since at least the early 1980s (Schware 1992; OECD 2004). Given this booming demand, it might be relatively easy for a national sector to grow fast but still be less competitive and growing less strongly than the same IT sector in other developing countries. Of the three measures offered, only export share touches on this since it discounts global market growth and since a share increase by one country must necessarily be matched by a share decrease elsewhere.

By contrast, there are specific difficulties with some of Porter's other suggested measures, particularly for the software sector in developing countries. Productivity—measured in terms of revenue earned per employee—is quite widely used as a measure in discussions of software and development. This does correspond to at least one part of a core definition of productivity: "value of the output produced by a unit of labor or capital." (Porter 1990, 6) and it may change due to productivity-related factors such as

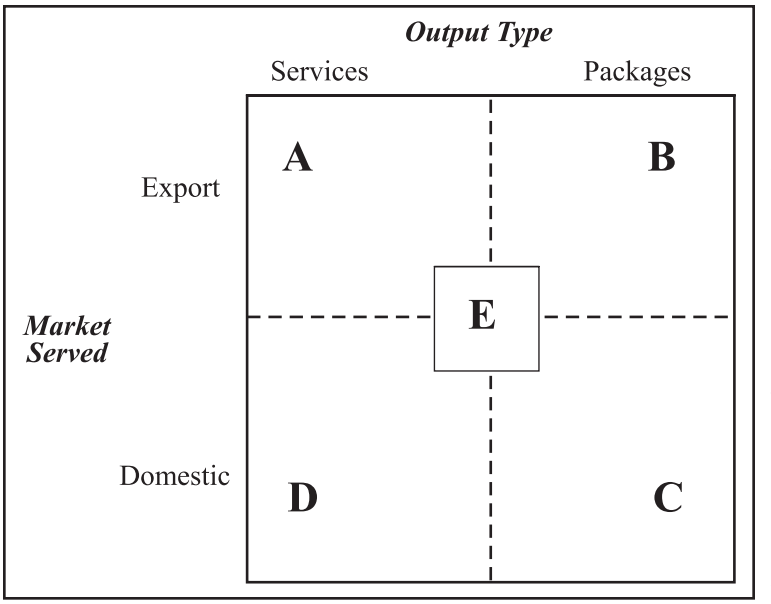

Figure 9. Strategic positioning in software.

process improvement (Athreye 2005); however, there are still problems.

In India, for example, the measure of revenue per employee has risen for reasons such as currency devaluation (because exports are significant and booked in US$ terms, causing higher rupee revenues for equivalent work as the currency devalues); changes in the mix of onsite versus offshore working (because expenditures on overseas travel/living are removed in the latter leading to higher revenues); and ongoing wage inflation in the sector (because rising wages lead directly to rising charges/revenues for software in such a labor-intensive activity). In other cases, where a significant role is played by software products, then a successful product will produce a vastly greater revenue per employee than an unsuccessful one. Yet in none of these cases has the productivity of the worker—in terms of amount of software written—necessarily changed at all. So productivity is not quite what it seems as a measure in software because of the particular nature of this sector.

Outbound investment could be used as a competitive advantage measure for software and other IT sectors in a few developing countries (including India), because a number of leading firms have invested in offices and even subsidiaries overseas. However, overall figures seem not to exist and, in any case, such investments are rare from developing country software/IT sectors (Indian firms' investments, in other words, are currently an exceptional case), so there seems little mileage at present in using this as a competitiveness measure.

Therefore, as a measure of competitive advantage for India's and other developing countries' software industries, one is left with share of world trade and/or growth in share of world trade. Even here, a problem arises because estimates of world trade in software vary significantly, as do statistics on software exports from developing countries: figures from one source may be two or more times different from those in another (DTI 2004). This arises partly due to the lack of clarity about software in industrial classification schemes, and partly due to issues of when, where and how revenues are booked for software (see Heeks 1996 for further discussion). One partial way around this—adopted in the case analysis provided above—is to identify one source for statistics and stick with it, in the hope that its scope/definition does not alter over time.

For those researching software and other IT industries without significant exports, Porter's work usefully identifies productivity—despite the shortcomings noted—as a measure of competitiveness. Porter's work is also helpful as a reminder that many of the other statistics typically cited in software/IT industry research—total industry turnover or the number of jobs created or number of firms operating—tell us relatively little about competitiveness, especially if the figures are static and if they are not comparative with other nations or sectors.

