Innovation and Inclusive Development

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Innovation and Inclusive Development

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Table of Contents

Summary

Introduction

Inclusive development is a key priority for governments in emerging and developing countries. In these countries, the growth process has often not helped lower-income groups, in relative and sometimes in absolute terms: a majority of the world poor now live in middle income countries. Because innovation matters for growth, it is increasingly prominent on government agendas. The importance of innovatin for the international development policy agenda was emphasised in the context of the OECD Innovation Strategy (OECD, 2010; OECD/IDRC, 2010). The relationship between innovation and inequalities in income and opportunities raises some important policy questions: Do innovation and the resulting technological change necessarily lead to increased inequalities? Do policies aimed at supporting innovation foster inequalities in revenues, rewarding only the best trained and most skilled with access to resources? To what extent can innovation be mobilised to improve the life conditions of the lower income groups ("inclusive innovation")? What can policy do to make this happen?

Purpose of the report

These questions are the basis of this report, which addresses a number of policy-relevant themes around "innovation and inclusive development" and reviews answers that have so far been proposed. It provided background reflection for the Conference on Innovation for Inclusive Development organised by the OECD and South Africa's Department for Science and Technology on 21 November 2012 in Cape Town, South Africa. The project was carried out in cooperation with the OECD Programme on Higher Education and Research for Development (IHERD).

Key observations and findings

Chapter 1. Defining Innovation for Inclusive Development

- Innovation relates to inequality in three ways: *i)* through direct impacts on income distribution (innovation favours the highly skilled and risk takers), *ii)* as solutions for improving the welfare of lower and middle income groups ("frugal innovation"); and *iii)* through innovations by lower-income groups themselves, *i.e.* grassroots activities.

Summary

- By innovation this report understands not only R&D-based innovation but also innovation based on practice rather than formal R&D, and social and business innovations. Many of the relevant innovations in the development context are of the latter types.
- Income inequalities are wider in emerging and developing countries than the OECD average and they result in poverty of large segments of the population. As income inequalities reduce opportunities for the poor and thus their contribution to the economy, they then hinder the development process.

Chapter 2. Innovation and Productivity Gaps: Evidence and Causes and Their Importance

- In many emerging countries "islands of excellence" – very innovative world-leading businesses, sectors, regions and research institutions or universities – coexist with a large group of low-productivity firms and a substantial informal economy. In consequence, productivity gaps across firms, even within narrowly defined economic activities, are much larger than in developed countries.
- Difficulty of access to skills, information, institutions and finance explain productivity gaps, as do more structural factors, notably the limited capacity of the rest of the economy to connect to high-growth sectors and firms. A substantial informal sector and high levels of underemployment imply that competition alone will not close these gaps.
- In the development process the transition towards modern sectors, firms or activities, which are more innovation-based and aim at international competitiveness, is necessary but may lead to transitory and possibly longer-term increases in inequality.
- Facilitating the dissemination of innovations and technologies can help increase overall performance, lessen income inequality and stimulate growth. Policies aimed at fostering innovation for development have to strike a balance between approaches aimed at supporting first "islands of excellence" and those favouring wider diffusion of knowledge.

Chapter 3. Innovation for and by Low- and Middle-Income Groups

- Many examples show that innovative products, particularly in the areas of food, health and basic livelihood, can contribute substantially to improving the welfare of lower-income groups. Both private for-profit actors and not-for-profit actors have supported many initiatives, not only financially.
- To serve lower-income markets, demand-side characteristics beyond high sensitivity to price, have to be addressed: such as the need to adjust products to specific user contexts (*e.g.* lack of electricity) and the challenge of providing information about product purpose and use (reflecting *e.g.* the low human capital of most poor).
- Entrepreneurs have used innovative pricing and financing strategies and business process innovations to serve lower-income markets profitably. Some multinationals are also targeting middle-income groups as a way of entering growing emerging country markets.

- A number of examples demonstrate that grassroots innovations (innovation by the poor) can be beneficial, particularly for empowering lower-income communities. However, for moving up the social ladder more substantive and human capital intensive innovation is needed.

Chapter 4. Information and Communication Technologies

- Infrastructure improvements and uptake have been substantial in developing countries and have connected an increasingly broad group of users to information and communication technologies (ICTs). In particular, the uptake of mobile telephony has connected previously unserved communities, which are a particularly involved in the "inclusive development" agenda.
- A variety of ICT-based applications – a set of "inclusive innovations" – developed in support of agriculture and fishing, health and education and mobile banking have successfully improved conditions for the lower-income groups they have reached. However, their scale is often still too small to improve living conditions more widely. A variety of factors, including the lack of profitable business models for such applications, explain why they have so far reached only relatively few.
- Businesses in developing countries have also taken up ICTs, with positive impacts on their innovation and productivity performance. Quantitative evidence shows that smaller firms and businesses in small cities – a group that is rarely among the leading firms – benefited as much as large businesses in capitals and large agglomerations: ICTs did not increase the gap between lagging and leading firms, *i.e.* the evidence suggests no "digital divide" in terms of impacts.

