Information technology, venture capital and the stock market

Ajit Singh and Alaka Singh and Bruce Wiesse

University of Cambridge, Lucy Cavendish College, University of Cambridge, Centre of Business Research, Judge Business School, University of Cambridge

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I. Introduction

This paper investigates the relationship between information technology and the capital markets. The central analytical and policy question addressed here is what kind of financial system or capital market arrangements are most conducive to fostering information technology and its use in the economy.

This question is closely related to an old debate about the relative virtues of the Anglo-Saxon financial system based on stock markets, and the German/Japanese bank-based financial model. Which system should developing countries attempt to emulate to foster their economic growth and technological development? This debate has recently taken a fresh turn with the apparent emergence of the "New Economy" in the U.S. The U.S. has not only experienced fast growth of ICT industries but there has also evidently been widespread successful adoption of ICT technology in many areas of the economy. It is suggested that a major reason for the U.S. lead in this area, and the apparent European and Japanese lag, has been the very important enabling and stimulating role of the stock market.

As Larry Summers, the U.S. Treasury Secretary, points out, "financial markets have played a central role, making available resources for guys who can raise a million dollars before they can buy their first suit." Similarly, Martin Feldstein, President of the National Bureau of Economic Research, suggests that "it may be that the nature of this technology is particularly favourable for the U.S., there are all kinds of facilitating characteristics here – the venture capital market, incentive-based rewards for managers."[1]

The critics of the stock market are not, however, entirely convinced by these arguments. They suggest the jury on this matter is still out. In their view, what the recent developments on the stock market indicate is, to the contrary, the market's periodic irrationality. It is impossible, in their view, to have a rational explanation for the astronomical price/earnings ratios of high technology firms that are not making any profits or distributing any dividends. In other words, the stock market critics regard the extremely high valuations of the dot.com companies during the period January 1996 to March 2000 as a classic bubble with potentially harmful consequences for the economy when the bubble bursts.[2]

Summers, who in the past was critical of the short-term focus of the U.S. stock market, now suggests that "increasing pressure for performance for shareholders" has played a crucial role. "I think our financial markets should get a lot of the credit for forcing money out of traditional management and entrenched corporations, and preventing what would have been negative internal rates of return on investments." He goes on to point out that the pace at which companies mature has greatly increased: "On conventional estimates it used to take five years to build a business to the point at which venture capital would be entering. Now it's less than a year."

However, in the view of the critics, the evolution of the stock market valuation of technology companies (the "New Economy") and "Old Economy" companies does not reveal a healthy situation. According to the Federal Reserve Bank of San Francisco, technology companies in the U.S. accounted for only 7% of total stock market value in 1990 but by March 2000 this share had risen to 36%, a fivefold increase. However, the share of employment accounted for by the technology companies rose from 6% in 1990 to only 9% in March 2000, while their share of sales increased from 6% to 10% in the same period. Even though technology companies had faster sales growth than old economy companies, the latter had faster earnings growth.[3] Evidently, the very high valuations given by the stock market to technology companies reflects investors' willingness to pay a premium for future growth opportunities. From the point of view of the economy as a whole, whether the implied diversion of resources from the old to the new economy will lead to a superior or worse allocation depends on the extent to which these valuations are justified by fundamentals.

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[1] All the quotations are from the *Financial Times*, "Winning ways: ready bucks and a flair for risk", 14 December 1999.

[2] Nasdaq rose faster than any other index between 1996 and spring 2000. However, the index has been unusually volatile during the millennium year 2000, in November 2000, the index fell below 3000, a value last reached in November 1999. These issues and their significance are discussed more fully in the following sections.

[3] FRBSF *Economic Letter*, Number 2000-15; May 12, 2000.

Although the U.S. is apparently the leader in information technology, notable progress has been made in this area by other industrial countries as well as by some developing countries. These countries have different financial institutions, different industrial structures and varying roles of the state in the economy. Such inter-country differences provide us with an opportunity to see to what extent variations in ICT development can be ascribed to differences in financial systems, controlling for other relevant variables.

The paper is organised as follows. Section II briefly considers the theoretical, conceptual and empirical issues concerning the relationship between technological development and the financial system. It reviews the new literature on the subject and assesses the controversy surrounding it. Section III provides a preliminary look at the empirical evidence with respect to stock market development and the development of ICT technology in various countries. The data pertain to 60 developed and developing countries in the 1990s. Section IV carries out a multivariate analysis of the determinants of ICT with particular reference to the role of stock market development. The central hypothesis tested is that the more fully developed and mature a stock market a country possesses, the faster, other things being equal, will be its development and use of information technology. In this analysis, four individual indicators of ICT development and one composite measure are used as dependent variables while three indicators of stock market development are used as independent variables together with relevant control variables. Section V considers the role of venture capital in ICT development as well as, importantly, the relationship between venture capital and stock market activity. It also comments on the significant role of the government in the financing of venture capital for ICT development in many developed as well as developing countries. Section VI examines the question of the optimal size of the firm in relation to ICT expansion. This section also outlines case studies of individual firms from both emerging markets and advanced economies. Section VII concludes and draws out the policy implications of the analysis.

II. Bank-based vs. Stock market-based financial systems and new technology{PRIVATE }

The relationship between the financial system and technological development has long been controversial. John Hicks (1969) argued on the basis of both economic history and theory that Britain's industrial revolution was only made possible by the development of financial institutions. The basic argument is that technology existed long before the industrial revolution but could not by itself generate sustained economic growth. The large-scale capital requirements of the industrial revolution could only be met by the development of capital market institutions that permitted the pooling of small individual savings into large funds for industrial development. An equally famous theorist, Joan Robinson, however, suggested that the causation is the other way around, finance follows where enterprise leads - in other words, financial institutions will spontaneously develop and evolve where there is a demand for capital. Technological and industrial development in this view is constrained by demand rather than by the supply of finance (Robinson, 1952).

More recently, following the development of endogenous growth models, formal models of finance and technological development have emerged in the neoclassical tradition. King and Levine (1993) suggest that risk diversification made possible by the development of stock markets positively aids innovation. Holding a diversified portfolio of new technological products reduces risk and leads to greater investment in new technology than would otherwise be the case.