However, there are other measures, not adopted by Porter, that may give insights into competitive advantage. One such is technological capability; a measure that draws particularly on threads of knowledge, learning and innovation within competitiveness (Lall 1987). It is a qualitative indicator and so must typically be drawn from field research but IT- and software-specific scales have been developed (see, e.g., Grundey and Heeks 1998), and it does

address a number of the argued shortcomings of other competitiveness measures.

Finally, the main emphasis of comparison has been intercountry: comparing the competitiveness of one country's IT sector with another country's. An alternative interest might be the relative competitiveness of an IT sector vis-à-vis other sectors within a single country. In that case, one could also think about using average profitability as a measure. Although not necessarily connected with other measures of competitiveness, it does offer some insight into relative returns on capital invested in the sector. Alternatively, one can look at comparative shares of GDP.

Working with the Determinants

In addition to the issues faced in measuring the dependent variable, there are challenges in operationalizing Porter's determinants of competitive advantage.[13] One of these relates to—admittedly fairly minor—overlaps between the determinant categories.[14] As examples, the issue of factor inputs was discussed under both factor conditions and, in relation to suppliers, under related/supporting industries; language skills appear at times under both factor conditions and firm strategy, structure, and rivalry; customers may appear under both demand conditions and related/supporting industries. In practice, this can be solved by deciding under which category to place a particular factor and then sticking with that decision.

Porter has also been criticized for the qualitative, even subjective, presentation of determinants, which can make his material feel more like assertion than proof (O'Toole 1996). This approach can weaken software sector analysis, at least for those readers who draw from a quantitative tradition. On the other hand, the qualitative method is fairly easy to operationalize, and those who have tried to quantify competitive determinants may present an even weaker case. Moon et al. (1998) and Kyeong and Ho (1999) follow this latter path but select quite unsatisfactory measures: using the percentage of respondents who agree that "foreigners are treated unequally as compared to domestic citizens" (Moon et al. 1998, 144) to measure firm strategy, structure and rivalry; or using the percentage of paved road as part of related/supporting industries (Kyeong and Ho 1999). If quantitative measures are to be used (and this would make sense for some factors, such as measuring domestic rivalry through concentration ratios), they need to be directly appropriate and sector-specific; typically gathered via a sectoral survey.

The Emphases of Porter's Theory

Porter appears particularly concerned about the shortcomings of macroeconomic work on competitiveness, and one of his work's strengths is to move beyond the unrealistic simplicity of models dealing with just a few input factors. Some critics (Davies and Ellis 2000) argue that Porter's expansion of factors underlying competitiveness is nothing new, that he has merely repackaged issues from earlier economics debates for a business/policy audience. Such repackaging is common among successful academic models and not a source of concern in itself. However, the move away from simpler economic models to a more qualitative and systemic approach also brings three more serious criticisms.

The first is that, by mixing in so many other factors, Porter's theory loses sight of the major sources of *comparative* advantage for developing countries; particularly of low-cost labor (Davies and Ellis 2000). In his advice about upgrading, he may therefore—wastefully and prematurely—be advising developing countries to move away from the roots of their advantage. There may or may not be validity in this criticism in other sectors but in software it seems unlikely that cost is the "elephant in the room," so large a factor that everyone ignores it. Not only is it easy to build in to competitive advantage analysis, as seen above, but there is explicit evidence from both software vendors and clients that cost is only one among a number of issues shaping sectoral decisions. It is also fairly clear that India's software sector upgrading has helped rather than hindered its competitive position.

13. A little surprisingly, Porter skirts around some challenges posed in operationalizing the diamond when presenting sectoral analyses in chapter 5 of The Competitive Advantage of Nations, because he does not systematically follow the diamond in structuring his work but instead adopts a hybrid structure that mixes diamond determinants, nondiamond factors, and chronology. This may be for reasons of readability because as may be noted in this paper, wading through an exhaustive list of factors can, for the reader, be somewhat exhausting.

14. Chance is also somewhat unclear: it was used above—not really appropriately—to lay out general sectoral context, which might be better presented as part of a general introductory analysis.

