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The Economics of ICTs and Global Inequality: *Convergence or Divergence for Developing Countries?*

RICHARD HEEKS & CHARLES KENNY

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Institute for Development Policy and Management
University of Manchester, Arthur Lewis Building, Manchester, M13 9PL, UK
Tel: +44-161-275-2800/2804 Email: idpm@manchester.ac.uk
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Richard Heeks[1] & Charles Kenny[2]
2002

Abstract

> "The potential of the modern information age seems overshadowed at every turn by the ancient forces that separate the rich from the poor." (Dertouzos 1999)

If debate on ICTs and development has drawn from any discipline, it has tended to be sociology. This paper attempts to broaden the debate by drawing on economic evidence to ask: will ICTs support economic convergence or divergence between developing and industrialised countries?

In an overall sense, technology is fundamental to development. However, ICTs – while having an uncertain impact on growth – are currently a force for global economic divergence rather than convergence. They diffuse more slowly in developing countries than industrialised countries, and they bring fewer benefits and greater costs to developing countries than industrialised countries.

This does not present an argument against adoption of ICTs by developing countries. Rather, it presents an argument for focus on particular applications and investment priorities.

[1] Corresponding author. Development Informatics Group, IDPM, University of Manchester, UK. Email: richard.heeks@manchester.ac.uk
[2] World Bank, Washington, DC, USA. The views expressed in this paper do not necessarily represent the views of the World Bank.

Introduction

Internet-fuelled developments in information and communication technologies (ICTs) have swept through the business world on a wave of great promise. From the business epicentre, ripples are now spreading through the development community:

> "Governments, donors and development organisations are rushing to realise the benefits that Internet access promises in the fight against poverty." (Panos 1998:11)

All major governments and donors have now incorporated explicit ICT elements into their aid programmes. These programmes typically present a largely positive and techno-centric view of ICT impacts (e.g. Malloch-Brown 2000), spearheaded by the G8-inspired DOTForce:

> "ICTs offer enormous opportunities to narrow social and economic inequalities and support sustainable local wealth creation, and thus help to achieve the broader development goals that the international community has set." (DOTForce 2001:3)

This paper tests some of these bold claims by focusing on the issue of inequality – of convergence and divergence – between nations; specifically between industrialised OECD countries and developing countries (DCs). In Section A, it argues that ICTs are diffusing – and will continue to diffuse – more slowly in developing than industrialised economies. In Section B, it argues that there is an inequality of ICT-related impacts. Developing countries are more likely to bear the costs of ICTs; industrialised countries are more likely to reap the benefits of ICTs. Section C therefore concludes that this is an economically-divergent technology and that investment priorities must be geared to address this divergence.

A. Economic Growth and Technology Diffusion

Two theories have dominated post-war economic growth model making, and both suggest a significant role for technology in development. What is now called *exogenous* growth theory, which dates back to Solow's 1956 model, predicted that the long-run rate of growth world-wide was determined primarily by an expanding and globally-available stock of technology. The presence of new technology allowed capital to produce higher returns, continuing economic growth even as the marginal return of capital relative to labour fell in the presence of increasingly large capital stocks.

Exogenous theory began losing popularity by the mid 1970s because it became increasingly clear that countries were not all growing. Indeed, poor countries were falling ever further behind. Nonetheless, technology remained central in the set of theories that replaced exogenous models – *endogenous* growth theories (Romer 1993, Lucas 1988). The new theories argued that technology played a similar role in promoting growth as suggested by exogenous theories, but that the rate of technological change in countries was not the same world-wide. Instead, it was determined by factors such as the investment rate, or the policy environment, or the level of trade.

Unlike its convergent predecessor, endogenous theory therefore saw a potentially divergent role for technology – with each average new addition to the global stock of technological knowledge having a greater net growth effect on rich countries as compared to poor countries. With the exception of the East Asian 'miracle' economies, we have seen such a consistent pattern of divergence of income between rich and poor countries – by and large, rich countries today are those countries that were comparatively richer in the past (Pritchett 1998, Kenny 1999).

A1. The Embodied Values of Technology

Theoretical developments that broaden our understanding of 'technology' help to explain this phenomenon, by showing why rates of diffusion and effective use of a particular technology should be different in different countries.

Building on the concept from endogenous growth theory of a technology being 'embodied' in both human and physical capital, these theories suggest the need for economies to have a particular mix of physical capital, human capital (skills) and labour in order to benefit from the potential productivity impact of a particular technology. Given that ICTs – like most technology – were almost entirely developed within the context of industrialised countries in order to spur productivity within a capital-rich setting, they are embodied in significant quantities of capital and are designed to save labour. They are thus inappropriate for a DC setting, where capital is rare and labour plentiful.