As noted above, the apparently successful ICT revolution in the U.S. has brought to the fore again the old debate on the relative merits of the stock market-based (U.S., U.K.) versus bank-based (Germany, Japan) financial systems. A large literature until recently attributed the much greater success of countries like Germany and Japan in international markets to the superiority of the bank-based system which promoted close and long-term relationships between corporations and banks. These relationships enabled Japanese and German corporations to have a long-term investment perspective rather than being concerned overwhelmingly with the short-term profits expectations of market analysts. A large number of theoretical contributions modelled the short-termism of the stock market and its harmful consequences for the rate of investment, a variable critical to technological development (see Stein (1988,1989) and Singh (2000)). Under the leadership of Michael Porter, Harvard Business School carried out a large empirical study of the U.S. financial system. On the basis of the findings of this research, Porter (1992), summed up the situation as follows: “the change in nature of competition and the increasing pressure of globalization make investment the most critical determinant of competitive advantage … Yet the U.S. system of allocating investment capital both within and across companies is failing. This puts American companies at a serious disadvantage in global competition and ultimately threatens the long term growth of the U.S. economy.”[4]

The U.S. financial system and ICT: The pros

Today the table appears to have turned. The American financial system is now regarded as being particularly conducive to innovation, specifically in relation to ICT. The huge investments in new technology firms in the U.S., despite their zero or negative short-term profits, is an obvious refutation of the short-termism of the stock market. Further, there are theoretical models that indicate that stock markets may be better at choosing the technological winners than the bank-based systems (Allen, 1993). This is because it is argued that stock market prices reflect the collective judgement of the public compared with the decisions of a small banking committee or the loan officer in the bank-based system.

Other aspects of the American financial system which, it is thought, are highly suitable for information technology include the system of incentives, rewards and punishments. Specifically, it is suggested that the stock market-based U.S. financial system has enabled the widespread use of stock options as a means of payment to those who work for new technology companies. This helps to align the interest of the employees with those of shareholders leading both to greater social efficiency and greater reward for innovations. The latter derives in part from the existence of an exit mechanism which the U.S. financial system provides in the form of IPOs and take-overs. Both these avenues are thought to improve enormously the rewards for innovations (compared with other financial systems that do not have such

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[4] Porter (1992), p.65. This paper reports the findings of a large project sponsored by the Harvard Business School and the Council on Competitiveness, a project that included 18 research papers by 25 academic experts.

mechanisms).[5] Last, but not least, the take-over mechanism in the U.S. financial market which allows for hostile acquisitions is regarded as being particularly helpful in the selection process, i.e. in being able to discriminate between useful technologies which benefit society by increasing shareholder value and those which do not.

II The case against the U.S. financial system and ICT

In the introductory section we have outlined the merits of the U.S. financial system in fostering technological development, and specifically its role in relation to the adoption and spread of ICT. At the macroeconomic level, the U.S. has achieved a trend increase in productivity growth since 1995 which leading students of the subject attribute to the widespread usage of the new technology.[6] Initially there was some debate whether the observed increase was a cyclical or long-term phenomenon. With the passage of time this issue has been resolved and there is a broad consensus that the ‘new' economy does have a faster rate of long-term growth.

However, the debate is far from being over. This is because the precise links between the stock market and ICT diffusion are far from being obvious, particularly in view of the high volatility of stock market prices and the technological boom and bust, which have characterised the last 10 years of stock market history.

At an elementary analytical level, it may be observed that the merits of the stock market system in relation to technological development depend crucially on the nature of the stock market pricing process and actual prices which emerge from this process. If share prices always accurately and exclusively reflected the true long term expected profitability of firms, the case for the virtues of the stock market system will have a more solid basis. Orthodox financial economists believe this would indeed be the end result of a pricing process based on rational expectations of investors and that their similar beliefs about the future prospects of companies. Actual prices generated by such a process of buying and selling shares on the stock market will generate prices which obey the so-called efficient market hypothesis.

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[5] See Black and Gilson (1998). This issue is discussed further in Section V.

[6] The success of the ICT revolution in the US itself is not fully accepted by all analysts. Some regard the recent upsurge in US productivity growth as simply a cyclical phenomenon. However, it will be fair to say that increasingly it is being acknowledged that there has indeed been a trend rise in US productivity growth over the last five years and that it is largely due to the adoption of ICT by

However, the prices may well be generated by altogether different processes where investors base their decisions on irrational exuberance and are motivated by speculative profits. The basic mechanism of such an alternative pricing process is neatly described by Keynes's famous beauty contest analogy. Keynes (1936) observed in Chapter 12 of the *General Theory* that

> professional investment may be likened to those newspaper competitions in which the competitors have to pick out the six prettiest faces from a hundred photographs, the prize being awarded to the competitor whose choice most nearly corresponds to the average preferences of the competitors as a whole; so that each competitor has to pick, not those faces which he himself finds prettiest, but those which he thinks likeliest to catch the fancy of the other competitors, all of whom are looking at the problem from the same point of view. It is not the case of choosing those which, to the best of one's judgement, are really the prettiest, nor even those which average opinion genuinely thinks the prettiest. We have reached the third degree where we devote our intelligence to anticipating what average opinion expects the average opinion to be. And there are some I believe who practise the fourth, fifth and higher degrees. (Keynes, p.156)

Which of the above two views of the stock market pricing process is more accurate is therefore a crucial question. Not surprisingly, it is also a controversial one. In interpreting empirical evidence on this issue, Tobin (1984) makes a useful distinction between 'fundamental valuation efficiency' and 'information arbitrage efficiency'. When financial economists claim that stock prices are 'efficient' they are in fact referring to the latter concept of efficiency. This simply refers to the fact that all information is rapidly circulated in the market, any new information is more or less immediately discounted by market players so that no gains are to be made from any publicly available information. There is however no necessary correspondence between this information arbitrage efficiency and fundamental valuation efficiency, and it is the latter which is required if stock prices are to perform their task of efficiently allocating resources in the economy as a whole. There are a number of theoretical models as well as empirical evidence which suggests that share prices often depart from fundamentals, being influenced by whims, fads, fashions and irrational pessimism or exuberance.[7]

American enterprises. See further papers by Gordon (2000), Jorgensen et al (2000).

[7] See further Camerer (1989), Singh (1999), Shiller (2000), Shleifer (2000) and the *Journal of Economic Perspectives* special issue on 'bubbles', 1990.

In terms of this critical analysis, the nature of the relationship between the new economy and the stock market, rather than being regarded as a virtue of the American financial system in facilitating the arrival of the new economy, becomes, instead, a cause for concern. There is important evidence that suggests that technology stocks are grossly overpriced. Shiller (2000) has carefully constructed data on real price-earnings ratios in the U.S. economy over a long time period, from 1881 to 2000 (see Figure 1). During the present stock market boom that began in 1992 and gathered pace during the last five years, the average real price-earnings ratio reached a value of 44.3 in January 2000. This compares with a peak value of 32.6, the highest ever recorded before, reached in September 1929 on the eve of the Great Depression. After this peak, the S&P index fell by 80 per cent for the next three years and did not regain its 1929 value until 1958.