The second criticism is more difficult to refute: that Porter's theory lacks predictive power. Porter (1990, 175) claims the diamond is "a tool for *predicting* future industry evolution," and he includes some (rather varied) predictive material in his case analyses. Yet overall, the theory is much stronger as a post hoc tool for historical analysis rather than as a pre hoc tool for futurology. Predictive power is undermined because of what has—not unreasonably—emerged from Porter's inductive approach to theory building:

- The inclusion of chance as an influence on competitive advantage because, by definition, chance events cannot be predicted.
- The fuzziness over the sign of variables. For example, both factor presence and absence and both large and small domestic markets are argued as sources of advantage in different situations. Porter does provide guidance that any weakness should offer neither too much nor too little pressure and that other determinants such as supportive home demand, sustained commitment, and the right institutions, do need to be in place. But overall, how does one know which particular impact a variable will have in future?
- The complexity of the model with its systemic inter-relations and dynamism that make it very hard to foresee how a particular combination of current factors will emerge in future.

Yet, although Porter's work may be predictively weak in a specific sense—and it had little to offer about where India's software industry may be headed—he does offer a fairly clear generic "roadmap" for sectoral development. From this some quite specific prescriptions for both government and industry could be drawn out for software sector development, meaning that his theory is not just for historical analysis. Prescriptive strength may thus partly compensate for poor predictive power.

There is finally the more minor point that Porter does treat competitive performance as a dependent variable. Yet, in practice, the relationship between performance and "determinants" is two-way: determinants shape competitive performance but performance also impacts structures, resources and processes (Buckley et al. 1988). Thus, for instance, India's software success draws more skilled labor and capital into the sector, increases rivalry, and even shapes demand. However, this can be incorporated readily into discussion of determinants once it is recognized.

More Challenging Critiques of Porter's Theory

This discussion ends with three further issues on which Porter's theory can be criticized that are less tractable and that, it is argued, require some modifications to the theory if a full understanding of software (and other IT) sector competitiveness in developing countries is to be achieved.

The Role of Government

Some critics make quite a fuss about what they see as the underemphasis given to government's role by Porter, wanting his model to be amended by incorporation of government into the diamond (van den Bosch and de Man 1994) or even by giving government its own diamond (Kyeong and Ho 1999).

On the basis of the Indian software evidence, one could argue both for and against the idea that government intervention has *directly* created competitive advantage for the Indian software industry (as opposed to Porter's view that government influence can only be indirect via the four determinants). Ultimately, though, this may just be a matter of semantics: what is clear is that government policy has indeed, as Porter claims, been "an important influence on competitive advantage." He is certainly no mainstream neoliberal and is more akin to the "business-in-development" mindset, for instance, allowing for competitive benefits from both infant industry protection and certain regulatory standards.

Perhaps more useful to consider is the danger that Porter's work on policy is too concerned with prescription and content (i.e., with laying out the "menu" of interventions that are required to upgrade sources of competitive advantage). Alongside content, though, policy prescriptions for IT sectors should also consider (Heeks and Nicholson 2004):

- *Structural capacity and relations:* the need for autonomous and capable state agencies with IT sector responsibilities, combined with a strong representative body for the firms in that sector *and* a mechanism for robust interaction between these two groups.
- *Processes:* the need for flexibility, learning, and iteration within the institutions of sectoral intervention.

Of course, in light of the comprehensive nature of Porter's work, both of these issues do receive at least a glancing mention but there does not seem to be recognition of the possibility that content of interventions may be less important than the capacity to observe and react to the impacts of interventions and contextual changes that beset the IT sectors of developing countries.

Upgrading and Innovation

This issue of government is an instance of a broader criticism of Porter's theory, that—despite its very great length—it tends to provide a general sense of the "what" of structure and process rather than specific details of the "how" (Grant 1991). Thus, for example, while accepting that Porter makes constant reference to the need for processes of upgrading and innovation, one can argue that he does not satisfactorily explain how this happens. Indeed, one could further argue that there is a strongly misplaced emphasis in Porter's work: he focuses mainly on analysis of the determinants and influences on competitiveness. Yet, as he makes clear, what actually matter over time are the determinants of *upgrading competitiveness* and of *innovation.* These determinants may be similar but they are not the same, and yet Porter only very briefly (1990, 560–61) looks at the determinants of upgrading and innovation.

Hence, in general terms, there is an argued need for greater detail about processes of innovation, learning and knowledge transfer, and about how relations between actors develop to facilitate these processes (Dayasindhu 2002; Wignaraja 2003). This requirement has at least two particular implications of relevance here.