Chapter 1

Defining Innovation for Inclusive Development

Introduction

"Inclusive growth" has been at the forefront of policy discussions in OECD and non-OECD economies. These discussions reflect a concern that economic growth does not necessarily improve the welfare of all citizens and might even reduce incomes in some groups (OECD, 2011). A variety of factors shape inequalities within societies. As a key factor for growth, innovation has figured prominently in debates about growth. Yet, there has so far been little discussion of the role innovation plays in more "inclusive" growth. However, in shaping and substantially altering how labour and capital are deployed within an economy, technological progress and innovation have implications for the distribution of income. When development leads to substantial transformations of the economic systems of developing and emerging economies, distributional issues can be even more substantial. At the same time innovation offers potential means of addressing outcomes of growth dynamics that are not inclusive. "Inclusive innovation", that is, harnessing science, technology and innovation know-how to address the needs of lower-income groups, is one. Moreover, lower-income groups may themselves be innovators and find means of improving their welfare. This chapter describes what inclusive innovation involves, sets out the major questions it raises and discusses its policy relevance for developing and emerging economies. It is worth noting that these are working definitions only: the complexities, which are natural of this emerging multi-disciplinary field, require additional conceptual work, especially if a measurement agenda is to be set up.[1]

Basics and overview of major challenges

Innovation relates to inclusive development – *i.e.* growth dynamics which benefit not only high- but also low- and middle-income groups in society – in three ways.

Innovation and its impacts on low- and middle-income groups

In a traditional Schumpeterian setting, innovation will increase inequality as benefits accrue only to innovators and possibly their customers. It is the diffusion process that leads to equalisation and thus to benefits for all actors in society. At least initially, innovations and the technological changes brought about by innovations are not adopted in the same way across all regions, industries, firms, employees, entrepreneurs and capital investors. These differences result notably in substantial within-country gaps in productivity and innovation. They affect the within-country distribution of incomes as well as inequalities in wages and income (see Box 1.1). While many factors shape a country's distribution of income, the features of its production system play a central role. This is particularly the case if redistributive policies are rather weak, as market returns to labour and capital will be especially important in terms of individuals' disposable income.

Important questions here include the following (discussed in Chapter 2):

- What is the relationship between growth and inequality at the country level?
- How important are inequalities in innovation activities across firms, including across and within sectors of activity and regions? How costly are such gaps for a country's economic and innovation performance? What explains them?
- What are the relationships between inclusive and frontier innovation? Is there a bigger payoff for centralised or dispersed innovation activities? How do they relate to high-technology and lower-technology and non-technological types of innovation?

- Are inequalities in production processes a transitory and necessary phenomenon in the development process? What determines whether transition effects persist over time?
- What affects spillovers from frontier performers to the rest of the economy? Should weaker linkages with the rest of the economy matter for choosing among growth strategies?
- What role do innovation-related growth policy strategies play in shaping productivity gaps?

Box 1.1. Explanations of wage and income inequality due to technological change and innovation

The relationship between technological change and employment involves both a quality effect (*i.e.* relative wage changes) and a quantity effect (*i.e.* employment gains or losses).

a) Wage inequality across skills and the role of technological change

The role of technological change in explaining wage inequalities has a long tradition in the "skill-biased technological change hypothesis". Attempts have been made to see how well it explained the wage inequalities that arose in United States and the United Kingdom over the 1980s and 1990s and the more limited increases in other OECD countries and emerging and developing economies. A main underlying hypothesis is that technology is skill-biased, *i.e.* it rewards skilled labour more than unskilled labour. In that case, technological progress will lead to wider inequalities across skill groups unless workers' education keeps up with technological change. Rising levels of inequality can then be understood in terms of educational levels not keeping pace with technological change.

More recently, attention has been paid to the fact that inequalities have generally increased across establishments within closely defined sectors of activity. It is thought that innovation activities play a role, in that quality upgrading will reward skilled workers more strongly in establishments that engage in such activities (Verhoogen, 2008). Other technology-related and other factors may provide explanations for the recent US wage trends: stagnant earnings for less- and moderately-skilled workers and rising superstar earnings (*e.g.* Blanchard and Wilmann, 2011) as described later in Box 1.2. Moreover, the inherent uncertainty of the innovative process and the novelty of an innovation result in less formal workplace regulations which further affect income inequality. New innovative sectors also tend to hire more part-time and specialised workers with less union power, which facilitates greater income dispersion (Autor and Dorn, 2009). Also, a selection mechanism may be at work: the innovative sector attracts skilled workers because of skill-specific complementarities so that skilled workers can demand relatively high wages (Echeverri-Carrol and Ayala, 2009).

b) Income inequalities via the relationship between employment and technological change

The second dimension is employment effects since whatever the nature of technological change in terms of complementarities with skilled or unskilled labour (or neutrality) its direct effect will be labour-reducing. This relates particularly to process innovations. Several compensation mechanisms can, however, have opposing labour-generating effects. This includes: a) *new investments* made possible by the profits of firms that introduced the innovation, if market conditions push them to invest and if the investments create employment; b) *increase in demand* with the introduction of new products and the creation of new employment in the new expanding sectors which compensates for earlier employment losses and c) a *decrease in the price* of the product, made possibly by process innovation, which generates new demand for products and results in additional production, but aggregate effects would require it counterbalances the loss in purchasing power.

It is difficult to evaluate overall aggregate effects empirically. Firm-level studies can only partially assess compensation effects owing to their scope.

Source: Vivarelli (2012) and cited sources.