The unprecedented levels of price-earnings ratios for most of the 1990s are largely due to the stock market's very high valuation of the new economy stocks relative to that of the old economy. If Dow Jones is regarded as representing mainly the old economy and Nasdaq as the representative index for the new economy, the price-earnings ratio of the average new economy stock in April 2000 was 62 compared to 23 for the old economy.[8] This was so despite the fact that the Nasdaq index had fallen by about 15 per cent between March and April.

Most economists regard such valuations of technology stocks to be unrealistic and as representing a classic case of a stock market bubble. This is perhaps brought home more clearly by taking a closer look at some of the individual stocks rather than the market averages. Figure 2 provides data for the last ten years on share prices and profits of the foremost icon of the new economy, Amazon.com. The share price of the company has been rising rapidly while it has been making increasing losses in each successive year over the entire period. Another case that depicts even more vividly the irrational exuberance and speculative character of stock market prices for technology companies is that of a recent British IPO. The *Financial Times* (September 22, 2000) observes:

> It is often an amusing, if futile, exercise to read the 'investment considerations' section of a prospectus. In the case of Arc International, the customisable chip designer, this ran to nine pages and advised investors that the company had never

[8] Federal Reserve Bank of San Francisco (2000).

> made, and might never make, a profit; that if it did that profit might not be sustainable; that revenues were likely to be volatile, unpredictable and subject to factors outside the company's control; that all manner of dreadful things could happen that would have a material adverse effect on the company and its share price; and that anyone buying the shares would 'experience substantial and immediate dilution in the net tangible book value of their investment.
>
> Investors in technology stocks are made of stern enough stuff to set aside such dire warnings, and the falls in the sector since the bookbuilding exercise began two weeks earlier. Knowing what happened to other chip company flotations, they were not going to miss this one. The issue was a great success and yesterday the shares more than doubled in first dealings.

Shiller (2000) has rigorously considered a wide range of structural factors that could justify the present high price-earning ratios in terms of fundamentals. He specifically examines the role of the internet, the baby boom and other factors such as the decline of inflation and the growth of mutual funds and finds that none of them individually or collectively provides a satisfactory explanation for the observed rise in the average price-earnings ratio.

The prices of technological stocks, apart from being speculative, are also highly volatile. This is shown by a comparison of the standard deviation of Nasdaq indices with those of the Dow Jones, S&P 500, FT100 as well as the Nikkei indices (see Table 1). The volatility of Nasdaq is considerably higher than those of other index numbers reported in Table 1, except for Nikkei. Share price volatility is however a negative feature of stock markets for several reasons. First, it reduces the efficiency of the price signals in allocating investment resources. Secondly, it increases the riskiness of investments and may discourage risk-averse corporations from financing their growth by equity issues and indeed from seeking a stock market listing at all. Thirdly, at the macroeconomic level, a highly volatile stock market may lead to financial fragility for the whole economy (Singh 1995, 1999).

Share prices of dot-coms, the high technology companies, have been particularly volatile during the millennium year 2000. Since its peak in March 2000, the index had fallen by 45 per cent by the end of November, trading below 3000 for the first time since November 1999. By the end of October 2000 the index had fallen by 36% from its record high. The volatility of dot-com companies share prices and their rise and fall is best illustrated by considering cases of individual firms from various sectors of the technology market. The share prices of the leading e-commerce company Amazon.com fell from a high of $113 to $36 towards the end of October. The share prices of a flagship B2B company, VerticalNet, rose to $140 a share, but on 27th October, 2000 the share price had fallen to $25. The internet infrastructure company Nortel Networks has halved in value during this year. The ultimate blue chip of the technology world, Cisco Systems, has fallen by about 38 percent. [9]

A main issue is whether these sharp falls represent the final bursting of the technology bubble, or whether there is still some way to go before prices reach rock bottom. Opinions differ on this score. The stock market historian David Schwartz notes in the *Financial Times*[10] that the bursting of the bubble image of a stock market collapse of share prices is not accurate. He suggests that historical evidence is more in accord with the alternative analogy of a slowly leaking tyre – prices ultimately fall to very low levels but it may take a long time to reach that position. For example, the London stock market downturn of 1973-74 was a result of a number of separate 'waves', each one plunging prices even lower. This was the pattern of both the Wall Street)1929-32) and the Japanese (early-mid-19990s) downturns as well. Thus the complacent view that the technology stocks were overpriced and that since then the market has corrected the position may turn out to be incorrect. *The Economist* (November 25 2000) reports that the 20 most valuable technology, media and telecom (TMT) still have a price-earnings ratio of 55, down from 78 earlier in the year but still well above the long term median for the sector of 33. On the other hand, in the old economy, despite a smaller flow in the S&P index, the typical medium sized firm (market capitalisation of £450 m. - $ 8.6 b.) has a price-earnings ratio of 16 which is close to the historical median.

There is also a downside to the use of stock options as a means of payment to employees in the new economy. This negative feature is represented by the increased income inequality in the U.S. in the recent period. Although this rising income inequality may be attributed to a number of factors (e.g. globalisation, skill biased technology), the growing use of stock options has also been a contributing factor.

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[9] These data are from the International Herald Tribune, 30th October, 2000 in an article by David Ignatius.

[10] Financial Times, October 28, 2000.

This is particularly true in relation to the widening income gap between the top ten per cent and the median.[11]

It is significant that despite the large fall in share prices, particularly on Nasdaq the net sellers of shares have been experienced institutional investors. Individual investors are still continuing to invest in mutual funds and have not been scared away by the falling stock market prices. However if and when the small investors flee the market, the consequences for the economy could be quite serious. The U.S. may be lucky and achieve a soft landing, unlike the Japanese who got trapped in a prolonged period of slow growth following the end of the bubble in the late 1980s. However, many leading economists believe that there are such serious imbalances in the U.S. economy (e.g. the current account deficit, the negative savings of the private sector) that a soft landing may not be possible. There is a certain irony in the leading U.S. officials attributing the East Asian crisis in part to the absence of reliable price signals due to crony capitalism and the nature of the relation between government, corporations and banks in these countries. The above analysis indicates that the share prices in the new economy were distorted during the boom years, not due to government intervention but rather through the market processes themselves. These may also therefore not be a useful guide for resource allocation.