First, in studying any IT sector, there is a need for greater detail on how IT firms upgrade and innovate. At present, at least in the software sector, there are still strong disagreements on this, with tactics lying on a continuum of perspectives from "software as art" to "software as science," which can prescribe tactics that range from "throw away the rulebook" (Patching and Chatham 2000) to the "by numbers" approach of techniques such as the capability maturity model.

Second, Porter does cover developing countries but, as he admits (1990, 675), focuses on those countries like Korea and Singapore that have already moved some way along the road to industrialization. The scope of enquiry needs to be broadened to cover the tactics used by firms in all developing countries. For those IT firms in contexts of very limited demand, these may have to include tactics of generating demand and diversifying into alternative businesses (Garcia-Murillo 2004).

The Local and the Global

Despite the fact that Porter roots his work explicitly within the context of internationalization, he has been criticized for his handling of this (e.g., Rugman 1992). Some of the criticisms can be deflected a little because of the way in which Porter deals with developing countries. Accusations that he focuses too exclusively on the domestic situation are addressed (albeit only once) by Porter's (1990, 146) acknowledgment that competition in international markets can substitute for absent domestic rivalry. Criticism that he sees inbound foreign direct investment as essentially a "bad thing" (Davies and Ellis 2000) is not borne out in Porter's analysis (1990, 678–80) of the role of foreign direct investment in developing countries, where his view is quite balanced and incorporates many potentially positive roles for multinationals. Other criticisms have also been slightly acknowledged: the 1990 framework treats domestic firms as those of the country of origin; later versions (e.g., Porter 2001, 2004) include subsidiaries of multinationals based in the country, and changes the notion from "local firms" to "locally-based firms."

Nevertheless, Porter's theory still struggles to deal with the international dimension of competitive advantage. In theoretical terms, we can see an unmistakable difficulty in dealing with multinationals in developing countries since they are all "bidomestic": being part of domestic industry in both their home and overseas location. In practical terms, it is international linkages—especially with markets and customers in the United States and, to a lesser extent, Europe—that have been a key factor underlying the Indian software industry's competitive advantage (Heeks and Nicholson 2004). Some aspects of these linkages—the importance of global demand and the catalytic role of Indian managers abroad—were levered into various categories of the diamond determinants discussed above. Other aspects, though, were not included in the understanding of competitive advantage: the broader role of the Indian diaspora, Indian investments overseas, and the building

of international trust and reputation both within specific client-developer relations and more broadly as a "brand image" of India as a software location.

Different authors have proposed different ways to deal with this shortcoming of Porter's theory. For example, Rugman and D'Cruz (1993) develop and apply a "double-diamond" model that they believe will work wonders by combining a relatively standard domestic diamond with an international one that considers input factors, demand and other linkages provided by international connections to the domestic sector. Other developments take this even further, seeking to move beyond the strong domestic emphasis of domestic models such as Porter's theory and related ideas such as business systems theory (Whitley 1992) and national innovation systems theory (Lundvall 1992). One example is global commodity chain theory, which offers a central focus on the institutions, relations, and processes of global connections (Gereffi et al. 1994).

However, such radical surgery seems unnecessary, even for the strongly globalized Indian software industry. Other studies of that industry suggest more modest amendments. Kapur and Ramamurti (2001) propose addition of "U.S. demand conditions" to sit alongside the weak interactions to domestic demand conditions. Heeks and Nicholson (2004) do not use Porter's model as their starting point, but their work can be read as just adding international demand/linkages to Porter's framework as a fifth determinant.

Overall Conclusions About Competitive Advantage Theory and Development Informatics

When questions arise about the IT sector in developing countries, then frameworks drawn from literature on competitiveness have a role to play. Specifically, this paper has made use of Porter's theory of competitive advantage and has shown it has a contribution to make in answering at least three types of research question:

- Is this sector competitive?
- Why is this sector competitive?
- What can be done to improve or continue this sector's competitiveness?

That contribution was demonstrated in relation to India's software sector; a sector that does have some particular features not found in most developing countries, such as its being a first-mover among "follower" nations, its strong export emphasis, and its relative competitive success. These features, however, do not make any great difference to the applicability of Porter's model, which has been used for analysis of software sectors in other developing countries (e.g., Quarshie 2002; UNCTAD 2004). Further work would be required for confirmation, but it is likely that the amendments to Porter's theory suggested in the previous section would also be valuable for analysis of competitive advantage in other IT sectors and in other developing countries.