Innovation for low and middle-income groups

"Frugal innovation" or "inclusive innovation" can provide solutions for reducing gaps in living standards between the richest and poorest groups in society. These solutions typically consist in obtaining cheaper (often simplified) versions of existing products for purchase by lower-income groups in order to improve their welfare and provide opportunities for their businesses. Another dimension of "inclusive innovation" is business process innovations that can provide lower-income groups with

access to goods and services which they previously could not afford. "Pro-poor innovation" and "innovation for the bottom of the pyramid" are other terms that have been used to describe these types of innovation.

Important questions here include the following (discussed in Chapters 3 and 4):

- Will markets facilitate access of low- and middle-income groups to innovations? Are there profitable business models that can provide low- and middle-income consumers with access to innovations on a large scale?
- To what extent are traditional product cycles (in which the price of innovations decreases over time as productivity improvements and competition reduce the price) a successful way of supplying lower-income groups with innovations?
- What has been the impact of ICT-based innovations targeted at lower-income groups?
- Is price the only barrier to uptake by lower-income groups? If not, what determines the success of different approaches to reach lower-income groups successfully?

Innovation by low-and middle-income groups

"Grassroots innovations" are solutions developed by low-income groups to meet challenges which they and their community face. They draw on two sources of knowledge: *i)* traditional knowledge such as traditional medicines; and *ii)* a range of externally developed technologies. There is often a strong local dimension to grassroots innovations. Moreover, some innovations facilitate entrepreneurship in previously marginalised groups and may help them participate in circuits of economic activities. Related terms are social entrepreneurship and innovation, frugal innovation, indigenous innovation, community development and traditional knowledge for development. A related area is innovation in the informal sector.

Important questions concern grassroots innovation (Chapter 3) and informal sector innovation (Chapter 2):

- How important are innovations of low- and middle-income groups for welfare, *i.e.* the issue of critical re-assessment of the relative importance of "below the radar innovations" (Kaplinsky *et al.*, 2010)?
- What is the role of "community ownership" of innovations in their adoption by lower-income groups?
- Is the informal sector a potentially important generator of innovations? Does it provide employment and training opportunities that can facilitate the insertion of lower-income groups into formal economic activities?

Relations among the different factors

Innovations that are made accessible to lower-income groups can help grassroots innovations and the informal sector. In fact, innovations developed in the formal sector often enable such innovation initiatives, *e.g.* business opportunities based on the mobile banking service M-Pesa (discussed in Chapter 4). Grassroots innovation can be important for the adoption of innovations targeted at the poor both because specific local situations may have to be taken into account and because of the need for community involvement. Finally, informal business innovation activities may serve to bridge gaps in firm performance.

Innovation in the context of this report

It is worth looking at how the type of innovation examined in this report relates to other types of innovation. Innovation is about "new and/or significant improvements to existing goods and services" (OECD/Eurostat, 2005). Essentially, it goes beyond a "technology-based perspective" on innovation for two main reasons. "Frugal innovations" modify existing technologies or products so as to supply lower-income markets. For example, they may focus on retaining only key functionalities of products so as to reduce their price (see discussion of the "no frills" approach, Chapter 3). Moreover, process innovations are equally important as discussed in Chapter 3. Similarly, "grassroots innovations" essentially adopt novel approaches to using existing technologies in a given local context. Some of these innvaotions can equally involve organizational innovations and the creation of specific technologies. The "bottom-up" rather than "top-down" nature of innovations can notably improve responses to community challenges.[2]

In addition, many cases of "inclusive innovation" do not involve technology-based innovations to goods. Often, the innovations that provide lower-income groups with resources involve innovation that goes beyond the good and/or service itself. Notably, the "business models" which have been developed have allowed substantial product cost reductions and found ways to address specific challenges such as lack of access to information on new products and their use in lower-income markets (discussed in Chapter 3). Innovations may be incremental in nature and involve adjustments to existing products and technologies rather than more radical innovations (*e.g.* the ICT-based applications discussed in Chapter 4). Furthermore, as lower-income groups lack access to capital for technology-based innovations, many of their innovations are less technical in nature. Lack of skills and lower educational attainment, including knowledge of science and engineering, mean that grassroots innovations will mostly be ingenious adaptations of products to local contexts and often limited to their contributions to the local context (discussed in Chapter 3). These types of innovations are inclusive in that entry barriers are low and all can participate, unlike more technology-intensive types of innovations for which participation requires adequate skills. However, raising educational levels will create more opportunities for lower-income groups to contribute to and benefit from more complex types of innovations.

Moreover, private research and development spending tends to be relatively low. That is not to say that no innovation is taking place. Rather it is often based on external knowledge sources, notably intermediary inputs. Because such innovation is difficult to measure both for developed and developing countries, productivity performance and gaps in productivity are used as a proxy but have well-known downsides (discussed in Chapter 2). It is worth noting that in recent years substantial progress has been made in measuring innovation: a notable example demonstrating such progress is the African Innovation Outlook (AU-NEPAD, 2010).