One of the claimed virtues for the U.S. financial system is the availability of the take-over mechanism and its absence in Germany and Japan. However, both analysis and evidence suggest that the stock market selection process in the real world is far from being efficient in the sense that it does not select for survival high performing firms and punish the poor performers. Evidence suggests that the selection in the market for corporate control takes place only to a limited extent on the basis of profitability and stock market valuation but mainly on the basis of size. A large but relatively unprofitable firm has a greater chance of survival than a small profitable company (Singh 1975, 1992; Meeks 1977 and Hughes 1991).

One issue which is raised by the extremely high valuation of the New Economy relative to the Old Economy stocks is that the market has supplied so much capital to new technology firms that they cannot use it productively in their own enterprises. To

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[11] See Singh and Dhumale (2000).

some extent it will be conspicuously consumed or fuel a take-over binge on the part of the New Economy firms, a good example being the takeover of Time Warner by America Online. Some may think that is as it should be – by this means the New Economy is able to increase the efficiency of the Old. However, it is far from certain that the managers of the New Economy firms will even know how to run Old Economy businesses, let alone enhance their efficiency. It is more than likely that the net effect of the New taking over the Old may be considerably negative for the economy as a whole.

To sum up, the theoretical case for a stock market economy as being particularly conducive to fostering technical change is far from being unequivocal. The analysis and evidence reviewed above suggests that the stock market based U.S. financial system has both positive and negative features in relation to promoting technological change. There is yet inadequate data to arrive at firm conclusions on this issue. However, the broad controversy over the question of the superiority of one financial system over the other cannot be based on the experience of the U.S. alone. It is necessary to consider other countries both with systems similar to those in the U.S. (such as the U.K., Canada, Australia, etc.) and those that possess markedly different systems (Japan, Germany, continental Europe). With respect to the policy question as to which advanced country system, if any, is more suitable for developing countries, it is also necessary to consider the actual experience of these countries so far. These quintessentially empirical questions are considered below on the basis of data for a large group of emerging and developed country markets.

III. Empirical evidence: A preliminary look

This section and the following one will empirically investigate the relationship between stock market development and the development and usage of ICT technology on the basis of data for a large number of developed and emerging market economies. The present section will provide a preliminary univariate and bivariate analysis of the data while Section V will carry out a multivariate analysis.

The full sample used in this survey contains observations from 63 developed and developing countries on fourteen variables. Three variables, averaged over the 1990-1995 period, relate to economic output and growth (GDP, GDP growth and GDP per capita); five variables, also averaged over the 1990-1995 period, relate to stock market development (market capitalisation, market capitalisation as a percent of GDP, value traded, the inverse of the turnover ratio, and the number of listed companies). ICT development and usage are represented by six variables that are taken from the late 1990s: mobile phones, personal computers, and internet hosts, respectively, per 1000 people; high technology exports as a percentage of manufacturing exports, scientists and engineers in R&D, and a composite index of ICT development and usage. A smaller sample of 33 advanced and emerging market economies, summarised in Tables 2 and 3, has also been included covering the same variables and time periods.

The variables relating to economic production and growth are of importance in unravelling the determinants of ICT development. It is clear that we would expect *a priori* that countries with higher levels of per capita GDP to have a higher degree of ICT development. Similarly, we might expect countries with a higher rate of GDP growth to have higher investment rates and thus, *ceteris paribus*, greater ICT development. We would also expect some disjuncture between the GDP per capita variable on the one hand and GDP growth on the other. Theory suggests that less developed countries further behind the technological frontier can achieve, *ceteris paribus*, higher growth rates than countries at the frontier since they can take technology "off the shelf" and dramatically improve their productivity and growth. At the frontier, countries are limited to more marginal improvements in technology that can generally be expected to have only smaller effects on the growth rate. The ICT "revolution" may have a greater effect on labour productivity in advanced countries but it remains to be seen how large this turns out to be.

Regarding the stock market data, empirical studies have shown that these indicators are the best for revealing the extent and depth of equity market development. Market capitalisation is the market value of all the companies traded on the stock exchange, while value traded is the total value of equities traded on the exchange in a given year. The turnover ratio combines both variables – it is defined as the ratio of value traded to market capitalisation – and thus provides a measure of liquidity in the market (please note that we have used the inverse turnover ratio in this paper, therefore the higher the value the lower the turnover and liquidity). It is claimed to be a more important variable than the market capitalisation to GDP ratio as a determinant of the level of development of the stock market since it measures the degree to which easy entry and exit from the market is possible. Given the greater sophistication of developed country markets and in particular their more efficient and streamlined order and payments systems, we would expect this variable to be negatively related to per capita GDP (that is, the inverse turnover ratio decreases – markets become more liquid – as per capita GDP increases). Market capitalisation as a percentage of GDP indicates the relative size of the stock market in relation to the national economy, but this variable is found to be a less reliable guide to the extent of stock market development than the turnover ratio (see Levine 1997). The number of listed companies is another indicator of stock market development and one that is particularly important in the context of ICT development since it gives an indication of the number of IPOs.

As noted above, the development and usage of ICT technology is reflected in a set of six variables. The first three variables capture the use of mobile phones, personal computers and internet hosts per 1000 people in the population. We would expect these variables to be highly correlated with GDP per capita. High technology exports as a percentage of manufacturing exports is a rough measure of the sophistication of the country's technological base. We would expect in general a positive – though not necessarily linear – relationship between high technology exports and per capita GDP. The relationship may not be exact because multinationals from OECD countries have significantly expanded their production platforms in emerging market economies (such as, for instance, Malaysia) from which they export to developed countries. The number of scientists and engineers in research and development also provides a measure of the sophistication of the country's technological base and can be viewed as an explanatory variable that helps determine the degree of ICT development.

The final variable, the "ISI score", is a composite index based on four broad categories measuring ICT infrastructure development and informational and social freedom compiled by the Information Society Index. Table 4 presents the 23 variables in the four main categories that comprise the index - computer, information, internet and social infrastructure. The broad scope of this composite variable make it an excellent measure of the relative standing of countries in ICT technology and thus an effective dependent variable with which to test the determinants of ICT development.