Of course, there will be differences between countries. Analysis of the Indian case suggested that key sources of competitive advantage were: ever-improving advanced skills, rivalry, clustering, and government vision/policy. Only competitive analysis of other countries will show whether these apply elsewhere. In addition, given the relative lack of success of software industries in many other developing countries, the second question above might need to be amended to, "Why is this sector *not* competitive?" Alternatively, the recommended comparative approach could be used, amending the question to, "Why is country *X*'s IT sector less competitive than country *Y*'s?"

This paper has focused on application of competitive advantage theory to the software sector. However this theory will have broader value to development informatics research: it can be used, for example, to analyze any of the initially identified IT sectors: hardware, telecommunications, IT training, back-office processing, and other types of IT-enabled services. We can summarize other aspects of its applicability in development informatics research using Figure 10. This shows that competitive advantage theory will be most applicable to "upstream" research questions related to the development and production of ICTs, rather than to "downstream" issues of the technologies' diffusion, application, and impact. It also shows the theory is most applicable to research focused on individual economic sectors, with some application to nations or individual organizations, but little value to research taking a whole-world or individual-person perspective.

One can also note the different ways in which Porter's ideas can be applied. In this paper, we have demonstrated a fairly comprehensive approach that works through all elements of the theory and does not stray from the one theory, but there are other approaches. The advanced analysis used here provided additional insights into the value of clusters

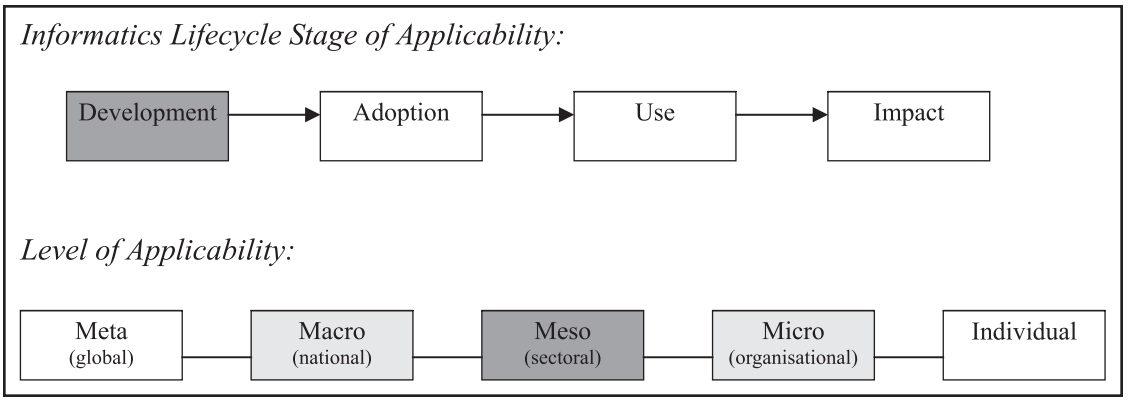

Figure 10. Applying competitive advantage theory in development informatics research.

and into a dynamic perspective that facilitated strategic prescriptions. However, just the basic "diamond" analysis can be used instead, for example, as the partial basis for a SWOT analysis or to provide the background or context to other types of strategic analysis.

In summary, then, Porter's theory of competitive advantage is a tool of demonstrated value to ICT4D researchers. It can be applied to research on any IT sector and to a variety of research questions about past, present, and future performance of that sector, including issues of poor performance, comparative performance, and strategic actions to improve performance. It does require some modifications to account for the specific realities of IT sectors in developing countries, but these do not undermine the central research value of the theory. ■

References

ACM. (2006). *Globalization and Offshoring of Software.* New York: Association for Computing Machinery. Available online at www.acm.org/ [accessed May 4, 2006].

Arora, A., and S. Athreye. (2002). "The Software Industry and India's Economic Development." *Information Economics and Policy,* 14, 253–73.

Arora, A., and A. Gambardella. (2004). "The Globalization of the Software Industry; Perspectives and Opportunities for Developed and Developing Countries." *Innovation Policy and the Economy* 5. Available online at www.nber.org/books/innovation5 [accessed November 10, 2005].

Arora, A., A. Gambardella, and S. Torrisi. (2001). "In the Footsteps of Silicon Valley? Indian and Irish Software in the International Division of Labour." Working paper no. 2001–12. Heinz School, Carnegie Mellon University, Pittsburgh.