This is partly an issue relating to the impact of ICTs, as discussed in section B. However, it is also an issue relating to the implementation of ICTs. Let us take the example of Internet access. In rich countries that already have a large stock of computers and telephone lines, Internet access represents a small marginal investment compared to the existing fixed stock of ICT capital. In developing countries, with few computers and a limited telephone network, the same is not true. This technological advance is 'embodied' in the expensive capital of a computer and a phone line.

How expensive is this? Figures from Botswana suggest capital investment costs for a computer and phone line of at least US$2,500 plus running costs of at least US$500 per annum (Duncombe & Heeks 2001). First-year costs are therefore in excess of US$3,000 – more than six times the GDP per capita of the world's poorest countries. This is a relatively low-cost example. In many developing countries, tariffs, transport and other expenses mean hardware costs two or three times what it does in industrialised countries. Likewise, DCs pay, on average, three times as much for access to the Internet (Economist 2000d).

Added to these physical capital costs are the human capital costs of installing, operating and maintaining ICTs. The cost of personal computer ownership – including training and support – is estimated to be ten times that of the acquisition cost of the computer itself, further increasing the mismatch between ICT capital requirements and DC capital availability (David 2000).

The same issue of mismatch arises from the skill requirements of ICT installation, operation and maintenance. There is a clear relation between ICT investment and increased requirement for more highly-educated, more highly-skilled employees (Lal 1996, Autor et al 1998). Such skills are in much shorter supply in developing as compared to industrialised countries[3].

We can understand all this better by seeing that, as well as the physical artefact, technologies contain within them an inscribed "vision of (or prediction about) the world" (Akrich 1992:208). This 'world-in-miniature' derives from the – largely OECD-based – designers of the technology, and it reflects their own OECD context. It includes inscriptions – of how processes will be undertaken; of the skills (including language skills) and values that people will have; of the structures in which they are to be placed; etc – all of which are match OECD contexts (Heeks 2002). Not just with skills, then, these inscribed assumptions and requirements – about processes, about values, about structures – are likely to mismatch the very different context of developing countries. The result is slower diffusion and higher costs of ICT-based systems in these latter countries.

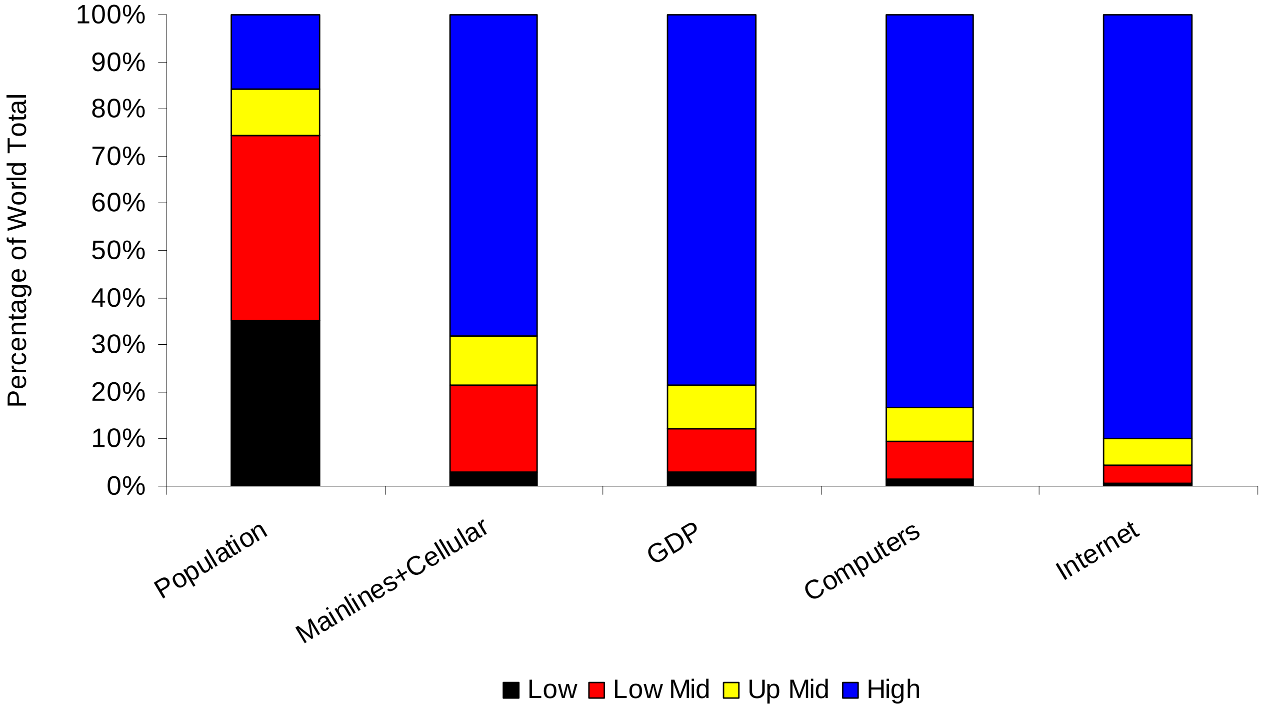
This applies equally to institutions. ICTs embody within them OECD-based assumptions about 'ICT-friendly' institutional strategies at organisational level, and 'ICT-friendly' laws and regulations at national level[4]. For developing countries, where such institutional arrangements are less likely to exist, this becomes a requirement for a range of investments in institutional reform if ICTs are to diffuse. Again, this imposes longer timescales and higher costs on ICT diffusion.