The relevance of "inclusive growth"

A sceptic might question the focus on inequality that ultimately underlies the issue of "inclusive growth" and emphasise the greater importance of absolute rather than relative factors for income, *i.e.* the issue of moving out of poverty independently of how much other income groups are better off. Such a position ignores, however, that the issue of improving conditions for marginal low-income groups (*e.g.* the debate on grassroots innovations or the question of providing affordable health technologies) is a key issue in debates on "inclusive growth". Moreover, differences in relative incomes can effectively be welfare-reducing if they exclude groups with lower incomes from certain types of services and/or commodities (*e.g.* the best schools). Finally, it is important to recall that a majority of the world's poor now live in middle-income countries.

Where the question does arise is in the debate on growth *per se vs.* inclusive growth, as the lack of inclusiveness may be a temporary phenomenon in the developmental process that will ultimately disappear. The evidence clearly shows that inequalities are complex and have a variety of dimensions not only across but also within sectors, not only across but also within regions, and so on. Also, even short-term dynamics are worth considering as they may have long-term impacts on the economy. However, it is certainly the case that the extent to which they are temporary will be relevant for policy. In fact, inequalities challenge developmental processes (as discussed in Chapter 2).

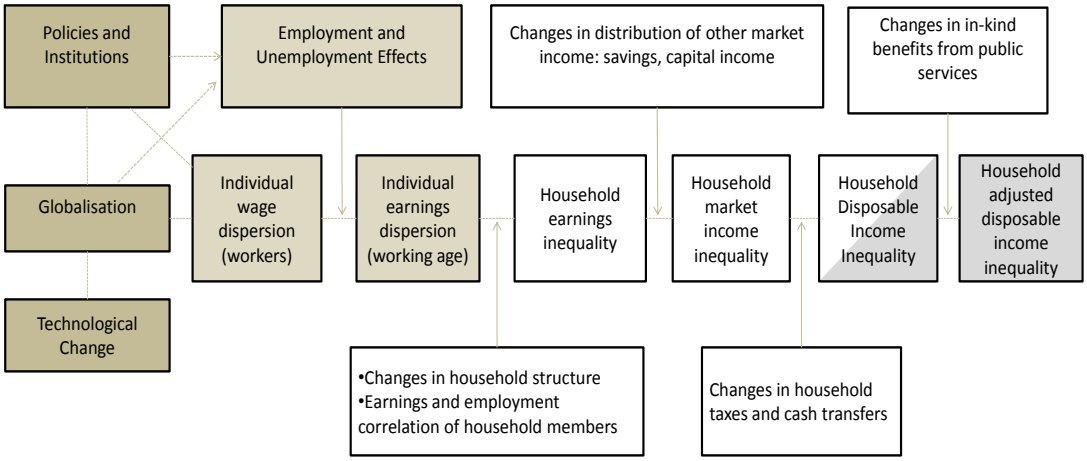
Another more powerful objection is that innovation-based growth strategies should not consider inequalities because growth ultimately has a much stronger impact on poverty reduction than changes in relative incomes across groups. In a cross-country study, Kraay (2006) found that a rise in average incomes explains 70% of the variation in absolute poverty reduction in the short run and as much as 97% in the long run. Dollar and Kraay (2002) find similar evidence with regard to relative poverty. In contrast, relatively faster growth in lower incomes or changes in the sensitivity of the lowest incomes to average incomes played less of a role. The substantial development of China and India have lifted some 1.2 billion into the middle class over 1990-2005 (Ravallion, 2005). This does not mean, however, that the inequality-growth debate is irrelevant from a poverty perspective. First, trickle-down dynamics are not automatic and there may be ways to stimulate them more effectively. Also, there is evidence that poverty reduction is affected both by the distribution of incomes and by growth rates in unskilled labour-intensive sectors (Ravallion, 2009). Poverty reduction is greater with growth in unskilled labour-intensive sectors such as agriculture and construction (Loayza and Raddatz, 2010). Second, there is limited evidence of a trade-off between poverty and inequality, an issue that would arise if economic growth that reduces poverty happens in parallel with higher inequality (Ravallion, 2005). Third, the debate is even more relevant if inequality itself has implications for growth, particularly over the longer term, which might warrant inclusive growth strategies independently of poverty considerations. Better growth dynamics might result if less advantaged groups can participate in aggregate growth. It is not so much inequality of revenues as of opportunities that matters.

The relevance and the importance of the topic are due to the fact that growth has not been inclusive and that inequalities are a global phenomenon. The observed rise in inequalities, for example in the United States, where reductions in real income have been observed for some groups (Haskel *et al.*, 2012), have intensified debates on its underlying causes. The question of "fairer growth" has also gained relevance on policy agendas of OECD countries and beyond. The OECD's Ministerial Council of May 2012 raised concerns over "the worrying trend of rising inequality … in many countries". In fact, in most OECD countries and many emerging economies, the gap between rich and poor has widened over the past decades, even during a period of sustained economic growth. With very few exceptions, the ratio of the wages of the 10% best-paid workers to those of the 10% worst-paid increased significantly across the 23 OECD countries reviewed (OECD, 2011). The economic crisis has added urgency to the policy issues related to inequality. The social compact is starting to unravel in many countries. Young people see no future for themselves and feel increasingly disenfranchised. They have now been joined by protestors who believe that they bear the brunt of a crisis for which they have no responsibility, while those with high incomes appear to have been spared. Owing to the crisis, uncertainty and inequality-related issues have reached the middle classes in many societies.