Athreye, S. (2004). "Role of Transnational Corporations in the Evolution of a High-tech Industry: The Case of India's Software Industry." A comment. *World Development* 32(3): 555–60.

———. (2005). "The Indian Software Industry and Its Evolving Service Capability." *Industrial and Corporate Change* 14(3): 393–418.

Balasubramanyam, V. N., and A. Balasubramanyam. (1997). "International Trade in Services: The Case of India's Computer Software." *World Economy* 20(6): 829–43.

BLS (2006). *Computer Programmers.* Washington, DC: Bureau of Labor Statistics. Available online at www.bls.gov/oco/ocos110.htm [accessed May 4, 2006].

Buckley, P. J., C. L. Pass, and K. Prescott. (1988). "Measures of International Competitiveness: A Critical Survey." *Journal of Marketing Management* 4(2): 175–200.

Carmel, E. (2003a). "The New Software Exporting Nations: Impacts on National Well Being Resulting from their Software Exporting Industries." *Electronic Journal of Information Systems in Developing Countries* 13(3): 1–6.

———. (2003b). "The New Software Exporting Na-

tions: Success Factors." *Electronic Journal of Information Systems in Developing Countries* 13(4): 1–12.

CITGE. (2002). *IT in India: Tech Cluster Analysis.* Washington, DC: Center for IT and the Global Economy, American University. Available online at www.american.edu/academic.depts/ksb/citge/India%202.htm [accessed May 3, 2006].

Correa, C. (1996). "Strategies for Software Exports from Developing Countries." *World Development* 24(1): 171–82.

Das, G. (2006). "SW + Services Export. *Dataquest (India)* July. Available online at www.dqindia.com [accessed January 2, 2007].

Dataquest. (2001). "The DQ Top 20." *Dataquest (India)* August. Available online at www.dqindia.com [accessed May 2, 2006].

Davies, H., and P. Ellis. (2000). "Porter's *Competitive Advantage of Nations:* Time for the Final Judgement?" *Journal of Management Studies* 37(8): 1189–1213.

Dayasindhu, N. (2002). "Embeddedness, Knowledge Transfer, Industry Clusters and Global Competitiveness: A Case Study of the Indian Software Industry." *Technovation* 22: 551–60.

de Fontenay, C., and E. Carmel. (2003). "Israel's Silicon Wadi: The Forces behind Cluster Formation." In *Building High-Tech Clusters,* ed. T. Bresnahan and A. Gambardella, 40–77. Cambridge: Cambridge University Press.

DoC. (2004). *ExportITReport India.* Washington, DC: Department of Commerce. Available online at http://web.ita.doc.gov [accessed November 10, 2005].

DTI. (2004). *Sector Competitiveness Analysis of the Software and Computer Services Industry.* London: Department of Trade and Industry.

Field, T. (2001). "Hard Times." *CIO,* September 20.

Financial Times. (1989). "Software Sales Top $100bn a Year." February 22.

Garcia-Murillo, M. (2004). "Institutions and the Adoption of Electronic Commerce in Mexico." *Electronic Commerce Research* 4: 210–19.

Gereffi, G., M. Korzeniewicz, and R. P. Korzeniewicz. (1994). "Introduction: Global Commodity Chains." In *Commodity Chains and Global Capitalism,* ed. G. Gereffi & M. Korzeniewicz, 1–14. Westport, CT: Praeger.

Grant, R.M. (1991). "Porter's 'Competitive Advantage of Nations': An Assessment." *Strategic Management Journal* 12: 535–48.

Grundey, M., and R. B. Heeks. (1998). "Romania's Hardware and Software Industry: Building IT Policy and Capabilities in a Transitional Economy." IDPM Development Informatics working paper no. 2. University of Manchester, Manchester, UK.

Heeks, R.B. (1996). *India's Software Industry.* New Delhi: Sage.

———. (1999a). "The Uneven Profile of Indian Software Exports." *Networks and Communications Studies* 13(1–2): 197–221.

———. (1999b). "Software Strategies in Developing Countries." *Communications of the ACM* 42(6): 15–20.

———. (2002). "Information Systems and Developing Countries: Failure, Success and Local Improvisations." *Information Society* 18(2): 101–12.

———. (2004). "Facing In, Facing Out: Information Technology Production Policy in India from the 1960s to the 1990s." In *Information Technology Policy,* ed. R. Coopey, 276–303. Oxford: Oxford University Press.

