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What explains the growth of a Software Industry in some Emerging Markets

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Introduction

The last twenty five years have seen an explosive growth in the software industry. From a rudimentary base in the 1970s, the global software market now exceeds $370 billion on a rising trend. In the USA, which has remained the leading country, their software sector accounts for nearly half of global sales, with Western Europe accounting for roughly a third. Despite setbacks associated with the post-2000 fallout from the collapse in equity values, particularly in the technology sector, software remains among the most rapidly growing industries in the OECD. Both packaged software and software services have likewise seen a growth in their share of aggregate IT sales.

One striking and, as yet, partially acknowledged phenomenon has been that the software industry has developed and expanded dramatically in a number of countries outside the core of the advanced economies of North America, Europe and Japan. The share of developing countries in the global software market has risen and now accounts for around 5 percent of sales [1]. A small number of developing countries have successfully developed their own software industries and have, in some cases, continued to strengthen the sector even post 2000. This growth in software activity has in part been attributable to the relatively low entry barriers operating in the industry, relatively high local human capital and strong cost advantages favouring developing countries. Software also has relatively low physical capital requirements – being mainly labour intensive - a feature that obviously plays to the advantage of developing countries. Even so, this has occurred despite the fact that the bulk of the developing economies that have seen strong software growth remain relatively rich in unskilled labour and at fairly low levels of aggregate development.

Clearly countries that may be poorly endowed with physical capital but have a significant stock of educated labour may pick to specialise in skill-intensive activity, rather than in the labour intensive production associated with abundant unskilled labour. However, for that to happen may also require supportive government policy to ensure that the high skill activity can get off the ground. For example, in the context of East Asia, Rodrik (1995) has argued that public interventions that raised educational levels and improved coordination supported, rather than replaced, the market and may have been key in allowing the shift toward higher skill activity. In the

case of software, human capital combined with the importance of efficient communications and information flows, is evident and a priori this is an area where it might reasonably be expected that the payoff to public actions could have been substantial.

Possibly the most striking case among developing countries has been India where the growth of a skilled labour-intensive software sector has been dramatic and where much of the growth has been generated by domestic rather than foreign firms. Over the 1990s the sector expanded at an average annual rate of over 40 percent. And although by 2000 the software sector only accounted for around 1 percent of national income and less than 0.5 percent of total urban employment, exports accounted for over 75 percent of sales and around 7 percent of the total value of Indian merchandise exports [2]. Further, export growth has remained strong at around 30 percent for 2002. This expansion has occurred in a period of economic liberalisation, but – it is important to note – one where trade restraints and limitations on competition have remained pervasive. Indeed, some commentators consider it to be an anomaly [3].

But India has not been alone. Brazil and China have seen sharp increases in growth for their software sectors and a steep rise in the skill content of output, if not necessarily of exports. In both instances, there has also been strong growth in IT manufacturing. In the Chinese case, in particular, their strength has principally been in hardware and manufacturing. Again, while liberalisation has been proceeding over the period in which such growth has been strongest, these local environments remain marked by substantial regulation and constraints on trade. Moreover, the fact that all these settings suffer from major deficiencies in the protection of intellectual property rights makes these changes all the more remarkable, given the danger that investors may have their ability to appropriate returns undermined by such deficiencies. And then there is the case of Israel. While hardly a developing country, Israel nevertheless provides some interesting lessons for developing countries that seek to raise the profile of their software - and more generally their high technology - sectors, not least through the mix of openness to external markets and ideas, as well as supportive public policy.

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[1] Note that trade in software tends to be significantly underestimated as, for example, it is commonly measured in terms of the value of supports , such as CDROMs, rather than content.
[2] Note that for the European Union software comprised around 0.07 percent of GDP: in the USA that share was just about 1 percent., see OECD (2002).

This paper provides an overview of these disparate developments and locations – Brazil, China, India and Israel. As will become clear, despite a common engagement with software, they remain very heterogeneous in their attributes, as well as in the local dynamics of the industry. The paper concentrates on trying to answer three important questions. Why is it that some developing countries have successfully spawned and sustained dynamic software industries? Is the industry likely to act as an engine for growth in these developing countries or is it likely to be a set of enclaves? Finally, what – if any – lessons concerning replicability do these examples hold for other developing countries?

The paper is organised as follows. Section 1 provides some basic information on the four countries that the paper covers. Section 2 contains an overview of what the software industry looks like in these different countries and any changes that have occurred over time. Section 3 looks at the locational features of the industry - in particular, the strong agglomeration that has occurred - and the degree to which it has induced spillovers to the rest of the economy. Section 4 then turns explicitly to the role of public policy in sponsoring or impeding the growth of the industry over the recent past. Section 5 is concerned with the important issue of the mobility of skilled software labour across borders and, in particular, looks at whether this constitutes a brain drain for developing countries. Section 6 concludes.

1. Country characteristics

Table 1 brings together some summary numbers for the four countries as well as for some advanced economy comparators. What is evident is that the four countries under review have some very different properties. In terms of income per capita and other indicators the distance between Israel and the advanced economies of Europe and North America is relatively slight. By contrast, Indian income per head (in purchasing power parity terms) remains under 7 percent of the USA level and China's income is only just over 11 percent. Brazil is an intermediate case. Two commonly used measures of human capital – gross tertiary enrolment rates and average years of schooling – similarly show wide divergences. In India and China enrolment rates are no greater than 6 percent, as against 50 percent in Israel and France, while average years of schooling are also notably lower than in the advanced countries or Israel.

[3] Hausmann and Rodrik (2002) who note low levels of IT penetration, obstructive government policies and

Turning to communications infrastructure – a key requirement for high technology industries and software, in particular - it is also evident that access to telephones and personal computers remains very restricted in Brazil, India and China. Indeed in India telephones and personal computers per thousand population remain as low as 32 and 4.5 respectively. And only between 0.5-3 percent of India, China and Brazil's populations respectively are internet users. However, in all these countries the share of ICT expenditure in GDP has risen and, for example, in the case of Brazil is now comparable to the advanced countries.

Table 2 now provides some basic information on the software economies in these countries. It can readily be seen that all have experienced very strong growth through the 1990s with, however, a significant deceleration after 2000. From a low base, Chinese software grew at over 65 percent per annum through the 1990s. Further, both Chinese and Indian software sales have continued to grow at over 20 percent after 2000. What also stands out is the particularly strong export profile of the Indian and Israeli software sectors. By 2001 nearly 80 percent of India's software sales were exports. By contrast, both Brazil and China have had very small export exposures and, at least in the case of Brazil, a relatively small change over the past decade.