Types of inequalities and the relevance of different dimensions of innovation

Inclusive development requires giving some consideration to different types of income inequality. Inclusive development is also about equal opportunities (by reducing gender gaps, promoting decent work, giving the poor access to knowledge and information). The publication *Divided We Stand* (OECD, 2011) provides a useful framework (Figure 1.1) with four dimensions of income inequalities.

Figure 1.1. Analytical framework for analysis of income inequality



Source: OECD (2011), *Divided We Stand*, OECD, Paris.

Inequalities in wages

A first type of income inequality is the dispersion of hourly wages among full-time (or full-time equivalent) workers and wage dispersions among workers (*e.g.* annual wages, including wages from part-time or seasonal work). Many analyses of technological change and its impacts have focused on differential wage returns to innovation among full-time workers and seek to understand, in particular, whether and to what extent skills are better remunerated in response to technological change. It is gaps in education and training across individuals that effectively shape these differences. Wage inequalities among workers with different skill levels have risen in several OECD countries and also in developing and emerging countries. Most people's income depends on the productivity of the firm in which they work which, in turn, partly depends on firms' adoption of technologies and innovation performance. Wage inequality has also been (jointly with self-employment) the most important driver of the recent rising income inequality across the OECD; capital has contributed comparatively little. Of course, many other factors also enter, including globalisation (Box 1.3), labour unions, regulations and the availability of suitably skilled workers.

Individual earnings inequality

A second type of inequality involves inequality of individuals' earnings: all workers, the self-employed and the entire working-age population (including those who are not working). Such inequalities relate to innovation to the extent that innovation shapes entrepreneurs' returns. Moreover, innovation and technological change, by affecting firm dynamics, can have implications for unemployment. Labour may be shed following the adoption of (particularly process) innovations and firm survival may not always follow the expected pattern according to which innovative firms would necessarily have higher survival odds (Fernandes and Paunov, 2012). Regulations on self-employment or labour-market conditions for firms can also affect the impact of innovation-related changes on inequalities.

Households' earnings inequalities

A third type of inequality concerns household earnings (the earnings of all household members) and household market income inequality (based on capital, savings and private transfers). Beyond returns to work, differential returns to capital and savings have impacts on income inequalities. Factors related to technological change and innovation have impacts on returns to capital; the role of ICTs in raising returns to capital on a global scale is a prominent example (Box 1.2). At the same time, several other factors drive inequalities with potential impacts on innovation and technological change.

Box 1.2. Global superstars, the increasing returns to capital and the role of ICTs

The substantial increase in real and relative earnings of workers at the top of the income distribution – the superstars – is one of the strongest sources of increased wage inequalities in the United States from the mid-1990s onwards. The share of after-tax household income for the top 1% more than doubled from about 8% in 1979 to 17% in 2009 (OECD, 2011). On average relative wages for different skills groups have risen only modestly, whereas from the mid-1970s to mid-1990s there was a general increase to skills for the highly skilled. Evidence on the United States shows returns to middle-level skills appear worse than those to both high and low skills. The modest rise in real incomes overall compared to GDP and productivity growth during the 2000s further shows that returns to capital increased during the period.

The explanation most frequently given involves information technologies (IT). Specifically, they may have affected wage remuneration by making certain tasks – those in the middle of the skills distribution – obsolete. The reason is that IT can often replace repetitive routine tasks while it has little effect on less-skilled tasks (*e.g.* food preparation and personal care) and facilitates highly skilled non-routine cognitive tasks. The result is a polarisation of tasks towards the high- and low-skilled. Cumulatively, these two trends – rapid growth of jobs for those with high and low levels of education – have substantially reduced the share of employment in "middle skills" jobs. This provides a natural mechanism for technological advances – even factor-augmenting technological change – that can lead to real declines in the wages of certain groups of workers and to changes in the structure of employment by occupation. Similar arguments have been made for globalisation: mid-level tasks can probably be more easily replaced whereas many less-skilled tasks have to be provided locally and more skilled ones have to be more strongly rewarded (Goldin and Katz, 2007).

These effects are probably mutually reinforcing: for at least some superstar industries (as e.g. finance, consulting, entertainment or law), globalisation has played an important role in boosting demand for their services, both via the IT evolution by reducing trade costs and thus boosting tradability, and via fast economic growth around the world by boosting demand for these services. With regard to explaining higher returns to capital, intangible capital and reputation capital in particular (*e.g.* Apple) are among the more rewarded types of capital. One explanation – again focused on IT – is the increased return to reputation which comes with wider opportunities for anonymous and global transactions. Interestingly, a potential outcome of such a scenario can be ongoing economic growth with benefits to superstars and capital while generating an increasing gap in returns from growth.

Source: Acemoglu and Autor (2012); Haskel *et al.* (2012).