The data presented in Table 2 for the small sample of countries conforms to our expectations. It reveals the obvious differences in the median values of GDP and GDP per capita between developed and emerging market economies. It also indicates the far higher median growth rates of GDP in emerging markets over the 1990-1995 period (5.2% versus a median of 1.6% in developed countries). The data also indicate that the inverse turnover ratio is both higher (a median value of 3.5 for emerging markets versus 2.2 in developed markets) and more variable in emerging markets than in developed country stock markets. The median value, however, somewhat disguises the fact that many major emerging markets have very high trading values relative to market capitalisation and hence very liquid exchanges. Brazil, China, Korea, Malaysia, Thailand and Turkey each have (inverse) turnover ratios below the developed country median. The other variables exhibit the expected behaviour, with developed countries having higher median values for market capitalisation, market capitalisation as a share of GDP, value traded and the number of listed companies. It should be noted, however, that the values for developing countries exhibit a high degree of variability. For example, Chile, Jordan, Thailand and South Africa all have market capitalisation to GDP ratios far above the median developed country value. Malaysia had a ratio more than four times higher than the developed country median.[12] In terms of the number of listed companies, several countries had numbers above the median for developed countries. India was particularly noteworthy, having over nine times more listed companies than the developed country median.

The data presented in Table 3 reflect the development and usage of ICT technology in the small sample of countries. As expected, the results show a clear relation between ICT development and per capita GDP. The usage of mobile phones, personal computers and internet hosts are all substantially higher in developed countries. Similarly, the percentage of high technology exports in manufacturing trade and the number of scientists and engineers are significantly higher in developed countries. Not surprisingly, the composite ISI score – which measures the degree to which a country has developed ICT capabilities – reflects the global "digital divide" and is thus heavily weighted in favour of developed countries (a median value of 2815 versus 214 for emerging markets).

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[12] Note that this is an average of the 1990-1995 period – the period before the Asian financial crisis.

The same patterns can be seen in the summary of the findings for the full sample contained in Table 5. The division of the sample into four categories reveals the non-linear relationship between the growth rate of GDP and per capita GDP. Similarly, the ratio of high technology exports to manufacturing exports also shows a non-linear relationship, with "rich" countries having a higher percentage than "very rich" countries (a median value of 20% versus 16%) and "very poor" countries having a higher percentage than "poor" countries (a median value of 7% versus 4%). The inverse turnover ratio shows a clear negative relationship with per capita GDP – the higher the level of per capita GDP the more liquid the stock market. The ISI score is also strongly positively related to per capita GDP, rising from a median value of 923 for "very poor" countries to 4174 for "very rich" countries. The other variables related to stock market development and ICT development and usage are highly positively related to per capita GDP. Thus, in testing the hypothesis that the greater the development of a country's stock market the greater will be its ICT development – which will be carried out in the multivariate analysis in the next section - it is important to control for per capita GDP.

IV. Multivariate analysis

The informal bivariate analysis of the last section indicated that there is a close relationship between per capita income and most of the variables representing ICT development. There also seemed to be a generally positive relationship between per capita income and stock market variables.

Here we investigate the relationship between the variables measuring ICT development and those pertaining to stock market development by means of multivariate regression analysis. The latter controls for the effects of per capita GDP and economic growth. The following regression model was fitted to cross-sectional data from 63 countries including both emerging markets and developed economies. The choice of countries was dictated entirely by the availability of data.

$$\begin{aligned} \text{ICT development indicator} \quad = \; & \beta_1 \text{constant} \\ & + \beta_2 \text{ GDP growth rate} \\ & + \beta_3 \text{ GDP per capita} \\ & + \beta_4 \text{ number of scientists and engineers per 10,000} \\ & + \beta_5 \text{ stock market capitalisation ratio} \end{aligned}$$

+ β_6 reciprocal of the turnover ratio
+ β_7 number of listed companies
+ U random error term

This equation was fitted successively with each of the five indicators of ICT development as a dependent variable, i.e., (i) mobile phones per 1000 population; (ii) personal computers per 1000 population; (iii) internet hosts per 1000 population; (iv) high-technology exports as a per cent of manufacturing exports; and (v) ISI scores.

For each of these dependent variables, four regression equations were fitted - one with all the independent variables listed above and the three others, each successively keeping only one of the three stock market variables as an explanatory variable and dropping the other two. The reasons for adopting this procedure is that the three variables are correlated and it may be difficult to isolate the influence of each one when they are considered together in the same equation. Tables 6a-6e therefore report results on fitting twenty regression equations to the data.

Table 7 is a bi-product of the regression analysis and reports the zero order inter-correlation for all variables used in the analysis. The following notable points emerged from this table:

(i) there appears to be a relatively close positive relationship between four of the five dependent variables and per capita GDP. For example, the simple correlation coefficient between per capita incomes and personal computers per 1000 is 0.91, with mobile phones per 1000 is 0.68, with number of scientists and engineers per 10000 is 0.91, with the composite ICT index (see last row) it is 0.92. However, the correlation coefficients relating per capita GDP to high-tech exports is only 0.20.

(ii) the correlation coefficient between GDP per capita and the three stock market variables is small but has the expected sign in each case.

(iii) the relationship between the five dependent variables themselves is generally quite close, with the composite index ISI having a correlation coefficient of 0.96 with personal computer per 1000, 0.94 with scientists and engineers, 0.84 with mobile phones and 0.74 with internet hosts. However, the value of ‘r’ for the correlation between the ISI score and high-tech exports is only 0.22. The interrelationship among the three stock market variables is positive but small. Another notable feature of Table 7 is that it indicates generally a negative relationship between GDP growth and most of the other dependent as well as explanatory variables.

Turning to the results of the multivariate analysis reported in Tables 6a-6e. Consider first Table 6e where the dependent variable is the composite index of ICT development - ISI scores. The table shows a good fit for the regression model with an adjusted R^2 of 0.892. However, the only statistically significant variable at 5% levels or less is the 'scientists and engineers'. GDP per capita is significant at the 10% level. None of the stock market variables are significant and one of them (number of listed companies) has the wrong sign. The successive dropping of two of the three stock market variables in the other three equations reported in Tables 6a-6e does not alter this picture.

Overall, the results for Table 6a-6e reveal a broadly similar story. For some of the dependent variables, the stock market variables are indeed statistically significant but often have the wrong sign or changing values in alternative specifications of the equation. The most consistently significant variables with correct signs in the regression analysis as a whole for four of the five dependent variables is 'scientist and engineers' followed by 'GDP per capita'. However, for 'high-tech exports' as a dependent variable, two of the three stock market variables are statistically significant but the 'scientist and engineers' is not. This result is curious from an economic point of view as one would expect *a priori* 'scientists and engineers' to be a more important explanatory variable in this equation relative to the others. There are perhaps non-linearities in the data that are not being captured by the linear regression model.

Thus, the multivariate regression analysis carried out so far in this study does not suggest a robust relationship between stock market development and ICT development and usage.