In short, the software industry has expanded very rapidly from a low base in these four countries over the last decade. However, this growth has occurred in contexts (with the exception of Israel) where access to tertiary education has remained limited and where the aggregate level of human capital has not been high but where pockets of skills have formed. As the industry has grown, however, these localised skill–intensive places have in turn attracted in other skilled individuals, as well as expanding the local demand for skills acquisition and training. Later, the paper asks whether these pockets have in effect been successful enclaves with limited linkages back to the rest of the economy.

2. Industry attributes and evolution

The global software industry took off in the mid-1980s, initially in the developed countries with the provision of packaged software and, later, with a mix of systems, applications as well as increased demand for integrating software and solutions for larger firms. A distinction can also be drawn between customised

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a strong endowment in unskilled labour.

software and more generic products. The latter may, however include a fair share of customisation before they can be applied by an individual client. As such, the industry encompasses a variety of activities with very different relative profitabilities and levels of technical difficulty. A simple hierarchy of complexity would rank product development at the top, followed by development of packages, then customisation and finally, maintenance, coding and other more repetitive tasks [4]. For obvious reasons, product development generally requires strong intellectual property rights protection. Most of the major product space is occupied by firms operating in developed economies with just such protection and technological infrastructure. These various activities in return involve different levels of skills. At the top end of the skill distribution lie the conceptualisers. Programming, coding, testing and support activities are the realm of less skilled workers and this is naturally reflected in their wage differences [5].

In the case of the four countries, it is clear that very different niches have come to be occupied, although there is some evidence that over time firms have tried – but not always succeeded – in moving up the value chain. At risk of simplification, Israel has largely concentrated on products, nearly 40 percent of China's software output has been in products, while Brazil and India have concentrated more on services. In the Indian case, most of the firms have been involved in relatively less complex, relatively low skill activities such as coding, maintenance and other services. However, there is also additional evidence that some of the larger Indian software firms have been trying to diversify and develop on the product side, as well as offering solutions. The following sub-sections now try and provide an overview of developments in each of the four countries.

2.1 Brazil

The origins of the Brazilian software industry lie with the protection instituted by a nationalist, military government in the 1970s. While much of their focus was on hardware, an associated effect was the training of a labour force that was able later to provide the bedrock of the nascent software industry. This occurred when protection for the hardware sector was finally phased out in the early 1990s.

[4] See, for example, Yourdon (1992)

[5] A common ordering of activity has the following ranked categories; requirements analysis, high level design, low level design, coding, testing and post-production support.

Although the software sector remains small in terms of its contribution to output and employment (0.1 percent of formal employment), what has been striking in Brazil is that, firstly, the sector has largely developed for the domestic market and, second, that it remains quite heterogeneous in terms of skill content and firm organisation. Thus, most firms are small and involved in customised software development or packages, although there appears to be comparatively little specialisation. However, there are a number of major software ventures – mainly linked to the banking industry – which have developed highly complex software products. For example, Brazil remains something of a leader in offering Internet based banking and other forms of networked transactions. E-commerce has flourished despite some regulatory obstruction. The two major private banks – Itau and Bradesco – have operated successful, captive software development units. Interestingly - and in common with the rest of the sector – there has been little attempt to market these products beyond Brazil's borders and the industry as a whole remains almost exclusively devoted to the domestic market. Part of this can be attributed to language and other barriers, but also to apparent deficiencies in business strategies, including a weak client focus. In the domestic market, competition from foreign software companies in recent years has also increased, putting downward pressure on revenues. This has been exacerbated by the problem of lack of intellectual property rights. In short, Brazil has developed a widely networked economy, a hardware sector – albeit one increasingly dominated by foreign owned firms - but a relatively restricted software industry.

2.2 China

Chinese software grew very robustly in the 1990s but from a small base. The industry has the potentially important advantage of being located in an economy that has overall experienced substantial growth, including in the hardware and IT economy more generally. The software industry remains oriented almost entirely to the domestic economy with exports accounting for no more than 6 percent of sales. While foreign firms have entered and dominate the product market, over 60 percent of output is accounted for by services and this is where Chinese firms are dominant. However, there are a number of large and growing Chinese firms that concentrate mainly on products. As in Brazil – but here mainly due to the particularities of the local accounting system - Chinese firms have built an important niche in financial

software. The domestic industry remains highly fragmented with most firms small and involved in developing niche applications, such as systems integration, as well as adapting products to the Chinese language. The predominance of small firms can be related not only to the charcateristics of the financial sector but also to the relatively lack of integration between markets.

Preferential treatment – more than trade protection - has been an important factor behind the growth of the software industry. Government institutions have systematically favoured domestic software firms over foreign competition. Public resources have also been allocated by various layers of government to domestic firms in a conscious attempt to build local players. The inexact boundaries between public and private interests have also played a part. Given the size and role of government in China – including its role in granting licenses, permits and other requirements for business activity - the evidence suggests that private firms need commonly to cultivate and maintain close connections with public agencies and decision makers. Not surprisingly, this has tended to be associated with non-transparent decision making and allied inefficiencies. The same underlying weakness in the way decisions are made and the limited scope for judicial oversight has also been manifest in the pervasive presence of software piracy. As such, lack of adequate protection for intellectual property rights continues to be a major problem in China, particularly for firms offering products. This helps explain some of the changes in the structure of output - for example, the strong relative growth of system integration firms where piracy is less of a problem. Despite impressive growth, Chinese software still remains held back by the vestiges of the planned economy and its subsequent mutations.

2.3 India

The Indian software industry was originally largely oriented to the domestic market. A greater export orientation was initially helped by a shift in public policy, whereby import entitlements for hardware were made conditional on exports. Later, in the 1990s, both hardware and software imports were liberalised – as part of a wider abolition of import licensing for capital goods - and joint ventures were encouraged. At this time, the dominant players were spin-offs from established Indian businesses, but some of the new entrants were multinationals. In this phase, offshore development operations generating software for their own use were often established and this was helped by English being the common language. Innovations in communications, such

as the use of VSATs and better telecommunications, were critical in allowing greater decentralisation reducing the need for proximity between suppliers and users. Over time, there has also been a dramatic increase in out-sourcing of IT functions and tasks by firms in developed countries. The example of leading airlines outsourcing back-office functions to India is a case in point [6]. The use of outsourcing has been driven not simply by technical facility but by important cost differences. In the late 1990s Indian firms were pricing programming labour at roughly 20-30 percent of rates in either the USA or UK, although the cost differential was smaller for more skilled labour, particularly for on-site work . This cost advantage has been sustained post-2000.