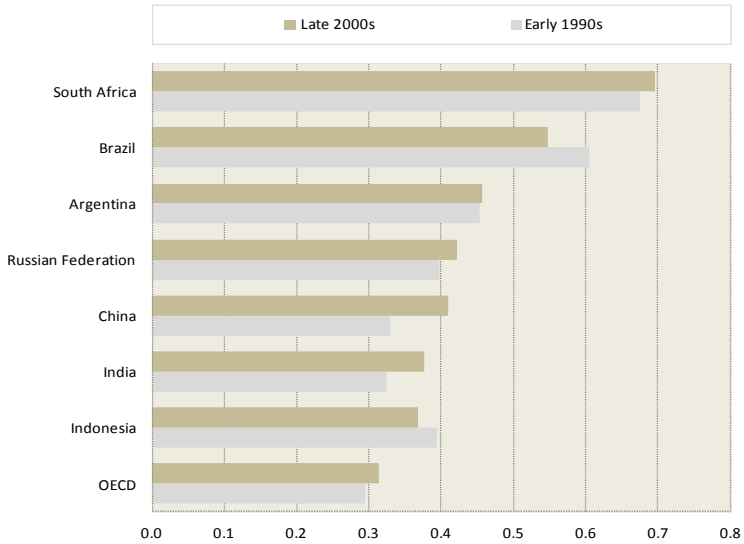
Households' disposable income inequalities

Finally, there are inequalities in households' disposable income (taking into account public cash transfers received and direct taxes paid) and households' adjusted disposable income (taking into account the value of publicly provided services such as health or education). The impact on individuals' income inequality will be a function of a country's tax base, redistributive policies and level of public services. This type of inequality relates to innovation and technological change in very specific ways, such as innovations in the provision of public services. Many examples of "frugal innovations" focus on health and educational services. ICTs might play a role in improving allocations and/or the quality of redistributive policies. Social services face considerable challenges in developing and emerging countries thus rendering agricultural services, rural or distance e-education, e-health and e-government potential areas of application and quality improvement. The ID programme in India will create unique identifiers that may help reduced problems with redistributive policies. Given the relevance of education for reducing inequalities innovative approaches to delivering education will be important.

Characteristics of inequalities in emerging and developing countries

Income inequalities will differ in specific contexts and be particularly pronounced in certain areas such as race, religious groups, gender, regions, sectors of activity, occupations and age groups as well as within groups. Historical factors often play an important role. Inclusive growth does not exclusively concern developing and emerging economies, although some important characteristics of these countries are worth emphasising. First, inequalities are much larger in many developing and emerging countries (Figure 1.2). It is worth noting that inequality levels differ substantially across OECD countries; for example, while the Gini coefficient of income inequality of the United States was 0.38 that of Denmark was 0.25 (OECD, 2011). Moreover, it is important to emphasise that different Gini estimates for countries exist; two important reasons are that *i)* computing those measures depends on measuring well incomes at the extremes of the income distribution (which tends to be very difficult for both the richest and poorest income categories) and *ii)* different "income" measures are used as basis for computing inequality. On the production side inequalities are also much larger in these economies i.e. the dispersion of total factor productivity (TFP) within sectors is particuarlly high (Hsieh and Klenow, 2009; discussed in Chapter 2). This points to striking differences in opportunities for individuals and results in high poverty rates at the lower end. Inequalities that lead to poverty also require innovation policy, among others, to take account of immediate social concerns to justify expenditures so thattheir "catching-up" opportunities are not constrained. The existence of an informal sector makes it generally more difficult to use traditional policies so that specific policy approaches are needed.

Figure 1.2. Change in inequality levels, early 1990s versus late 2000s[1]



1. Figures for the early 1990s generally refer to 1993, whereas figures for the late 2000s generally refer to 2008.
2. Gini coefficients are based on equivalised incomes for OECD countries and *per capita* incomes for all EEs except India and Indonesia for which per capita consumption was used.
Source: OECD-EU Database on Emerging Economies and World Bank, World Development Indicators.

Many factors beyond innovation and technological change shape income inequalities: redistributive policies, education policy, labour market reforms (*e.g.* labour unions), and regulations regarding the hiring and firing of workers. Redistributive policies are much weaker in developing and emerging countries mainly because the tax base is smaller. Moreover, political pressure by richer groups can affect what redistributive policies can do. This means that market incomes have an even larger impact on disposable income in developing countries so that policies targeting the production sector are

important.[3] Trade and globalisation also affect inequality (Box 1.3).[4] Moreover, differences in educational attainment perpetuate inequalities and lead to differences in the impacts of technology and innovation on different groups. By lessening opportunities for potentially important groups in society, educational differences can weaken growth itself. Fewer skills affect the types of innovations which lower-income groups can engage in and benefit from and potentially the impact of their innovations. A variety of policies, including innovation policy, are needed to address inequalities.[5]

Box 1.3. The role of trade in driving wage inequalities

Simple trade theory based on the Heckscher-Ohlin-Samuelson (HOS) methodology predicts that trade openness may affect factor returns and may therefore introduce a gap between two of these factors, skilled and unskilled workers. The theory was extensively analysed as a competing approach to the skill-biased technological change approach. The main conclusions, which suffered from empirical and methodological shortcomings, pointed to limited impacts of trade within the HOS framework.

However, new dimensions of trade and its connections to technology have renewed debates of this issue:

Offshoring and outsourcing of activities and tasks probably provide a different way for trade to affect inequalities, particularly in view of their role in segmenting activities along global value chains. This makes differentiating the impacts of skill-biased technological change and trade rather more challenging and questions some of the earlier evidence on the contributions of trade to inequality.