V. Venture capital, stock market and bank-based systems and the government

The U.S. venture capital industry has rightly attracted a great deal of attention in the wake of the success of the new technology firms in that country. However, venture capital, although normally associated with stock markets, is not peculiar to stock-market-based systems. It is also found in bank-based systems and is at one level an age-old phenomenon: people with money providing finance to high risk businesses to gain large rewards when they back an enterprise that becomes subsequently successful. In modern parlance, the term “venture capital” normally describes equity investments in unquoted companies. In the U.K., continental Europe and much of the rest of the world, the term private equity is used synonymously with that of venture capital. In the U.S., venture capital usually refers to the provision of funds for younger, early stage and developing businesses, whereas private equity also includes the financing of leveraged management buyouts (MBOs) and buyins (MBIs) (BVCA, 27 January 2000). Therefore, statistics on venture capital comparing the U.S. to other economies are not always directly comparable.

The U.S. venture capital industry has expanded enormously in the last five years as there has been a share price boom for technology firms on the stock market. As Table 8 shows, U.S. venture capital investments have increased by a factor of four between 1995 and 1999. In 1999, according to the *Financial Times*, American venture capital funds raised $56 billion, whereas ten years earlier, in 1990, the amount raised was only $3 billion. In the first quarter of 2000, before the downturn in the Nasdaq, the venture capital funds invested $22.7 billion in start-ups, nearly four times the amount of $6.2 billion dollars in the first quarter of 1999. This amount is an understatement as it does not included money invested by wealthy individuals, the so-called “angels”, who are thought to have invested twice as much in start-ups in 1999 as the traditional venture capital firms. Although U.S. venture capital investments have been extremely volatile, often moving in line with the Nasdaq index, there has been a huge trend increase since the 1980s. There has been more venture capital investment in the last two years than in the previous twenty. An obvious question is why was there so little venture capital investment before the sudden boom of the last few years.

Nevertheless, it is important to keep a perspective here. Total investment by venture capital funds accounts for only a small part of the $1.2 trillion invested by American companies in gross non-residential investment. The European venture capital industry is much smaller in absolute size, but larger in relation to GDP. In absolute amounts, Manigart *et al*.(2000) report that investment by venture capitalists in the U.S. was larger than the combined total of venture capital investments in the U.K., France, the Netherlands and Belgium, while the amount invested by venture capitalists in the U.K.

was larger than the combined total of the other three. However, as a proportion of GDP, U.S. venture capital investment in 1995 was only 0.05% of GDP, compared with 0.06% in Belgium, 0.07% in France, 0.05% in the Netherlands and 0.31% in the U.K. Manigart *et al.* also suggest that the European venture capital industry invests much less in start-ups than American venture capitalists. Investment by existing businesses is preferred by European venture capital, with management buyouts representing nearly two-thirds of the figure invested in the U.K. The degree of state involvement in the provision of venture capital also distinguishes some European venture capital industries from their counterparts in the U.S. For example, an important feature of the Belgian industry is that the government-backed venture capital companies play a very important role.

Black and Gilson (1998) provide a detailed analysis of the differences between the U.S. and German venture capital industries. Their results are reported in Tables 9 and 10. A striking difference between the two countries in the sources of funds is that pension funds account for the bulk of venture capital resources in the U.S. whilst they contribute very little in Germany. Banks and insurance companies are more important in Germany relative to the U.S. In the U.S., government agencies did not contribute anything at all during the 1992-1995 period, while in Germany they contributed 8% of total venture capital funds. In terms of the nature of investment, the differences between the United States and Germany are very much like the differences noted above between the U.S. and other European countries: the U.S. venture capital funds invest more in seeds and start-ups than German venture capitalists. On the other hand, LBO acquisitions are much more important in Germany.

Black and Gilson argue that the venture capital industry is much more vibrant and successful in the U.S. compared to Japan, Germany and other continental European countries because of its critical link with the stock market through the exit mechanism of the IPO. This results in U.S. venture capitalists seeking to liquidate their portfolio company investments as soon as they can rather than investing, like German and Japanese banks, for the long term. Black and Gilson believe that the availability of an exit mechanism from a successful start-up through an IPO is crucial to American venture capital providers as it allows them to enter into implicit contracts with enterprises (concerning future control of start-up firms). No such implicit contracts are possible in bank-based systems. Black and Gilson's argument is of course totally plausible in a booming stock market. How credible it will be in conditions of falling stock market prices is a moot question.

The high growth, high risk firms, which normally disproportionately consist of high technology enterprises, of the kind financed by venture capital funds, have usually been funded by governments in many developing and developed countries. The East Asian developmental states have been prime examples of providing finance for such ventures. Through an active and interventionist industrial policy, the Korean government has obliged its firms to introduce new products and industrial processes through a mixture of carrots and sticks. However, it took the view that in the context of underdevelopment, such technical change is more likely to occur through the creation and expansion of large firms rather than through small start-ups. The Korean government effectively became a co-partner with these large enterprises (the *chaebol*) in financing high risk projects, effectively socialising the risks involved (see further Singh 1998). The Korean experience will become clearer when we discuss the case study of Samsung Industries in the next section.

The government of Israel has also encouraged technological development through direct aid to the venture capital industry. The state not only created the infrastructure - a high quality labour force - but also provided direct assistance for promoting technological change. In 1991 the government introduced a special program of "technological incubators" which provided prospective entrepreneurs with physical premises, financial resources, tools, professional guidance and administrative assistance. Enterprises under this scheme could receive 85 per cent of the approved budget subject to a maximum of $160,000. The money was, however, given for only two years after which the companies had to leave the incubator and become self-sustaining (UN, 1999, p. 214).

A similar scheme was implemented in France with the government creating twelve biotechnology incubators to commercialise research produced by government scientists. Government policies, often taking the form of direct assistance, have also played a major role in encouraging ICT development in Singapore and India. The Indian case is particularly interesting because despite very low per capita income and blanket import substitution policies, the country has managed to create a world class information technology industry. Tables 11 and 12 show the very fast development of the industry and its exports during the 1990s. Indian software exports rose from $128 million in 1991 to $2.9 billion in 1998-99 and are estimated to be on the order of $4 billion in 1999-2000. Some estimates project these exports to touch $50 billion in 2008 (Patibandla *et al.*, 2000). The industry has now reached a level of development where it is able to attract venture capital funds from abroad. Indian IT companies are able to have IPOs on the London Stock Exchange and on Nasdaq. The government helped the growth, development and maturing of the industry through a variety of channels, the most important of which were: (i) creation of highly trained quality manpower at elite technological institutions that the government had established; (ii) having a selective policy to utilise multinational investment and encouraging exports; (iii) the government provided finance, infrastructure, legal regulation and marketing assistance to start-up technology firms; and (iv) the government set up software technology parks in Bangalore and other Indian cities. One of the most successful companies in India, Infosys, was set up with seed capital provided by government financial institutions. The company had been refused funding by private banks and without government assistance it may not have started at all. More light will be shed on the Indian experience by an analysis of the optimal firm size for ICT development in the next section.