While much of the initial growth in Indian software was relatively low value added – involving mostly on-site services, including sending workers abroad to work on-site on a temporary basis, a phenomenon widely known as 'body shopping' – there has subsequently been greater substitution of labour in India for labour on site. Clearly, knowledge of English was an important factor in enabling this cross border flow of labour. There has also been a clear attempt by firms since the mid 1990s onwards to try and operate further up the value chain. A number of the larger firms - NASSCOM estimates suggest that by the end of the 1990s the top 25 firms accounted for nearly 60 percent of exports - are now first tier contractors for software projects from customers in developed countries. Even so, the majority of Indian software exports comprise maintenance tasks, development of small applications and e-commerce solutions with projects being mostly small and technologically unsophisticated [7]. A number of the leading domestic players nevertheless have clear aspirations for entry into the more lucrative ERP and software development markets.

In conclusion, the Indian software industry remains a largely export oriented services sector. The industry has throughout retained very strong links to the North American market and hence to a powerful source of demand for services [8]. This link has been principally organised around India's advantage as a supplier of relatively low cost labour, rather than as a product competitor. However, labour productivity in India– as measured by software revenue per employee - though greatly superior to that in manufacturing, remains at under 10 percent of levels in either Israel or the

[6] Arora and Athreye (2002) find that 185 out of the Fortune 500 outsourced software production to India.
[7] Arora et al (2001)
[8] A point emphasised in Bresnahan, Gambardella and Saxenian (2001)

USA. Most of the services provided by Indian firms are still relatively unsophisticated and the share of solutions or products in total output is still small. Linkages between the export and domestic sectors remain limited. Deepening of the domestic economy will be desirable by producing more domain expertise and allow greater market diversification.

2.4 Israel

Israeli software took off in the 1990s, fuelled by a massive inflow of foreign direct investment and equity investment. The timing was not fortuitous: it required a prior stabilisation of the economy and a movement away from high and volatile inflation. At the same time, strong domestic demand for security software was key in giving the industry an initial impetus, often with a substantial public financing component. Over time, however, the growth of software sector was mainly driven by exports with bilateral and regional trade agreements enabling most of that trade to be with North America and Europe. While the performance of the sector was very strong, it is important to emphasise that this was part of a broader structural change in the economy. By 2000 information sectors accounted for nearly 15 percent of GDP.

A striking feature about the Israeli software industry is that it operates in a high number of technology niches with almost all firms being relatively high end players. Software applications are developed for a wide and diverse range of activities, including internet security and e-commerce, and most domestic markets remain strongly competitive. The strong export orientation of the sector has also been important in maintaining market-based discipline and incentives. The content of software exports has been quite varied - the largest shares have been for application development tools, middle- and serverware – but it has mostly been at the higher end of the product spectrum. In stark contrast to the Brazilian example, successful Israeli firms have placed a strong emphasis on marketing and attention to clients. With this strong export exposure Israeli software firms, not surprisingly, have been adversely affected by the global downturn in the industry.

Finally, an important stimulus to the sector was the large immigration of talent from the Former Soviet Union to Israel over this period. Aside from bringing appropriate skills to the sector, the enhanced supply of skills had beneficial effects on the domestic labour market, reducing upward wage and cost pressures.

2.5 Building reputation in export markets

In both the Indian and Israeli cases software exports have been an essential component. Both Brazilian and Chinese policy makers appear to place a strong emphasis on increasing exports, albeit with limited success, at least to date. This brings to the forefront the issue of how firms from emerging markets can effectively shift into export markets given lack of experience and reputation. Experience elsewhere also suggests that any shift from price to quality as the source of competitiveness involves significant changes in industrial organisation. It could be argued that for such a shift to occur larger firms may be better placed insofar as they firms could find it easier to deal with the important reputational issues associated with moving into high quality export markets. Indeed, there is some evidence from Korea and Taiwan suggest that scale may have helped in reducing negative reputational externalities, although small size did not impede Taiwanese firms entering high technology/high quality markets [9].

From the four countries covered in this project, the Indian and Israeli cases stand out as the ones that have had high export exposure. In the Indian case, a significant share of the activity has been in the type of work – customised software – where holdup could easily be prevalent and where the cumbrous and non-transparent Indian legal process would provide limited or non-existent remedy. So the obvious question to ask is; how have Indian software firms and their clients managed to circumvent or limit these tricky contracting problems?

For a start, there is clear evidence that many Indian firms have moved to getting quality certification, either ISO9001 or the Carnegie Mellon Capability Maturity Model (CMM) to signal quality to clients [10]. Indeed, certification is likely to become more important as Indian firms attempt to shift into higher end activity. It also seems to have been accompanied by a strong emphasis on the quality of processes of software development and methodology. There also appears to be some patterns with respect to pricing and contract design. Banerji and Duflo (2000) found that younger firms tended to use fixed price contracts. However, repeated association with a client was associated with greater use of cost plus or time and materials contracts. Indian firms in dealing with foreign clients also appear to have fairly

[9] Rodrik (1994)

scrupulously adhered to cost sharing on over-runs. As over-runs are common and significant, this latter aspect has been central to the accumulation of reputation. A complementary conjecture is that contracts have been conditioned on the type of work and its predictability in terms of labour input. The greater the predictability, the more contracts have largely involved specified payments for labour time. However, it is clear that by the end of the 1990s the larger Indian software firms – such as Infosys, Wipro and TCS – have managed to accumulate sufficient reputation for reliability and price advantage for firms in the advanced economies to trust them with complex and, often repeat, projects. As such, reputation has been accumulated by implementing repeated contracts for the same clients, with reputation and contract size positively correlated over time. These projects appear to have been mainly organised around cost-plus contracts. Margins have been materially affected by the slowdown in the industry.