Not surprisingly, then, developing countries have 'less than their share' of computers and Internet access. As indicated in Figure 1, low income countries produce three per cent of world GDP but have only 0.5 per cent of the world's Internet users. Their physical stock of computers is similarly less than their GDP share. By contrast, technologies that have human, capital, physical and institutional embodiments closer to those available within developing countries have diffused more readily. For example, low income countries have a greater share of the global stock of mobile and fixed telephone lines than would be expected from their income. Similarly, they have a greater-than-expected share of literacy, the technological requirements of which match the endowments of developing countries relatively well (calculations from World Bank 2000b).

The position with ICTs is as bad when we look at access to Internet bandwidth. Africa had 249Mbps of international Internet bandwidth in 1999 (Abrahamson 2000). Compare this to 45,459Mbps for Europe. The bandwidth from London to New York alone is 21 times the size of the total international bandwidth in the African continent.

[3] In Kenya, for example, average tertiary education (producing the skills that are central to ICT implementation and use) is less than 3% the US length (Heston & Summers 1991, Barro & Lee 2000).
[4] For example, the stronger the legal environment (a strength that is highly correlated with GDP per capita), the greater the extent of e-commerce activity (Oxley & Yeung 2000).

Figure 1: Distribution of Population, Income and ICTs by Income Group, 1998



Source: Authors' calculations from World Bank (2000b)

A2. Future Trends

Is this position likely to change in future? Certainly, there are some positive signs. Projects such as NewDeal and Simputer promise to produce Internet-ready PCs in poor countries for just a few hundred dollars. However, such projects have been mooted in the past (such as India's People's PC) and failed to deliver. These aside, the cost of a PC has remained relatively static for at least a decade, with price held roughly constant in exchange for increases in hardware performance.

Spending on ICTs rose twice as fast during the 1990s in developing countries compared to the OECD average (Economist 2000d). However, this has still left ICT investments in DCs well below those of the richer nations: while North America spent 2.7 percent of GDP on ICTs, the four Asian Tigers could only manage 1.4 percent, while China and India invested just 0.5 per cent (OECD 1997). In absolute terms, the figures are even greater. For example, on average, US$3,000 per year is spent on ICTs for each American. The equivalent figure is US$1 for each Bangladeshi (calculated from Dertouzos 1999). Divergence in the growth rates of physical stock of ICTs is therefore likely to continue for the foreseeable future.

In general terms, the skill requirements for use of ICTs are diminishing. However, this is not clearly the case for many ICT-related development, installation, operation and maintenance tasks. At the same time, there are skills losses through the brain drain of ICT labour from developing to industrialised countries. Already, some DCs have lost as much as one third of their skilled workers to migration (World Bank

1999), and 17 percent of the 2.5 million workers employed in ICT research, design and testing in the US are foreign nationals (compared to 10 percent in the economy as a whole) (NRC 2000).

The brain drain is not a dead-weight loss – world-wide, migrant workers are estimated to remit US$75 billion to their home countries each year (Castles 2000). Nonetheless, this is a flow of labour that works to the greater economic advantage of the recipient rather than the donor country. With the recent liberalisation of visa regulations in both North America and Europe for IT migrants, this ICT-related source of economic divergence is only likely to strengthen.

Sector reform might help developing countries move toward lower costs and wider access for ICTs, but its impact should not be over-stated. Although reform is undoubtedly correlated with improvements in access, the scale of these improvements is just not that large. One recent cross-country study looking at Africa and Latin America, for example, suggests that moving from unreformed monopoly provision to passing reform legislation, privatising the incumbent and introducing significant mobile competition (in this case, six mobile companies) might increase mainlines per capita by 0.07 – about the same impact as increasing GDP per capita by $50 (calculated from Wallsten 1999). From this and other studies, we thus have no evidence to date that the digital divide will, in any real sense, be overcome by the move to competition alone.