To sum up, venture capital, IPOs and the stock market are not the only way of promoting ICT development. Venture capital is perfectly compatible with bank based systems and, indeed, in the developing country context, the government itself may well be the best venture capitalist.

VI. New Technology and Large Firms

An important policy issue in developing countries is whether large or small firms are the principal agents of technical change. This issue is particularly significant in the context of information technology where it is generally believed that the best way of developing and spreading this technology is through small firms and enterprising individuals. Hence the emphasis on start ups, venture capital funds and incubators.

This portrayal of information technology is not, however, necessarily accurate in relation either to developing or developed countries. In both groups of countries there are many large firms which have been successful in ICT markets -- Samsung in Korea and Nokia in Finland immediately come to mind. The question of the appropriate scale of enterprise therefore requires further consideration.

We consider first the case of developing countries. In successful East Asian countries such as Korea, large firms have generally been regarded as the main agents of technical change (Amsden, 1989). This is ascribed to the fact that in late industrialising countries, the chief objective is not so much to foster new technology but to adapt existing technology obtained from abroad to national needs. In Korea the government of General Park, instead of relying on foreign multinationals for this purpose, decided to create huge domestic conglomerates, the *chaebol*. As noted above, it used a carrot and stick industrial policy to make them invest in new technologies and new products which would be competitive in international markets. The result is that the manufacturing industry of Korea displays one of the highest levels of market concentration anywhere – whether among developed or developing countries. The top 50 *chaebol* accounted for 15 per cent of the country's GDP in 1990. Among the largest 500 industrial companies in the world in 1990, there were 11 firms in Korea – the same number as in Switzerland. A United Nations report observes in relation to the industrial structure of Korea:

> Such a structure is the deliberate creation of the government, which utilises a highly interventionist strategy to push industry into large-scale, complex, technologically demanding activities while simultaneously restricting FDI inflows tightly to promote national ownership. It was deemed necessary to create enterprises of large sizes and diversity, and to undertake the risk inherent in launching investments in high-technology, high-skill activities that would remain competitive in world markets. The *chaebols* acted as representatives and spearheads of the government's strategy: they were supported by protection against imports and TNC entry, subsidised credit, procurement preferences and massive investments in education, infrastructure and a science and technology network (UN, 1993, p.43).

The *chaebol* have conspicuously succeeded in producing and exporting an ever increasing range of new products as well as in propagating deep technical change in the Korean economy.

Significantly, as indicated above, the conglomerate firms have not lagged behind in information technology. The Samsung *chaebol* is now the largest producer and exporter of Dynamic Random Access Memory (DRAM) microchips in the world. The role of the government in Samsung's success is noted by the World Bank, which does not usually favour direct government intervention in the economy, in the following terms:

> The government's Economic Development Board was a key player in Samsung's success. Government officials were keenly aware that the Republic of Korea could not rely on forever on low wage manufacturing. Just as the US had lost countless textile industry jobs to Korea, they reasoned, so Korea would one day find it could no longer compete for labour intensive manufacturing jobs with lower wage neighbours such as China and Indonesia. To prepare for that day, government officials, working with consultation with the private sector, developed incentives for new knowledge - and capital - intensive industry. Incentives varied widely and included the government's build industrial parks, subsidising utilities, giving tax rebates for exports, and making cheap loans for investment in new products. By 1980, urged forward by subsidies and incentives, Korean industry had moved into steel, ships, and even cars and was about to leap into world-class electronics.[13]

Samsung was established in 1969 and its major products range from home appliances to sophisticated telecommunications equipment. In 1998, semiconductors, video tape recorders, audio players and communication equipment accounted for 71 percent of the company's unconsolidated revenues; computer and monitors constituted another 18 percent and home appliances the remaining 11 percent. Samsung is the world's largest semiconductor maker, the fourth largest mobile handset maker and the largest producer of thin film transistor liquid crystal displays. Samsung now accounts for 13 percent of the entire Korean stock market and attracts a large number of foreign investors. Recently, the share price has fallen sharply by 58 percent from its peak in mid-July owing to a selling of shares in leading chip-makers. Nevertheless, Samsung is expected to report record profits of 6,000 billion won this year against 3,600 billion in 1999. The fall in Samsung's share price has undermined the whole Korean market and is a cause of serious concern to the authorities.

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[13] World Bank (1993).

Other developing countries, such as India, have also found that in order to compete in international markets and to export IT products, it is necessary to have large firms. The exports of small software companies are no more than "body-shopping" - engaging in low value-added data and code entry – for U.S. firms (Parthasarathi 2000) Only large firms are able to export high value-added IT products which is what is needed to maintain the dynamism in international competiveness of the industry.
As Table 11 indicates, software exports have become increasingly important to the Indian economy as they increased more than five-fold during the 1995-1999 period and this rapid growth is forecast to continue. There were 716 companies involved in software exports but, as in other industries, the size distribution of export firms is highly skewed. The largest company, Tata Consultancy Services, an off-shoot of one of India's old economy's leading corporations, the Tata Group, alone accounts for 15 per cent of India's total software exports. The top ten software exporters include Wipro, Infosys, NIIT and Satyam Computer Services and account for nearly half of the exports. The top 25 account for 63 per cent of total exports of the sector.

As in the case with Tata, most of these indigenous software companies have emerged from existing Indian industrial groups. However, the list of the top 25 exporters also includes foreign joint-ventures and 'captive' companies e.g. IBM Global Services, Mahindra British Telecom and Hewlett Packard India.

Similarly, in advanced countries large firms are often at the cutting edge of the new technology revolution, particularly in Europe. Large firms such as Nokia in Finland, Ericsson in Sweden, and Intel and Motorola in the United States are outstanding examples.

The prevalence and success of large corporations in the ICT market contradicts the widely held view that the new technological revolution is fuelled most effectively by small, entrepreneurial firms. By extension, it also questions the assumption of many policymakers that the best way to jump-start ICT development is through incubators and start-ups. In this context we will briefly consider the case of Nokia. Following the collapse of its business with the former Soviet Union in the late 1980s, Nokia, a large and old Finnish company, decided to concentrate on producing mobile phones. It turned out to be a fortuitous decision since the market for mobile phones has exploded in the 1990s and Nokia has succeeded in capturing a growing share of this market (Nokia held 22.1% of world handset production in 1995 and today accounts for 32%). For the last eight years Nokia has been among the fastest growing companies in Europe and this growth has been, in contrast to other rapidly-growing companies such as the British telecoms firm Vodafone, organic, i.e. not based on acquisitions. Today, the company accounts for a quarter of Finland's exports and nearly four percent of its GDP. Its research division employs 13,000 workers.