Trade probably interacts with technology, as they are closely connected, particularly for developing countries; owing to a rather low internal base they largely import technology from abroad (particularly machinery). Some of the existing evidence suggests that skills are upgraded in response to adopting foreign technologies. Technological catch-up facilitated by trade (including outsourcing and offshoring) can be a driving force behind rising inequalities across skills, and trade can, in turn, be further stimulated by technological catch-up (Zhu and Trefler, 2005). Another factor connecting trade with technology is that trade itself may induce some firms to invest more in innovation by providing larger pay-offs to such investments (Bustos, 2011).

Source: Chusseau *et al.* (2008) and other sources as quoted.

In their efforts to catch up, emerging and developing countries often undergo substantial changes which may result in different dynamics, a different context for structural change and inequalities. The question of the "transitional" inequality-growth dynamics will require particular attention (as discussed in Chapter 2).

Conclusion

Innovation relates to inequality in three ways: i) through direct impacts on income distribution (innovation favours the highly skilled and risk takers), ii) as solutions for improving the welfare of lower and middle income groups ("frugal innovation"); and iii) through innovations by lower-income groups themselves, *i.e.* grassroots and informal sector activities, that may lead to community-based solutions. The innovation concept is broadly defined to include non-technological, social and business innovations, which characterise many of the innovations that will be relevant and better describe the innovation context of emerging and developing countries. Innovation plays a role in the different types of income inequality, which are widespread in emerging and developing countries, with poverty as one of its implications. Education is necessary to avoid greater innovation- and technology-based inequalities and to support the innovations of local actors. If inequalities affect the economic opportunities of different groups they will also affect the development process itself. The following chapters focus on the various dimensions of inequality.

Chapter 2

Innovation and Productivity Gaps: Evidence, Causes and Their Importance

2. Innovation and Productivity Gaps: Evidence, Causes and Their Importance

Introduction

The concept of inclusive growth figures prominently in recent political discourse. While the government of India's 11th Five-Year Plan (2007-12) focuses on sustainable growth, it also makes the reduction of economic disparities a key objective. It is a major policy domain for South Africa as well. These concerns raise the question of how innovation and production systems affect low- and middle-income groups. From a macroeconomic perspective they relate to the growth-inequality nexus question and from a microeconomic perspective to debates on "islands of excellence" – firms, regions or universities of international standing which are far in advance of others in the economy – and the spillover opportunities they generate for followers. A related issue is the often substantial group of informal businesses among the lagging firms. This chapter describes innovation and productivity gaps in emerging countries and their causes and discusses why they matter.

The "islands of excellence"

Inequality in terms of innovation performance is "visible" to varying degrees in countries. Countries often have "islands of excellence" which are highly innovative. These may be: *i)* geographic areas, clusters and urban areas; *ii)* innovation expertise and leadership in certain technology fields; *iii)* companies or conglomerates that are innovation leaders in certain activities or several domains; and *iv)* leading universities in certain areas/fields.

Knowledge-intensive production of higher-end sophisticated products often takes place in certain cities (see Box 2.1). Silicon Valley seems to be the model which all countries seek to replicate and, in fact, many have initiated cluster activities for innovation. Clusters have widely been identified as important focus points of innovation performance within countries.

Box 2.1. Dominant cities in low- and middle-income countries

Some cities and urban areas are effectively "islands of excellence" which become centres of innovation but have only weak links to neighbouring rural areas. Examples include: Dhaka (Bangladesh), which provides advanced global banking services that fund an export-oriented modern textile industry; Bangalore (India) which harbours a competitive knowledge-intensive software sector and is gradually moving into pharmaceutical and biomedical research; Karachi (Pakistan) which is competing in production of surgical equipment. The overall contributions of such cities to growth are substantial: Bangkok contributes just over 20% of Thailand's GDP, Lima around 45% of Peru's economy, Manila 47% of the Philippines' GDP, and San Paulo around 19.5% of Brazil's GDP with only 10.5% of the population. Cape Town, South Africa, has just under 8% of national population but generates 20% of GDP. Shanghai with only 1.4% of China's population accounts for around 3% of its GDP.

Source: UN Human Settlements Program (2011), The Economic Role of Cities.

There is substantial inequality in the development process of "modern" sectors as well. For example, Lach *et al.* (2008) describe how Israel's ICT sector failed in the 1990s to support economic growth beyond its own contributions (*i.e.* there were no spillovers to the rest of the economy) and remained an "island of excellence". India's ICT sector combines a cluster of specific sectors with some leading firms and a strong regional dimension to the cluster.

There are as well substantial productivity differences within industries, even when narrowly defined. Such differences are probably more pronounced for innovation performance, at least when the focus is on traditional indicators such as R&D investments and/or patenting. For the United States, the evidence shows that for a given industry the plant in the top 10% of the productivity distribution makes almost twice as much output with the same measured inputs as the plant in the bottom 10% (Syverson, 2004). That is, firms operating less efficiently owing to outdated technologies co-exist with highly efficient frontier firms with up-to-date leading technologies. Such inequality is even more marked in developing and emerging economies: Latin American economies have a very large dispersion of total factor productivity (TFP) within sectors (IADB, 2010). In this regard, Banerjee and Duflo (2005) suggest that in developing countries some firms thrive and use the latest technologies while others use more obsolete modes of production. That is, most low-income countries do not suffer from overall technological backwardness but from a lack of inclusive development (for India, see Hsieh and Klenow, 2009; McKinsey Global Institute, 2001).[6] The list of the top emerging-country R&D investors gives another perspective on leading firms within sectors; these are often large, internationally active establishments which may have little impact on their immediate environment. Technologically advanced firms like Embraer of Brazil, Huawei of China and Tata Motors of India have acquired prominent positions as innovators in the global market. An increasing number of developing and emerging country firms are responsible for major R&D investments (Table 2.1) and tend to account for the bulk of national investments or patents in their countries.