3. Agglomeration & spillovers

The software industry has been characterised by significant spatial concentration. In India the great bulk of activity is concentrated in no more than five urban centres [11], in China agglomeration along the eastern coastline has occurred, while in Brazil over half the employment of the sector is concentrated in the southeast of the country, most particularly in and around Sao Paulo. More generally, the economic geography literature has argued that it is the combination of economies of scale and transaction costs that determine the level of concentration. The former are necessary for concentration to happen at all, the latter will limit concentration by raising the benefits to locating production close to demand. Software provides an interesting case in that the principal transaction costs – associated with use of telephone lines, satellites or Internet – have not necessarily been low but have still been associated with concentration. In India, for example, agglomeration has also been driven by the ways in which high transaction costs on account of infrastructural constraints have been dealt with. The establishment of software parks with dedicated access to VSATs was itself a powerful factor favouring agglomeration. Further, there is clear evidence that there are non-trivial spillovers between skilled workers –

[10] Arora and Asundi (1999)

through knowledge sharing, teamwork and the like - and that these features of the industry also raise the return to agglomeration.

It has been argued that software generates few linkages with other sectors in these emerging markets, although the demonstration effects may be far from trivial [12]. In India, for example, the sector is commonly held up as an example of good corporate governance and entrepreneurship. At the same time, the sector has been noted for changes to the internal organisation of firms that have placed less reliance on hierarchy and applied incentive wages to induce effort. These attributes can in part be attributed to the strong market discipline exercised on the sector on account of its predominant export focus. Foreign listing – principally on North American exchanges – has also been accompanied by use of GAAP accounting and other reporting rules. Further, the strong income effects of the industry in its main locations has provided a powerful stimulus to the growth of services and the housing sectors and this, in turn, has created employment opportunities for unskilled, as well as skilled, labour from neighbouring areas.

However, Patibandla and Petersen (2002) have also argued that multinationals operating in India – by bringing in differentiated inputs, technologies and working norms - have induced significant and positive spillovers, particularly at the higher end of the technology spectrum [13]. While this may be plausible, technology spillovers are always difficult to identify and their evidence is drawn from a very small sample of firms. Other work suggests that multinationals – including through work experience abroad - can play a positive role through training and improving the skills of managers [14].

A further possible channel for productivity gain is likely to be the reduction in technology mis-match. To the extent that the relative success of the sector has induced a clear outward shift in the demand for education, the increase in human capital would tend to raise skill levels allowing firms in emerging markets to match workers to new generation technologies more easily. Over time, this should lead to falling income

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[11] They are, Bangalore, Mumbai, Chennai, Hyderabad and Delhi

[12] As argued, for example, by Arora and Athreye (2002). Of course, the absence of backward linkages can be an advantage to the extent that the sector need not be pulled towards the mean through reliance on domestic inputs.

[13] The channels include demonstration effects, direct investments in local R&D and strong research and other links to universities and institutes in the region.

[14] Bresnahan, Gambardella and Saxenian (2001)

differentials across countries, although it might be expected to raise inequality within the country, as returns to the skilled increase.

What is clear, however, is that there have been major differences across countries in terms of the linkages – as principally determined by the rate of overall ICT diffusion - to other parts of the economy. In India, such inter-industry linkages remain attenuated on account of the generally low quality of infrastructure, including low access to telephony – mobile and fixed line –as well as problems with bandwidth, pricing and energy shortages. As such, domestic demand for software products remains very limited on account of the combination of income levels and other constraints, such as labour legislation, and the relatively slow and regionally patchy adoption of ICT by government and the public sector. Not surprisingly, links between work on export projects and on domestic work remain quite restricted. Indeed, what is striking is the effective segmentation of firms serving domestic and export sectors. Even so, as liberalisation of markets proceeds, there is evidence of wider restructuring in the economy, not least as the manufacturing sector adapts to an environment of greater competition. This should in due course raise the demand for software in the domestic economy. It is also likely to be aided by the investments in the sector made by incumbent industrial entities [15] .

In Brazil, China and Israel, government policy has been explicitly aimed at raising the networked level of the economy and encouraging wider ICT diffusion. In Brazil, ICT adoption is widely diffused, as exemplified by both the levels of e-commerce and the integration in industrial production, as well as the level of e-government, that have been attained. Certainly, this has been associated with increased local demand for software. In China important linkages have been established to finance and telecom sectors which have been the main sources of demand for software. This has been helped by active public promotion and financing of infrastructure. However, in both countries income barriers obviously remain significant at the level of households while organisational impediments, combined – in the cases of both Brazil and China – with deficiencies in the business environment, principally piracy, have come together to limit, in particular, the market for software products. This has meant that demand has largely been driven by government but this itself – as will be discussed in more detail in Section 4 below – has brought its own

[15] A point made by Arora and Athreye (2002)

problems, not least through a lack of transparency in the allocation of contracts. On the positive side, increasing linkages to local educational institutions and research laboratories have been evident in all the four countries, most particularly in Israel.

Finally, the 1990s boom in software clearly placed strong upward pressure on wages in the sector, particularly for the higher skill categories subject to a more inelastic supply and to poaching from abroad. This increased demand for skilled engineers does appear to have induced ripple effects to other industries through wage pressure, particularly in China and India and to a lesser extent elsewhere. However, this has subsequently been offset by the slowdown after 2000 so that wage emulation effects appear not to have been long lasting. In addition, given the high level of firm or process specific knowledge associated with the industry, high levels of turnover – including through migration – should have imposed a cost on firms. This is certainly a common perception in China, at least with regard to higher skilled software developers. There has also been much anecdotal discussion of turnover costs in the Indian context. Section 5 below takes this issue up in more detail, where empirical evidence actually suggests a relatively limited adverse impact on firms on account of increased turnover.

4. Role of public policy

In common with earlier East Asian experience, it appears that an absence of high and volatile inflation, alongside a stable exchange rate regime, have been critical ingredients in stimulating growth in the software economies of these four countries. Certainly, in both Brazil and Israel, it was only after successful macroeconomic stabilisation that investment began to pick up. But all have been characterised by persistent fiscal and quasi-fiscal problems and, particularly in the case of Brazil and China, by high levels of debt. In India and China, the continued presence of controls and restrictions remains quite pervasive, even if the software sector has been relatively unaffected. Certainly, an argument that these places have succeeded in developing a software economy simply by conforming to the so-called Washington Consensus would be highly misleading. In addition, other aspects of government policy have also been important.