Forecasts calculated from Pyramid Research and World Bank population data (Pyramid Research 2000, World Bank 2000b) suggest that some countries will see significant increases in Internet usage levels over the next few years. In India, Internet subscription rates are forecast to rise from less than 1% of the population in 2000 to around 12% in 2010. In Brazil, the equivalent forecast rise is from 2% to nearer 17%. However, these are the 'star performers'. Tanzania is forecast to still have less then one subscriber for each 200 people by 2010. And yet, at the same time, rates in the US are forecast to rise from 50% of households in 2001 to 70-80% of households by 2006 and even higher by 2010 (Green 2001).

Care must be taken here. Subscription rates are not the same as access rates, with estimates that the latter may be five times the former in developing countries, given shared/communal access to ICTs (Heeks 1999). Even so, this still leaves the vast majority of DC populations 'offline' by 2010 and the majority of OECD populations 'online'. Penetration rates in the OECD economies must inevitably start to plateau, as they have done for previous technological innovations. At this point middle-income countries at least will start to close the gap. However, that still looks some way off; it does not apply to low-income countries that are the developing world's majority; and, by 2010, it is likely that new technologies will have entered the frame, setting off further rounds of divergence.

B. The Divergent Impact of ICTs

The message of the last section is that, to date and for the foreseeable future, diffusion of ICTs leads to divergence in the stock of implemented technology between industrialised and most developing countries. But what of the impact of these investments? Can ICTs help the developing countries play economic 'catch-up'?

There is some positive evidence. Developing countries export billions of dollars-worth of software each year (Heeks & Nicholson 2002). Likewise, a number of companies in developing countries trading handicrafts or related items have claimed dramatic rises in revenue since moving online (Kenny et al 2001). The application of ICTs in developing countries may therefore be associated with growth.

We analyse this association in two parts. First, in section B1, we summarise evidence of the association between ICTs and growth. From section B2 onwards, we discuss the distribution of any growth benefits between developing and industrialised nations.

B1. ICTs and Growth

There is a strong correlation between ICTs per capita and GDP per capita (World Bank 2000b), but in which direction does causality flow? As noted above, there is clear evidence that richer nations spend more on ICTs, but does spending on ICTs make nations richer? To investigate this further, we must recognise that the definition of 'technology' inherent within exogenous growth theories spreads far beyond 'things that are invented'.

Especially in most empirical discussions of economic growth, the impact of 'technology' is measured through growth accounting estimates of Total Factor Productivity (TFP). TFP is defined as the actual measured growth in output minus the growth rate expected from increases in stocks of capital and labour[5]. It is a measure of the efficiency with which capital and labour are combined to produce output.

TFP therefore includes physical inventions: innovations that should make more efficient use of capital and/or labour to produce output and should thus increase growth. However, it also includes much broader notions of 'technology' including 'business technology' (management techniques or systems), 'political technology' (forms of governance), and 'social technology' (forms of human interaction). In itself, this suggests that the impact of any individual technology on growth is likely to be small.

There is also evidence that physical inventions are less important for sustained growth than the other types of technology. Romer (1993) argues that 'technologies' such as Wal-Mart's management of inventory are probably more significant than inventions such as the transistor. This is also consistent with the fact that the number of R&D

[5] Growth accounting procedures measure increases in three things: stocks of physical capital (assets such as factories, equipment, roads measured in terms of financial value); stocks of human capital (typically measured by average years of schooling); and stocks of labour (typically measured in numbers of people of working age). From this, an estimate is made of how much growth can be 'expected' from increases in capital and labour stocks. TFP is the residual – the remaining amount of growth beyond that which is expected from those increases in capital and labour stocks.

scientists and engineers employed in the US increased five-fold from 1950 to 1990 while US growth rates fell (Keely & Quah 1998).

But perhaps ICTs are different and special. Some certainly claim that ICTs are not the 'standard' technology of the type seen since the 1970s (which has provided an investment avenue to avoid declining returns on investment, but which has provided little additional increase in TFP growth). Instead, some argue, ICTs have an 'additionality' effect – creating increasing returns on investment and additional TFP growth through improvements in the efficiency with which human and physical capital are utilised (Brynjolfsson & Hitt 2000).

These additionality claims are based on two effects of ICTs. First, the capacity of ICTs to dramatically reduce transaction costs – the costs of exchanging goods in a market or organisation. This leads to the creation of new markets and more efficient operation of existing markets and organisations. Second, the benefit of network externalities whereby the value of a connection to a network rises as others join the network. Investment in ICTs by one company or individual therefore 'spills over,' providing benefits to others connected to the network.