———. (2006). *India's Software Industry.* Manchester: IDPM, University of Manchester. Available online at www.sed.manchester.ac.uk/idpm/research/is/isi/index.htm [accessed July 6, 2006].

Heeks, R. B., S. Krishna, B. Nicholson, and S. Sahay. (2001). "Synching or Sinking: Global Software Outsourcing Relationships." *IEEE Software* March/April: 54–61.

Heeks, R. B., and B. Nicholson. (2004). "Software Export Success Factors and Strategies in 'Follower' Nations." *Competition & Change* 8(3): 267–303.

IDA. (2005). *Annual Survey on Infocomm Industry for 2005.* Singapore: Infocomm Development Authority.

Kalvet, T., T. Pihi, and M. Tiits. (2002). *Analysis of*

the Estonian ICT Sector Innovation System. Tartu, Estonia: Archimedes Foundation.

Kambhampati, U. S. (2002). "The Software Industry and Development: The Case of India," *Progress in Development Studies* 2(1): 23–45.

Kapur, D., and J. McHale. (2005). "Sojourns and Software: Internationally Mobile Human Capital and High-Tech Industry Development in India, Ireland, and Israel." In *From Underdogs to Tigers,* ed. A. Arora and A. Gambardella, 236–74. Oxford: Oxford University Press.

Kapur, D., and R. Ramamurti. (2001). "India's Emerging Competitive Advantage in Services." *Academy of Management Executive* 15(2): 20–32.

KPMG/Nasscom. (2004). *Strengthening the Human Resource Foundation of the Indian IT-enabled Services/IT Industry.* New Delhi: Nasscom. Available at www.nasscom.org [accessed November 10, 2005].

Krishna, S., A. K. Ojha, and M. Barrett. (2000). "Competitive Advantage in the Software Industry: An Analysis of the Indian Experience." In *Information Technology in Context,* ed. C. Avgerou and G. Walsham, 182–97. Aldershot, UK: Ashgate.

Kublanov, E., and S. Satyaprasad. (2004). *Mapping Offshore Markets Update 2004.* San Ramon, CA: neoIT.

Kumar, N. (2001). "Indian Software Industry Development in International and National Development Perspective." RIS discussion paper no. 19. Research and Information System for the Non-aligned and Other Developing Countries, New Delhi.

Kyeong, M., and S. Ho. (1999). *National Competitiveness of Mobile Telecommunication Industry.* Seoul: Seoul National University. Available at http://sias.snu.ac.kr/ [accessed November 10, 2005].

Lall, S. (1987). *Learning to Industrialize.* Basingstoke, UK: Macmillan.

Lema, R., and B. Hesbjerg. (2003). *The Virtual Extension: A Search for Collective Efficiency in the Software Cluster in Bangalore.* Roskilde, Denmark: Roskilde University.

Lundvall, B.-A., ed. (1992). *National Systems of Innovation.* London: Pinter Publishers.

Ma, H. (1999). "Competitive Advantage as a Theoretical Construct: A Conceptual Assessment." *Journal of Global Competitiveness* 7(1): 1–8.

Menon, R. (2005). "Software Exports." *Dataquest (India).* August. Available at www.dqindia.com [accessed May 4, 2006].

Molla, A. (2000). "Downloading or Uploading? The Information Economy and Africa's Current Status." *Information Technology for Development* 9(3,4): 205–21.

Moon, H. C., A. M. Rugman, and A. Verbeke, (1998). "A Generalized Double Diamond Approach to the Global Competitiveness of Korea and Singapore." *International Business Review* 7: 135–50.

Nasscom. (2003). *The IT Industry in India.* New Delhi: Nasscom. Available at www.nasscom.org [accessed November 10, 2005].

———. (2004). *IT Software and Services Market.* New Delhi: Nasscom. Available at www.nasscom.org [accessed November 20, 2005].

neoIT. (2004). *Total Cost of Offshore (TCO).* San Ramon, CA: neoIT. Available at www.neoit.com [accessed May 4, 2006].

Nirjar, A., and A. Tylecote. (2005). "Breaking Out of Lock-In: Insights into Ways Up the Value Ladder for Indian Software SMEs." *Information Resources Management Journal* 18(4): 40–61.

OECD. (2004). *OECD Information Technology Outlook.* Paris: OECD.

O'Malley, E., and C. O'Gorman. (2001). "Competitive Advantage in the Irish Indigenous Software Industry and the Role of Inward Foreign Direct Investment." *European Planning Studies* 9(3): 303–21.