Following Gerschenkron (1962), it has been common to emphasise the institutional dimensions behind episodes of accelerated development and, in particular, the case – or lack of it – for government intervention. Thus, it has been

widely argued that the East Asian growth spurt from the 1970s onwards was attributable not only to a rapid growth in investment but also the use of specific financing and coordinating mechanisms. These tended to favour concentration, economies of scale and long run relationships between financial institutions, firms and government. Some – such as Shleifer and Vishny (1998) - have argued that even if such interventionist policies succeed in raising investment they are likely to do so at significant cost and to have major dynamic disadvantages, not least the associated growth of vested interests and the crony relationships that, for example, became so powerful a feature in East Asia. Such interests may ultimately act to conserve inefficiencies and dull the ability of an economy to adapt [16]. Some of this longstanding debate has evident relevance for the software economy, not least because of the prolonged attempts of various governments to stimulate investment based growth through a mix of subsidies and competition reducing measures. However, the software example also highlights the apparent ability to shift into innovative, (near) cutting edge activity rather than simply strategies of imitation and this in itself raises a number of interesting questions.

The country studies highlight a number of areas in which public policy has been significant in either stimulating or retarding the software sector. They can broadly be grouped under three titles; (1) protection, subsidies, preferential finance and trades, (2) infrastructure – particularly communications - investment and, (3) investment in education and training.

4.1 Protectionism

All the four countries have pursued in one form or another protectionist policies that have had a significant bearing on the evolution of the industry. Such policies have comprised not only the erection of trade barriers but also the use of preferential fiscal and financial incentives to local firms. However, there have been major differences across countries.

In India, wider IT adoption was initially held back by the presence of embargos and protection of domestic hardware producers or assemblers. Such protection was reduced or eliminated in the 1980s giving an important fillip to the sector. Subsequent liberalisation further helped the sector shift from a supplier of

[16] See also, Acemoglu, Aghion and Zilibotti (2002)

labour to a complex constellation of domestic and foreign firms providing, for the most part, services to foreign clients. Of course, conventional trade restrictions would be difficult to implement for software exports once communications infrastructure was established. As such, both the Indian and Israeli cases appear to be a strong arguments for why trade liberalisation and an absence of non-transparent financing have been important in raising the longer run growth rate of the industry. However, in the Indian case, it is clear that the industry still faces major impediments to business – principally in terms of restrictive hiring and firing rules – and that the sector has been far from immune to the more general deficiencies in the overall business environment. As always, there are some important nuances to these arguments – notably the role of government as a provider of education and as a source of demand for products and services; of which more below.

By contrast, the origins of Brazilian software and the IT sector in general unequivocally lie back in a period of high protection and the so-called market reserve policies of the 1970/80s. While there is little doubt that this policy did not ultimately provide secure foundations for the domestic software industry, it did have a number of important consequences. In the first place, the IT sector as a whole remained very much domestic oriented, shielded as it was in part from competition. Once that protection was finally lifted in the 1990s, the market share of domestic producers declined substantially. More positively, the market reserve policy appears to have created a demand for IT related training and to an important increase on the supply of skilled personnel for the sector. Further, it led to a more general uptake in IT use and networked activity. In some sectors – such as banking – this was further stimulated by the challenge of managing assets under regimes of high and unstable inflation. Successive Brazilian governments since the 1970s have also pursued a policy of export promotion, using a mix of instruments, such as tax rebates and credit subsidies. More generally, this did lead to a tremendous increase in exports throughout the 1970s but a later export initiative particular to the software sector and focussed on products - SOFTEX (started in 1992) – has been generally unsuccessful. Further, as in India, employment in the sector has continued to be adversely affected by the presence of substantial payroll and other taxes that has effectively discriminated against sectors that are labour intensive.

The most pervasive and long lasting involvement of government has undoubtedly been in China. It was only in the 1980s that a partial liberalisation of the economy started and there is plenty of evidence that it remains incomplete. What is indeed striking is that while barriers to the entry of foreign firms have been progressively lifted, discretionary policies to raise the market share of local players has become a key feature of the Chinese software economy. Indeed, public policy explicitly sets up the objectives of building a domestic software industry to scale. This policy has manifested itself in a variety of forms, running from subsidised credits to both public and private firms (ownership boundaries remain blurred in many cases) to tax breaks, tariff exemptions for imports and incentives for exporters. And while the framework in which such incentives are allocated may not be consistent with WTO rules, they mark a clear shift away from earlier protectionist policies. What is far less clear – given the lack of transparency in both ownership and business practices – is the extent, let alone the consequences, of government preferences when granting licences and contracts. Certainly, there are explicit cases where domestic industry first policies have been pursued: the Beijing Government's purchase of local (Kingsoft) , as against Microsoft, software. The pervasive role of government and the public sector has contributed to restricting the range of firms and their competitiveness. The allied failure to safeguard intellectual property rights has undermined the willingness to try and innovate as well as more generally invest in the sector.

In short, in the early years of the industry protectionism has been important, particularly in Brazil and China. This has predictably skewed the sector toward a stronger focus on domestic markets. There appears to be little evidence that public enterprises have played an important role in raising returns to private investment by ensuring that key inputs were available locally for private producers downstream. As such, the gains from coordination that have been argued to be a feature of East Asia, do not appear to have been significant in the Chinese case. Further, whatever the exact mechanism for support, a key question concerns the ability of public agencies to reduce or eliminate support when appropriate, not least because of political economy considerations and rent seeking.

Public sector financing of the software industry has met with very mixed success. In Brazil, support has either proven to be too episodic or limited, while in China the principal problem remains a lack of transparency. The pervasive

interference of government in financing and other important commercial realms has contributed to the slow growth of alternative financing sources, such as venture capital, equity and bank finance. Bank finance has also been restrained by the common insistence on collateralisation. As such, much public funding has been ineffectual and ultimately wasteful in resources. In India – perhaps surprisingly – the software sector has not been the recipient of any direct large order public financing or allocation of discretionary resources. Some of the regional governments made land easily available for software parks, while in Bangalore, the relative ease by which property can be transacted has also been a further stimulus to the industry. Profits from exports across industry (not just for software) remained taxfree until 2000 – they are being phased out by 2005 - and this provided a further, powerful incentive for a strong external orientation.

One striking exception can be found in Israel where primarily through the use of matching funds programmes, public resources have been made available for high technology firms. Such resources have had enforceable repayment conditions attached. Other support to the industry has come through the timebound support for the creation of a venture capital industry. In this instance, an initial allocation of $100 million in 1992 under the Yozma programme was critical in jump-starting the domestic venture capital industry and enabled public resources to be withdrawn five years later. This appears to be a rare case of public funding being used for a specific objective over a limited time horizon. However, the Israeli venture capital industry has grown in tandem with a local capital market and on the back of offshore – principally North American - listings: a feature that is generally attenuated or missing in most developing countries, yet critical in providing effective exit from venture investments.