Yet others have challenged the view that ICTs have some special, additional impact on growth. Pohjola (1998) concludes in a 'survey of surveys' that the consistent finding until the mid-1990s was one of broadly negative correlation between ICT investment levels and economy-wide productivity in the US[6]. Similar findings have come from other OECD countries: from 1985-1996, despite a significant increase in ICTs' share of capital stock, there was no increase in productivity growth (Schreyer 2000).

It has been claimed that matters changed in the mid-1990s; that TFP growth in the US in the late 1990s was due to investment in ICTs. But this view is also challenged. By 1998, e-transactions were worth just 0.5% of US GDP: too small to have a credible impact on TFP growth (Economist 1999) Instead, that growth has been argued to arise from cyclical factors and from the strength of the durable manufacturing sector (Gordon 2000).

Evidence to date, then, on the link between ICTs and growth is confused and contradictory. What we can say is that there are no strong signs yet that there is anything special about ICTs; no sign that they have the power to generate strong externalities and spillovers that will catapult countries to greater levels of productivity growth. ICTs may be associated with some productivity increases at the micro level, but probably no more so than other recent technical innovations. Notions of a 'new economy' and of new economic models that break with the past are therefore ill-supported thus far.

[6] The same finding is present at sectoral level. Gross product originating per worker in ICT-intensive industries fell an average of 0.1% during 1990-97, compared to a 1.1% rise in non-ICT-intensive industries (DoC 1999). Similarly, TFP change averaged +4% during 1987-97 in mining, the industry that spent second least on ICTs as a percentage of output during that period; by contrast, it averaged close to –4% in banking, which was the highest spender on ICTs (Economist 2000d).

There are compelling reasons to believe that over the long term technological advance, broadly defined, is a driving force behind economic growth[7]. However, this broad definition of technology, as in TFP calculations, covers a multitude of factors – policies, institutions, organisational processes and structures – that may be more important in determining growth than research and developed inventions such as ICTs. Developing countries and others may therefore be better advised to focus as much or more on managerial or political innovations as on the new technology.

B2. The Skewed Return on ICT Investment in Developing Countries

Even if ICTs do increase productivity in industrialised country settings, their impact in developing countries will be very different because developing countries are different. We look at this first in terms of the productivity effects of ICTs.

As noted above, ICTs – being developed in labour-scarce, capital-rich economies – will tend to be labour-saving/labour-substituting technologies. However, in capital-scarce, labour-rich DCs, technology costs more while labour costs far less. Substitution of cheap labour by costly capital may therefore reduce rather than increase productivity. The likely outcome is an amplification of the differences in productivity between the two sets of countries (Zeira 1998).

The same point can also be made in relation to productivity benefits that arise from the network externalities which ICT investment may produce. There is evidence that a critical mass of networking is required (estimated at 24% penetration) before there arises a positive and significant link between telecommunications rollout and economic growth (Roller & Waverman 2000). Despite the global connectivity of the Internet, it is quite plausible that such effects apply to ICT investment and that most developing countries have less than the critical mass of current ICT infrastructure required to create productive externalities.

Together, these ideas would help to explain why global studies which do find a positive correlation between ICT investment and productivity in industrialised countries, find no such correlation in developing countries (Mayer 2000, Kraemer & Dedrick 2001).

We can now move to look at difference more generally in order to question a premise that has underlain preceding arguments about ICT impact: the premise of equivalent rates of *effective* use of ICTs between industrialised and developing countries. There is no good evidence to support this premise. Instead, what limited evidence there is points towards more effective use of ICTs in industrialised countries, and less effective use in DCs.

Reports from individual developing countries (e.g. Oyomno 1996) find failure to be the dominant theme, and an overview of cases concludes, "successful examples of computerisation can be found … but frustrating stories of systems which failed to fulfil their initial promise are more frequent" (Avgerou & Walsham 2000:1). This is supported by a summary of evidence from multiple-case studies:

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[7] Not least because differences in capital investment are distinctly incapable of determining fast and slow growers over the past few decades.

- Health information systems in South Africa: Braa and Hedberg (2000) report widespread partial failure of high cost systems with little use of data.
- IS in the Thai public sector: Kitiyadisai (2000) reports "failure cases seem to be the norm in Thailand at all governmental levels".
- Donor-funded ICT projects in China: Baark and Heeks (1999) reported that all were found to be partial failures.
- World Bank-funded ICT projects in Africa: Moussa and Schware (1992) report almost all as partial – often sustainability – failures.