The reason why large companies tend to be significant in ICT activities is that information technology encompasses industries such as mobile phones and computers as well as software and the internet. The former two industries are quintessentially old-economy type industries with huge old-fashioned economies of scale. For this segment of ICT, the venture capital model and the small entrepreneur may not be the most appropriate method for fostering rapid expansion. Successful ICT development in these areas may require long-term relationships between finance and industry rather than the greater uncertainties and instabilities inherent in the stock market and IPO system.

Nevertheless, it may seem that at least in software and internet applications the small firm and the small entrepreneur will be able to hold his own. Indeed, recent examples of small IT companies being able to attract huge amounts of capital and being able to overtake much larger (in terms of net assets) old-economy companies tend to confirm this impression. But here again we need to pause. Analysts point out that in e-commerce there are huge economies of scale and scope deriving from concentration of advertising and brand names. The Internet Advertising Bureau reveals that 71 percent of US dotcom advertising revenue are going to the top 10 sites, 83 percent to the top 25 and 91 percent to the top 50 sites. According to one internet analyst, the internet will end up as just an alternative channel of distribution for 'real' corporations, because they have the brands, the infrastructure, the expertise, the customers, the financial resources and all the other things dotcoms lack. Some argue that what we have seen – the rise and fall of dotcoms in the last three years – is a temporary phenomenon which is not going to effect the long term prospects of the dominant old-economy companies which did not get involved.

> The fact that most of these corporations did not move fast enough to position themselves for the internet, is irrelevant, because they now have a second bite at the apple… it's make versus buy - either they can buy a truly troubled dotcom operation at a very depressed price, or they can build it themselves. But most corporations have lost nothing by not becoming a force on the internet three years ago. (*Financial Times*, "Dotcoms devoured", October 23, 2000)

Industrial economists have observed that in a large number of industries, the industry generally starts out with many small firms but ends with a small number of stable oligopolistic firms. For example, in the US, the second industrial revolution during the last decade of the 19th century lead to the development of the railways network, spawning hundreds of railroad companies but, today there are only a handful of railroads in the US. It is arguable that the internet too is moving in the same direction. When the dust settles down we may be faced with a few giant internet companies dominating the world market.

VII. Conclusion

This paper has suggested that stock markets are neither a necessary nor sufficient condition for promoting the development of ICT. Many countries, particularly in Northern Europe but also elsewhere, have been able to achieve a high degree of ICT development without a central role for venture capital, IPOs and stock markets. Other countries, such as Britain which have flourishing stock markets, have failed to become leaders in ICT development. Econometric analysis did not reveal any robust systematic relationship between indicators of stock market development and those of ICT development.

Even in relation to the U.S. where stock markets have been helpful in the diffusion of ICT in the economy, the markets are not without considerable downsides. Specifically, the extremely high price earning ratios of technology companies between 1996 and January 2000, compared with any previous period in stock market history, raise the spectre of these valuations representing a speculative bubble. Even after a 45 per cent fall in the Nasdaq index since March 2000, many firms will still be over-priced. However, a further deflation may not turn out to be as benign for the US and the world economy as the fall in share prices during the last nine months. The deflation of this bubble could have serious implications for the U.S. as well as the world economy.

There is, however, another very important negative feature of stock market-based ICT development to which its enthusiasts do not pay sufficient attention, that is, the whole question of the digital divide. The availability of venture capital, IPOs and stock options no doubt create powerful incentives for budding entrepreneurs, but it also creates a "winner-takes-all" culture and contributes towards increasing social and economic disparity. The digital divide is not just a North-South phenomenon but also very much a within-U.S. phenomenon as well, as the following suggests.

A study produced by the U.S. Department of Commerce detailed the growing digital divide in the U.S. between different classes and ethnic groups. The survey found that people with a college degree were eight times more likely to have a PC at home and 16 times more likely to have internet access at home than people with an elementary school education. Similar divides were found between high income households in urban areas and rural, low-income households in rural areas; white low-income families and minority low-income families and between disabled people and people without disabilities. Thus, although internet access has increased across all demographic groups, the digital divide has mirrored persistent social and economic inequalities in the country.

The Economist notes "it would be hard to find a better real-life symbol for the digital divide than the gulf between Silicon Valley's leafy Palo Alto, home to dot.com millionaires where the average house sells for nearly $700,000, and East Palo Alto, the desperate little town on the other side of Highway 101 that not long ago claimed America's highest murder rate."[14] Thus, contrary to the claims of IT enthusiasts that the new technology is a great equaliser, it seems that by itself it perpetuates disparity if not to worsen it. These disparities can only be addressed by the government. It is not, therefore, surprising that in the absence of government intervention citizens groups in the San Francisco and Silicon Valley area have been promoting ballots to stop any further location of dotcom companies in their districts. It is not IT *per se* that creates the digital divide but rather the nature of social limits which are imposed on it which lead to greater or smaller disparities. It is significant that North European

[14] Economist, 24 June 2000, p. 22.

countries like Sweden and Finland, where there has been an equally strong development of IT, have not experienced the same kind of social divisions as the U.S.[15]

[15] The United Nations Human Development Report 2000 shows that in terms of human poverty index Finland and Sweden rank much higher than the United States or the UK. This index is based on probability at birth of not surviving to age60, adult functional illiteracy rate, percentage of people living below the income poverty line (50% of median disposable household income), and long-term unemployment rate (12 months or more)

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Table 4. Variables included in the ISI composite index

Computer Infrastructure	Information infrastructure	Internet Infrastructure	Social infrastructure
• PCs installed per capita • Home PCs shipped per household • Government and commercial PCs shipped per non-agricultural workforce • Educational PCs shipped per student and faculty • Percent of non-home networked PCs • Software vs. hardware spending	• Cable subscribers per capita • Cellular phone ownership per capita • Cost for phone call • Fax ownership per capita • Radio ownership per capita • Telephone line error rates • Telephone lines per household • TV ownership per capita	• Business Internet users per non-agricultural workforce • Home Internet users per household • Education Internet users per student and faculty • ECommerce spending per total Internet users	• Civil liberties • Newspaper readership per capita • Press freedom • Secondary school enrolment • Tertiary school enrolment

Source: ISI website at http://www.worldpaper.com