4.2 Infrastructure

Good communications are essential for the software industry. Yet, as the figures cited earlier in *Table 1* show, countries such as China and India have relatively low levels of telecommunications and other infrastructure when compared with developed countries and overall their economies remain weakly networked. However, such numbers disguise a number of salient features relevant to the industry. First, they disguise the substantial improvements in communications that were a pre-requisite for the industry to develop and subsequently expand. In this regard, there is

clear evidence that while secure, well priced and efficient communications have best been provided by the private sector – often following privatisation – the public sector has been able to provide significant infrastructural support to the industry. Second, they camouflage the fact that telecoms infrastructure looks significantly different and better in the main software locations than in the economy as a whole.

In the Indian case, the shortcomings of the state owned telecommunications system were effectively bypassed by the Government of India in 1991 through the creation of the Software Technology Park of India. Aside from providing specific locations for their business, these Parks were a way of circumventing the public sector's monopoly on telecommunication. VSATs could be located within these Parks and with them efficient and cost effective external communications links. Shortly thereafter firms located outside these Parks were also allowed access to the satellite connections, as well as the import of capital goods and inputs on a duty-free basis. Without these changes, the software industry would have been stillborn.

Of course, a more effective longer term solution would have been to privatise and allow new entrants to telecoms provision – as later happened – but at that time, this would likely have been a difficult political proposition. The Software Parks arrangement was an interim measure that was politically feasible, had the additional feature of encouraging greater spatial agglomeration in the industry and also facilitated the supply of complementary inputs, not least a reliable energy supply. The advent of the Internet, coupled to privatisation, subsequently improved access further.

Although a robust communications infrastructure in both Brazil and Israel has been very widely established, this alone has not been a sufficient recipe for rapid growth of the industry. It is interesting to note that in both places initiatives involving software parks or zones have been tried, albeit with different degrees of success. In Brazil, a government agency – SOFTEX – originally set up to raise software exports moved into sponsoring incubators and regional software nuclei. However, this does not appear to have been particularly successful. Certainly, most of the industry continues to be located in the South East of the country near the major sources of demand, while the incubator programmes run by SOFTEX have continued to suffer from weak market orientation and ability to launch viable projects. In Israel, numerous software parks have been set up by regional development authorities throughout the country, but these have never just housed software firms. It appears that while being of some importance in peripheral areas, such parks have not been a

central feature of the Israeli software industry. Interestingly, in 2001 the Chinese moved to consolidating a group of software centres with a view to giving them priority in the allocation of support services, finance and other inputs. It is too early to know whether these will effective mechanisms for coordinating support and realising gains from agglomeration.

4.3 Education

Common to Brazil, India and China is the large absolute number of educated workers. For while the share of the total labour force with tertiary education remains small - particularly in China and India - a rough estimate for India in the mid-1990s placed the number of scientists, technicians and engineers in India at over 170,000, while annual growth in the number of software professionals at end of the 1990s was estimated at around 67,000. The obvious questions are what factors account for the rate of enrolments and the extent to which this was dependent on public investments in education?

The answers are, predictably, far from formulaic. It is certainly the case that public resources have been critical in all countries in financing the tertiary sector. In Brazil, the years of protectionism were also ones in which significant resources were ploughed into higher education and training. The number of universities and course offerings increased and this has been maintained into the more recent period. At the same time, IT technical education has been increasingly provided at secondary or non-university levels and this has raised the effective supply of labour to the software sector, albeit at the lower end of the skill spectrum. The picture at postgraduate level is less positive. Relatively low exposure to education abroad and a weaker science orientation than for India or China has limited the availability of high end skills for the sector. In addition, while Brazilian universities – rather than firms - have tended to produce the major stream of R&D, much of this work has had limited market application while serious legal difficulties in assigning patent rules for work done in universities has also had adverse consequences for incentives.

The Indian example also speaks strongly to the initial importance of a high quality publicly funded educational system. Indeed, the role of Indian Institute of Technology graduates – primarily engineers – has been widely discussed. While a significant share of such graduates has been among skilled migrants to advanced economies – primarily the USA – this has often resulted in important and positive

gains in terms of networks, investment and establishment of commercial relationships with firms and individuals remaining in India. At the same time, education abroad, mainly in the USA, has also raised skill levels. Section 5 explores in more detail the various ways in which such a beneficial brain drain could have resulted, not least through the rapid growth in enrolments as individuals sought to acquire marketable skills.

Enrolments in software related training – principally engineering - rose dramatically as the sector expanded. Between 1992-2002 the number of Indian graduates trebled for engineering, IT degrees and diplomas. And it is here that in both India and Israel that some important innovations on the supply side were made in the 1990s. With the public system unable to provide a sufficient flow of skilled labour, private institutions were allowed to enter and offer training on a fee basis to applicants. Particularly in the south of India, there was a rapid growth in the share of engineering graduates coming out of self financed colleges [17]. These institutions have received notably lower subsidies than the state financed institutions. In addition, private firms have emerged to provide non-degree training. In India, the largest such provider – NIIT – established a strong market niche – often through franchising - in providing workers with basic coding and other skills. As such, innovative private sector training initiatives raised the supply of lower level skill groups while the public tertiary system and self financed colleges continued to provide a flow of graduates. At the height of the 1990s boom, the diversion of graduates, mainly engineers, into the software industry did indeed force up wages in other parts of the economy but these effects – not least after the 2000 slowdown – were not long lasting.

In Israel, the relatively high quality of public universities, the large resources channelled to R&D by the public sector – civil and military – was fused with the dismantling of the state monopoly on education and led not only to a proliferation of educational institutions but also to higher enrolment rates. Thus, between 1980-200 degrees conferred by private colleges jumped from under 5 percent to nearly a third of all first degrees granted. While the state kept tight control over accreditation, this liberalisation of the educational market, both domestically and to foreign institutions, was important in raising the supply of skilled labour. This – coupled with the large inflow of skilled workers from the Former Soviet Union – was central in ensuring that

[17] Arora and Athreye (2002)

skill shortages and wage pressure were not strong constraining factors. Training aboard by Israelis – particularly in the USA - has also been important in help build strong networks and links to best practice.