Comparisons with studies of ICT project failure in industrialised countries (e.g. Sauer 1999) suggest failure rates in developing countries are higher. This is hardly surprising. The mismatch has already been noted between embodied design assumptions/requirements of ICTs (which derive from an industrialised country context) and the realities of developing country contexts. This design—reality mismatch means that the data, processes, values, skills, organisational structures, technical and institutional infrastructure, etc. required to effectively use ICTs are often not present in developing countries. Thus failures significantly outnumber successes. Hence, global studies which do find a positive return on ICT investment in industrialised countries, find no such return in developing countries (Kraemer & Dedrick 2001).

In sum, even when developing countries are able to invest in ICTs, they are less able than industrialised countries to obtain a beneficial quantitative or qualitative return on those investments. ICTs therefore cost developing countries more than industrialised countries, and yet they bring fewer benefits. This can only exacerbate the divergence between the two sets of nations. This will be reinforced as the cost-benefit skew reduces incentives to ICT investment in developing countries.

B3. ICT-Based Defence of Market Share in Industrialised Countries

There is evidence to support the idea that a good deal of investment in Internet-related ICTs has been to protect market share rather than increase productivity. Banking provides one example. Cap Ernst and Young estimate that rather than the predicted 25 percent savings in UK banks' costs thanks to Internet banking, real savings were around 0.1 percent (Economist 2000c). This is because going online is a zero sum game that does not expand the market. Instead, it is a strategy designed to protect market share against new Internet-based rivals and against other traditional competitors who may themselves move online.

Similar results have been found for the impact of ICTs on stock market activity – ICTs do not increase the social gain from such activity, they only affect who receives those gains (Triplett 1999). This may help explain the finding that, broadly, goods and services online are no cheaper than those sold in stores – any ICT-related productivity gains are wiped out by the increased costs required to create or defend market share (World Bank 2000a).[8]

[8] This, in turn, adds further weight to the earlier argument about limited TFP additionality contribution of ICTs.

Use of the new technology in this way is the ICT equivalent of Sunday trading in the UK. When stores were allowed to trade on Sundays, the first to do so found their market share increase. However, when all major stores followed suit, market shares settled back to their original levels. There were only two changes. First, costs rose for those taking part. Second, smaller stores that could not afford to open on Sundays lost revenue and market share.

Developing countries are the equivalent of these smaller stores. If DC firms involved in traded sectors do not or cannot invest enough in ICTs to protect market share, they will lose share and lose revenue to the OECD-based firms that can make such investments. All the evidence presented in this paper suggests this is a likely outcome, and there is further evidence in the geographic and economic concentration of supply chains found when firms move their supply chain and inventory management online (World Bank 2000a, Venables 2001).

Without necessarily adding to productivity or to global gross output, ICTs thus redistribute income away from (developing) countries with low ICT investments towards (industrialised) countries with high ICT investments. As WTO pressure increases the range of tradable goods and services and as ICT investment levels continue to diverge, this impact is likely to increase rather than decrease.

B4. The Global Imbalance Between ICT Production and Consumption

The redistributive and divergent effect of ICTs just referred to is reinforced because – as a generalisation – industrialised countries are both producers and consumers of ICTs, whereas developing countries are mainly just ICT consumers. Industrialised country domination of ICT production brings significant benefits.

For example, US companies produce 56 percent of the revenues and receive 96 percent of the profits in the global IT production business (Strassman 2000). IBM, Hewlett-Packard and Dell alone deliver 96 percent of net global profit in the computer manufacturing business. US total profits in computing are 130 percent of net global profits – the average computer firm outside the US is losing money. Microsoft, Oracle and Cisco alone account for 69 percent of global net profits in software production.

Put bluntly, most ICT expenditure in developing countries flows out of those countries to create revenues and profits for industrialised country – especially US – ICT firms. This all points to economic divergence as developing countries receive the certain costs and uncertain benefits of ICT consumption while delivering to industrialised countries the certain benefits of ICT production.

This is not a pattern that seems likely to change. Industrialised countries dominate the R&D expenditure that lies behind the production of high technology goods. OECD nations spent 1.8% of GDP on R&D, compared to 0.8% in South Asia or 0.2% in sub-Saharan Africa: the United States alone spends three times more on research and development than all developing countries combined (World Bank 2000a). Industrialised countries hold 97 percent of patents world-wide, and half of global licensing and royalties fees were paid to just one country – the US. Even in DCs, 80 percent of patents belong to residents of industrial countries (Braga et al 1998). The R&D juggernaut therefore increases the opportunities for innovations that will provide new revenue and profit streams for OECD-based ICT producers.