O'Toole, B. J. (1996). "Porter's Diamond and Its Relevance to Irish Trade." *Student Economic Review.* Available at http://www.tcd.ie/Economics/SER/archive/1996/BTOOLE.HTM [accessed May 4, 2006].

Patching, K., and R. Chatham. (2000). *Corporate*

Politics for IT Managers. Oxford: Butterworth-Heinemann.

Patibandla, M., and B. Petersen. (2002). "Role of Transnational Corporations in the Evolution of a High-Tech Industry: The Case of India's Software Industry." *World Development* 30(9): 1561–77.

Popper, K. (1959). *The Logic of Scientific Discovery.* London: Hutchinson.

Porter, M. E. (1985). *Competitive Advantage.* New York: Free Press.

———. (1990). *The Competitive Advantage of Nations.* London: Macmillan.

———. (2001). "How Government Matters: Influences on Prosperity, Competition, and Company Strategy." Paper presented at Academy of Management All-Academy Session, Washington, DC, August 6. Available at www.isc.hbs.edu/ [accessed May 5, 2006].

———. (2002). "Building the Microeconomic Foundations of Prosperity." In *Global Competitiveness Report 2002–3.* Geneva: World Economic Forum.

———. (2004). "Indian Competitiveness: Where Does the Nation Stand?" Paper presented at Mumbai, India, January 21. Available at www.isc.hbs.edu/ [accessed May 5, 2006].

Quarshie, M. (2002). *Building National Competitive Advantage in the Software and ICT Industry.* Accra, Ghana: Persol Systems.

Robb, D. (2000). "Offshore Outsourcing Nears Critical Mass." *Information Week* June 12.

Rugman, A. M. (1992). "Porter Takes a Wrong Turn." *Business Quarterly* 56(3): 59–64.

Rugman, A. M., and D'Cruz, J. R. (1993). "The Double Diamond Model of International Competitiveness." *Management International Review* 33(2): 17–39.

Sahay, S., B. Nicholson, and S. Krishna. (2003). *Global IT Outsourcing: Software Development Across Borders.* Cambridge: Cambridge University Press.

Saxenian, A. (2002). *Local and Global Networks of Immigrant Professionals in Silicon Valley,* San Francisco: Public Policy Institute of California.

Schware, R. (1992). "Software Industry Entry Strategies for Developing Countries." *World Development* 20(2): 143–64.

Singh, N. (2003). "India's Information Technology Sector: What Contribution to Broader Development?" Technical Paper no. 207, OECD Development Centre, Paris.

Tessler, S., and A. Barr. (1997). "Software R&D Strategies of Developing Countries." Paper presented at Council on Foreign Relations' Study Group on the Globalization of Industrial R&D, New York, January 9.

Tessler, S., A. Barr, and N. Hanna. (2003). "National Software Industry Development: Considerations for Government Planners." *Electronic Journal of Information Systems in Developing Countries* 13(10): 1–17.

Thirlwall, A. P. (2005). *Growth & Development,* 8th ed. Basingstoke, UK: Palgrave Macmillan.

UNCTAD. (2004). *E-Commerce and Development Report 2004.* New York: United Nations.

van den Bosch, F., and A.-P. de Man. (1994). "Government's Impact on the Business Environment and Strategic Management." *Journal of General Management* 19(3): 50–59.

Vedpuriswar, A. V., and N. V. Chowdary. (2001). "Building a Globally Competitive Software Industry." Unpublished paper, ICFAI Business School, Hyderabad. Available at http://ismindia.org/faculties/ved/bgc.html [accessed May 5, 2006].

WEF. (2004). *Global Competitiveness Report 2004–5.* Geneva: World Economic Forum.

Whitley, R. (1992). *Business Systems in East Asia.* London: Sage.

Wignaraja, G. (2003). "Competitiveness Analysis and Strategy." In *Competitiveness Strategy in Developing Countries,* ed. G. Wignaraja, 15–60. London: Routledge.

Wong, P.-K. (1998). "Leveraging the Global Information Revolution for Economic Development." *Information Systems Research* 9(4): 323–41.

Xi, X. (2004). *China's IT Market to Continue Strong Growth in the Next Five Years,* Washington, DC: U.S. Department of Commerce. Available at www.buyusainfo.net [accessed May 5, 2006].