Although, the role of public institutions in education remains overwhelmingly dominant in China, the number of graduates who have studied abroad – and increasingly have returned – has grown substantially over the past decade. Furthermore, the blurred distinctions between public and private control have increasingly extended to the education sector and to the allocation of public resources. By the late 1990s the government was allocating resources for science and technology not just to universities but also to private firms, at the same time as controls over the selection or import of technology were being eroded. Even so, it appears that Chinese public universities have a rather weak record not only in R&D but also in taking innovations to the market. Further, its ability to provide an adequate supply of IT trained graduates and diploma holders has been restricted. Shortages exist at both high and low ends of the software skill distribution, leading – among other consequences – to private firms, such as India's NIIT and APTECH, beginning to offer training, as well as the selective use of migrant labour. At the same time, the evidence points to strong growth in enrolments in science and engineering degrees in the traditional universities.

In short, the software industries in these countries could not have got off the ground without a strong, prior set of investments in human capital. That investment was almost entirely made by the public sector. However, over time - and essential in ensuring that pervasive skill shortages did not emerge - governments have tended to reduce the barriers to entry for private suppliers of education, domestic and foreign. Such providers have increasingly operated over the full skills spectrum with some effectively internationalising their training programmes. At the same time, the acquisition of education abroad has become an important channel for skills and networks acquisition and knowledge transfer.

5. A conduit for brain drain from developing countries?

The software industry has been notable for the high degree of cross-border migration by skilled labour. In particular, the migration of talent to the USA – and especially Silicon Valley – has been widely cited. In addition, in the 1990s the rapid growth in customised software applications, involving greater on-site interaction

between supplier and customer, as also for turnkey projects, led to greater mobility of labour across borders including from developing countries [18]. These features have led many to question whether this is not an aggravated case of a brain drain from these emerging markets. By contrast, others have argued that due both to the nature of the industry and the often temporary nature of migration – as illustrated by the earlier widespread use of 'body shopping' from India - that this is more a case of 'brain circulation' than an example of brain drain [19].

In addition, a body of literature – largely analytical – has emerged in recent years which places emphasis on the possible demonstration effects that migration abroad may induce and, in particular, the impact on the demand for education [20]. The key argument is that if the possibility of emigration encourages more acquisition of skills than loss of skills, sending (or home) countries might increase their stocks of skills as opportunities to move or work abroad open up. If, in addition, this accumulation of skills has beneficial effects beyond the strictly private gains anticipated by those who acquire the skills, the whole economy can benefit; a beneficial brain drain, in short. For example, increased investment in human capital should raise skill levels in turn allowing firms to match workers to new generation technologies more easily. Certainly, anecdotal evidence from the software sector shows workers in developing countries working with very similar technologies as their counterparts in the advanced economies. Over time, this should reduce the productivity – and wage – gap between developing and developed countries. This, in turn, will lower income differences across countries, although within-country inequality in incomes may well rise.

In all these models, it is of course assumed that wages for given levels of skills are higher abroad than at home: a fact that is clearly true in the case of the software industry. For the beneficial brain-drain argument to go through, however, requires that the increased incentive to acquire education still results in some skilled workers remaining at home; only some fraction of those who acquire education can migrate abroad [21]. However, if the developed country or organisation can effectively screen

[18] For instance, at the top end of the skill chain network administrators in India cost roughly one third of their USA counterparts and the gap was very substantially higher for less skilled staff

[19] Saxenian (2001)

[20] For example, Mountford (1997); Beine et al (2000)

[21] A critical assumption is that the probability of migration is fixed and exogenously given for any individual aspiring to migrate. This implicitly arises because foreign firms cannot screen migrants to

migrants for ability, this will have an impact on the willingness to acquire education [22]. Indeed, a necessary criterion for a beneficial brain drain is that the marginal person in education has a positive probability of emigrating.

Although it is clear that developed countries cannot practice perfect screening of talent, the organisation of visa programmes – such as the USA's H1B visa and other similar initiatives in Canada, UK and other countries in Western Europe – indicates that such countries actively attempt to screen [23]. However, if the sending/developing country has some unexploited capacity for education, in the sense that the returns to education are primarily determined by the demand for skilled workers rather than the ability of the population, in this case even a perfectly screened emigration would generate net benefits. What empirical evidence exists that can throw some light on these issues and help sort out the net impact of skilled migration on the developing country?

Commander et al (2003) use evidence from a detailed firm level survey of 225 software firms in India to shine some light on a number of these issues. They find that there is evidence of both short and longer run migration of skilled Indians from software firms, particularly pre-2000. Clearly, the principal motivation for migration was generally perceived as being the wage advantage from moving abroad and, to a lesser extent, career opportunities. In response, the majority of firms in the sample had raised salary levels to try and retain workers. However, it is striking that only 15 percent of the firms that were interviewed considered that migration had imposed a major cost on their firms over the previous three years. Further, less than 10 percent of respondents thought that skilled migration had significantly affected their main activity. Indeed, over 60 percent of respondents thought that skilled migration had been of benefit to the Indian software industry and their firm, principally by allowing contact with cutting edge technology, changing working habits and providing access to new markets and customers.

The evidence from posted visa requirements and national policies certainly points to screening by the developed countries, with possible implications for the demand for education in the sending country. The presence of screening is further confirmed by evidence from sending firms. For those firms that had lost a high skill

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distinguish the able from the less able and it is this market failure that makes it possible for the brain-drain to be beneficial for the developing country.

[22] See Commander, Kangasniemi and Winters (2002) for a more detailed discussion

employee (conceptualiser) or manager abroad, between 7-22 percent ranked those employees that left as being in the top 1 percent of their employees respectively for conceptualizers and managers, while 51-58 percent put them in the top 10 percent respectively. One conjecture is that the loss of top talent to firms in developed countries might induce software firms in developing countries to choose to work lower down the value chain: this could in part explain, for example, why Indian firms concentrated on maintenance and legacy work. Further, high turnover of skilled workers could lead to firms making production and technology decisions that matched to skill levels with lower poaching probabilities. High poaching probabilities from foreign firms should make firms' unwilling to internalise training costs. Yet the survey suggests that neither has been the case. Indeed, to help reduce turnover over half the sampled firms had actually increased training for their workers.

Furthermore, even if the developed countries appear to be able to cherry pick, it is important to emphasise the positive impact on the demand for education. Educational enrolments have continued to grow significantly. As already mentioned, in India between 1992-2002 the number of graduates trebled for engineering, IT degrees and diplomas. Of course, it is problematic to infer that this was driven primarily by migration possibilities, but it seems very probable that this was one contributing element. And interestingly over 80 percent of the Indian software firms surveyed in 2003 noted that the skill level of the workforce had unequivocally increased over the previous five years. This can be attributed in part to the demonstration effect that resulted in shifting outwards the demand for education.