Defence of revenue and profit streams has been strengthened by the extension of the patenting system to many 'products' that are very different from the Alexander-Bell-researched-and-built-it-in-his-laboratory traditional image. This is particularly true of the Internet, with the US patent office having granted patents on 'non-material' processes including group buying, one-click shopping and reverse auctions (Economist 2000b). This US government-enforced monopolising of 'disembodied' technologies has international ramifications, because the WTO TRIPS (Trade-Related aspects of Intellectual Property Rights) agreement forces DC members to accept minimum standards on patents, copyrights and trade marks, based on OECD practice. As patents become more widely applied across types of invention and around the globe, the ability to catch up in (and benefit from) the race to produce ICTs is made more complex (UNDP 1999).

International recognition of business applications patents ensures that most benefits of technological advance go to 'inventors' rather than consumers and reduce spillovers as a proportion of new technology even while they might (arguably) promote the creation of such technology. If this is the case, it is likely that they will increase divergence between technology-surplus countries and technology-deficit countries – or rich and poor.

WTO pressure is also pushing down software piracy rates within developing countries, directly benefiting OECD producers at the expense of DC consumers. A 10% reduction in global piracy rates, for example, would bring an increased transfer of hundreds of millions of dollars from developing to industrialised countries for little tangible return. As piracy rates are pushed down through international pressure, this will therefore create a further imbalance of the ICT cost-benefit equation, and further divergence.

C. Conclusions

C1. Divergence and Convergence

This paper does not take an 'anti-ICT' stance. Case study evidence can certainly be found of the positive contribution that ICTs can make to the development process. However, it is all too easy to be carried away on a wave of pilots, possibilities and exaggerations, just like those who predicted the telegraph would engender world peace and that television would revolutionise education.

The economic evidence suggests that evolutionary, not revolutionary changes are underway. There is a stark lack of good evidence that ICTs are making a radical contribution to efficiency or effectiveness at either national or organisational level. The notion that 'the best is yet to come' in terms of ICT impacts is also highly contestable, with some evidence of declining marginal returns on ICT investment (Gordon 2000, World Bank 2000a).

What uncertain economic benefits there are from ICT consumption, and what more certain economic benefits there are from ICT production, are likely to accrue far more to industrialised than to developing countries for the foreseeable future. Two reasons stand out. First, ICTs are a Western technology embodying Western endowments of physical, human and institutional capital. They will therefore diffuse more quickly in industrialised countries and they will therefore be used far more effectively in industrialised countries. Second, industrialised countries – the US particularly – dominate the ICT production that does produce a clear link between ICTs and growth. As a result, ICTs – for the foreseeable future – will be a technology supporting global economic divergence rather than global economic convergence.[9] Like other 'standard' technologies before them, ICTs may support growth (and even this is contested) but they do not support 'catch-up'.

This, of course, is not an argument for developing countries to ignore ICTs. Quite the opposite. The evidence on use of ICTs for defence of market share suggests the greatest divergence may well be between those who do adopt and those who do not. However, this rationale is very different from one based on notions of high

[9] Even if we were to ignore all this evidence, it makes little difference because of the great size of both static and dynamic gaps between rich and poor nations. A highly optimistic account of ICTs (not supported by the evidence presented above) would see them adding 0.5% to annual GDP growth in industrialised countries over a twenty year period (Goldman Sachs 2000, Economist 2000a). An absurdly optimistic account of ICTs (flying in the face of all available evidence) might see them adding 1.0% to annual GDP growth in developing countries. Even this would represent divergence. Long-run developing country growth rates have been 1.7% per year, compared to long-run growth rates of 2.7% for industrialised countries (Pritchett 1998). Our absurdly, unrealistically optimistic scenario changes this to 2.7% and 3.2% respectively: poor countries grow but rich countries grow faster. And divergence is the norm even in the face of far greater forces than ICTs. During the past few decades, transaction costs on international trade have fallen some 40% due to tariff reductions and falling transportation costs (Law Journal Extra 1996, Hummels 1999). These significant changes have not slowed global divergence (or reversed the long-term slowdown in productivity growth). How much less likely is it, then, that the Internet's much lesser effect will do so – an effect most optimistically estimated to be a reduction of some 10% in transaction costs on goods and services (Goldman Sachs 2000). More realistically, as presented here, ICTs will increase GDP growth in industrialised countries more than in developing countries, and will therefore increase not decrease the divergence rate.

productivity and high returns on investment thanks to ICTs. Developing countries must therefore look beyond the hype to the real impacts that ICTs are likely to have.

C2. Investment Priorities

From the evidence presented in this paper, three economic priorities emerge.