With respect to possible network effects linked to migration, about a quarter of firms had retained links with workers that had gone abroad, although there was little evidence from this sample of emigrants investing in firms at home. However, over 10 percent of respondents reported that emigrants or their firms were now customers of their firm, suggesting that commercial links could result.

In short, the migration of skilled labour from the software industry does not generally appear to have imposed a major cost on software firms in India. Indeed, the case which had many of the attributes of a classic brain drain was the migration of Jews from the Former Soviet Union to Israel in the 1980s and 1990s. While in the Indian case, it is true that the top part of the talent distribution appears to have moved

[23] OECD (2001)

permanently to advanced countries – principally the USA - this has not necessarily been the case for other skilled labour in the sector. Further, it is not obvious that the developing countries would have been able to match the top talent to appropriate jobs or activities at home. In addition, the severe slowdown in the industry post-2000 has actually resulted in a number of skilled migrants returning home. Finally, there is evidence that movement abroad has often been associated not only with remittances [24], but also with the establishment of business relationships and networks. These have generated positive results for the sending countries.

6. Conclusion

The software industry is still overwhelmingly dominated by firms from North America and Europe. But a number of emerging market firms have made significant headway in this market and in the current post-boom period have even consolidated their positions on account of major cost advantages. This paper has attempted to explain the factors behind these developments concentrating on the heterogeneous experience of four countries, Brazil, China, India and Israel.

What emerges is that software and emerging markets have come together for a variety of factors, not least the availability of relatively low cost skilled labour, low start-up costs and enabling infrastructural investments. Prior investment in educational services and infrastructure, often by the public sector, has been critical. The subsequent outward shift in the demand for education has, in turn, been best associated by an increasing mix in education provision with private suppliers playing a more important role. Measures to improve the quality of communications infrastructure by the public sector have been a powerful contributory factor, although greater private provision has been – and will be - critical in the longer run.

To date, the international division of labour that has been associated with the growth of IT and the software sector in particular has largely involved the developed countries concentrating on the higher value products and services, with firms from developing countries providing outsourcing and on-site labour services to firms from developed countries. India, for example, has strongly benefited from being closely linked to the North American market and firms. In addition, emerging market firms have provided software services, and to a far lesser extent, products and applications,

[24] A recent World Bank report notes that remittances to developing countries dwarf in scale other capital

in their domestic markets. With the exception of Israel, productivity levels in the industry have remained low compared to developed country firms. There are some signs that this is changing as developing country firms try and shift into higher end products [25]– including by establishing subsidiaries in developed country markets – but such changes have as yet not been that dramatic. However, software firms with significant exposure in export markets have had to place a major emphasis on quality control and reliability, as well as increasingly seeking certification, in order to build reputation and clients. There have been other allied changes. For example, Indian firms have begun to outsource to China signalling the advent of a more complex set of trading relationships.

The software industry has been generally characterised by its striking openness; openness to ideas, trade and labour flows. These have generally been powerful and positive features. Yet the greatly increased cross-border mobility of skilled labour from the sector has provoked fears that talent has been siphoned off from the developing to developed countries. But there are good grounds for scepticism. One feature that stands out – notably in the cases of China, India and Israel - is the importance of networks and, in particular, the commercial and other links associated with flows of humans across borders, as well as within countries. Links between diasporas and the originating country have been important – and are likely to remain important - through a variety of channels, including remittances, investment and enhanced knowledge flows. As such, the migration of skilled workers from the industry appears not to have constituted a classic brain drain, but one where the positive impact on the demand for education at home, as well as these network effects, has helped offset any loss of talent to the developed countries.

Can software act as an important engine of growth for the larger economy? Here, despite significant gains, there are reasons for being cautious. First, the industry rarely accounts for more than a small share of GDP – even in the USA, software accounts for no more than 1 percent. Second, high growth over the 1990s in these four countries has come from a shallow base. Third, the industry is generally very concentrated spatially and with limited inter-industry linkages. This can change over time but – in China and India, particularly – this will require further liberalisation and

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flows.

[25] Arora et al (2000) who cite figures for India showing that revenues per employee jumped by around two and a half times in dollar terms between 1993 and 1999.

changes to the business environment in the rest of the economy. Nevertheless, it is striking how rapid has been the growth of the sector – particularly in China - even when handicapped by such deficiencies. This may suggest that small improvements to the business environment will tend to be associated with substantial, further growth in activity. Already, through its ability to project good corporate governance, its lack of hierarchy and widespread use of motivating working practices and compensation schemes, the software industry has exerted a powerful demonstration effect on other sectors in these emerging market economies.

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TABLE 1 : COUNTRY CHARACTERISTICS

	BRAZIL	CHINA	INDIA	ISRAEL	USA	FRANCE
GDP and EDUCATION						
GDP per capita in 2000 (PPP$)	7300	3920	2400	19930	34100	24420
Education Gross Tertiary Enrolment rate (1998)	14	6	6	49	77	51
Average Years of Schooling (1999/2000)	4.9	6.4	5.1	9.6	12.0	
PC and INTERNET ACCESS (2000)						
PCs (per 1000)	44.1	15.9	4.5	253.6	585.2	304.3
Internet Users (% population)	3	2	0.5	20	34	15
Service Provider Charge ($)	22	7	10	11	5	20
Telephone User Charge ($)	0.90	0.14	0.18	0.18	3.50	0
ICT Expenditure to GDP	8.4	5.4	3.8	7.4	8.1	8.7
TELECOMMUNICATIONS (2000)						
Telephones (per 1000)	182	112	32	482	700	579
Mobile Phones (per 1000)	136	66	4	658	493	398
Cost of Local Calls ($ per 3 months)	0.03	0.00	0.01	0.05	0.00	0.10
Cost of Call to USA ($ per 3 minutes)	108	6.7	4.2	3.3	--	1.0

TABLE 2 : SOFTWARE INDUSTRY: DESCRIPTIVE STATISTICS

	Brazil	**China**	**India**	**Israel**
Total software sales 1991	$0.3bn	$0.06bn	$0.56bn*	$0.65bn
Total software sales 2001	$7.7bn	$9.1bn	$9.0bn	$7.1bn
Annualised growth rate 1991-2001	38.1%	65.0%	43.1%	29.9%
Growth rate 2000-2001	6.9%	26.4%	23.0%	12.7%
Export share 1991	-	n.a.	58.9%	42.3%
Export share 2001	2.0%	8.9%	79.0%	42.3%

* 1993 for India