First, DCs should look to invest in more appropriate ICTs. The type of technologies required by developing countries – for higher rates of diffusion and implementation, and for higher rates of quantitative and qualitative return – are those which match their factor and environmental endowments. Such technologies would require little human or physical capital, and their design would match the data systems, cultural values, institutional structures, policies, etc within developing countries.

At first sight, it might seem that ICTs do not match developing country realities, and that they will therefore be universally problematic. However, there are ICTs and ICTs. Some provide a better match to DC factor and environmental endowments; some provide a worse match. We can draw up a continuum of technologies from those at one end that support most DC realities to those at the other end that fixedly require – or seek to impose – OECD factor conditions and other inscribed assumptions.

Developing countries should be encouraged to adopt those technologies closer to the reality-supporting end of the continuum. Stepping away from just digital ICTs for a moment, this supports the growing evidence that investment in telephony should be given a higher priority than investment in Internet-connected PCs (Duncombe & Heeks 2001). It supports mechanisms – such as shared access to ICTs – that decrease the capital-labour ratio of use. It would also mean giving a higher priority to flexible applications like email and the Web, and a lower priority to rigid applications like decision support systems.

Even this assumes too passive a role for developing countries, and too immutable a picture of ICTs. To some extent with hardware, but particularly with software, adaptations can be made: hardware can be 'tropicalised' or 'ruggedised'; local language interfaces can be provided for software; above all, applications can be customised to match local user requirements. While, in theory, anyone can undertake such adaptations, they are more likely to be successfully undertaken by local organisations. This points to the value and need of developing a local base of ICT production capacities.

Second, DCs should look beyond the physical technology. There is little evidence to suggest that any 'invented' technology, such as those encompassed by ICTs, has a large impact on economic growth by itself. Even the impact they do have is dependent on a range of economic, institutional and other environmental factors, and it may well be more appropriate to focus on innovations within such broader notions of 'technology'. This can be interpreted in two ways. At most, that ICTs should be downgraded as an investment priority, and that developing countries should be taking more interest in managerial, institutional and other types of innovation[10]. At the least, DCs must discard their current techno-centric approach to ICTs. Instead, they must see ICTs' main role as their ability to support – even leverage – related organisational innovations such as process reengineering or inventory management.

Third, there should be a much higher priority given by developing countries to local ICT production. Some developing countries have already recognised this in various areas including components (Costa Rica, Malaysia), hardware (Taiwan, China), and software (India, Egypt). Most, though, have not. This must be kept in proportion – there are good reasons why the US is a key ICT producer while Chad is not, and good reasons why this situation will not radically alter in future. Nevertheless, there is a multi-billion dollar opportunity here for developing countries. Input factor supplies may be limited rather than plentiful, but what is often lacking more than relevant physical and human capital is vision and belief.

More broadly, developing countries need to switch their gaze away from 'intensive' applications of ICTs: application to pre-existing processes and outcomes (Narasimhan 1983, Heeks 2002). They should pay more attention to ICTs 'extensive' capacity to develop new processes and, hence, new products and services. Areas of new economic activity produced through ICTs include:

- ICTs as an enterprise output: production of hardware, software and telecommunications products, as just described.
- ICTs as a primary, processing technology: provision of data entry services, ICT-based business services, software customisation, ICT-based distance learning, etc.
- Other ICT-related support activities: provision of computer training, consultancy and other services.

In extensive applications, there is a much clearer link between ICTs and the creation of jobs, incomes and skills than is the case for intensive uses of the new technologies.

C3. Differentiating Within Categories

The focus of this paper has been a crude one, homogenising the world into just two categories: industrialised and developing nations. A more sophisticated analysis would unpack these categories. For example, as indicated at points during the paper, a very few developing countries have been able to successfully harness recent waves of technology (Venables 2001). An important element in the growth of East Asian 'miracle' economies has been their ability to develop an ICT production capacity.

Some second-tier developing economies, such as China, Malaysia and India, are attempting to replicate this experience by expanding their ICT production base. These economies may be able to 'catch the wave' of ICTs and use the technologies as a convergent economic force.

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[10] Such innovations could, of course, include innovations that will support diffusion and productive use of ICTs. This will be a long haul. Developing countries have arguably yet to introduce the managerial or institutional reforms required to support diffusion and productive use of Gutenberg's or Bell's inventions, let alone those of von Neumann, Berners-Lee, and the like.

On a less positive note, within individual developing nations too, there are signs – not unexpected given the history of technology in development – that ICTs may be a catalyst for divergence between groups: helping the rich more than the poor, men more than women, and urban dwellers more than those in rural areas. The issues and conclusions presented above are therefore relevant within as well as between nations.

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