Table 2.1. Top 15 firms from emerging economies in terms of R&D investment, 2011

	Firm	Sector of activity	Economy	R&D investment (million USD)	Employment (thousands)
1	Huawei Technologies	Telecommunications equipment (9578)	China	2392	110
2	PetroChina	Oil & gas producers (53)	China	1774	553
3	China Railway Construction	Construction & materials (235)	China	1407	229
4	Hon Hai Precision Industry	Electronic equipment (2737)	Chinese Taipei	1314	*n.a.*
5	ZTE	Telecommunications equipment (9578)	China	1188	85
6	Taiwan Semiconductor Manufacturing	Semiconductors (9576)	Chinese Taipei	1006	33
7	Petroleo Brasiliero	Oil & gas producers (53)	Brazil	980	80
8	Vale	Mining (177)	Brazil	867	71
9	MediaTek	Semiconductors (9576)	Chinese Taipei	789	5
10	Gazprom	Oil & gas producers (53)	Russia	781	393
11	China Petroleum & Chemicals	Oil & gas producers (53)	China	724	373
12	HTC	Telecommunications equipment (9578)	Chinese Taipei	438	13
13	Tata Motors	Automobiles & parts (335)	India	413	*n.a.*
14	CSR China	Commercial vehicles & trucks (2753)	China	366	80
15	Wistron	Computer hardware (9572)	Chinese Taipei	335	*n.a.*

Source: EC (2011), "Monitoring industrial research: the 2011 EU Industrial R&D investment Scoreboard", European Commission, Luxembourg; OECD (2012), *OECD Science, Technology and Industry Outlook 2012*, OECD, Paris.

Finally, measures of research performance by universities and institutes are similarly skewed, with some of the best universities concentrating a great deal of the research. While this is true of all countries, the distribution tends to be more skewed in emerging economies; for example, Brazil's Escola de Minas is a leader in research in the steel sector while other educational institutions have fairly low performance levels. Embrapa, a state-owned company devoted to agricultural research, is another example from Brazil.

The informal economy

Many developing and emerging economies have a substantial informal sector. The informal sector includes all economic activities which are not officially registered and, in consequence, are not taxed or monitored by governments and therefore not counted in official statistics on the economy. These firms often operate at the "margin" of economic activities. Since this often very diverse sector does not appear in official statistics, all characterisations are necessarily rough. Some point to the fact that these firms operate at low productivity levels owing to their reliance on outdated technologies, have limited or no access to any form of finance, employ largely less-skilled lower-income groups and are not highly innovative (at least in terms of the technological innovations that require finance and skills). Moreover, government support is often limited: most policy instruments only apply to firms in the formal sector and, even more fundamentally, lack of information on these firms makes it difficult to develop adequate policy.

An important policy question is whether informal businesses can be a stepping stone for lower-income groups to enter the formal sector. The informal sector might be a place for the poor to acquire basic skills in addition to making a living. Indeed, whereas codified knowledge is obtain through formal education, tacit knowledge is based on experience, which can be transferred through employment and labour mobility. Some studies show in fact that on-the-job training, self-training and traditional apprenticeships are the most important ways for the poor to acquire work skills in Africa (Liimatainen, 2002; Monk *et al.*, 2008). Suame Magazine, an enormous industrial district in Ghana which provides space for more than 10 000 informal vehicle repair shops, is an example of a successful transformative informal business project. Obstacles such as poor electricity, ICT and transport infrastructure hamper the development of more advanced business solutions which might allow competing with the formal sector for customers.

Other views on the potential of the informal sector are less positive. Schoar (2010) argues that it is wrong to assume that "subsistence" entrepreneurs will move on with time and become transformational entrepreneurs. The author shows that there is no empirical evidence supporting this assumption and argues that, in consequence, protecting subsistence entrepreneurs, for instance, by providing specific regulations for micro and small firms, can hurt transformational entrepreneurs.

Explanations for differences across firms

Why do such striking differences across firms exist? The question can be broken down into two parts: a first concerns why, contrary to the simple classical view, less competitive firms are not eliminated by the more competitive or, alternatively, catch up to survive on markets so that inequality does not occur. A second concerns what, given the existence of such gaps, explains the absence of catch-up in spite of the benefits that lagging firms could reap from it. The relevant factors are described below, with the exception of ICTs which are discussed in Chapter 4.

Competition

A simplified economic framework predicts that because of competition there should be no gaps in productivity among firms within a sector. The reason is that to survive in the market firms need to keep up with others in terms of productivity or they will be driven out of the market and resources will be absorbed by more productive firms. There are several explanations for the possible productivity gaps:

- As firms adapt, there may be temporary differences that will be eliminated in the long run. While this may explain some productivity gaps it does not explain why low-productivity firms survive over extended periods.
- Competition is in fact imperfect so that some firms have monopoly power. They may be protected by various factors: regional scale, transport costs, low product elasticities, fixed entry barriers of various types or political support mechanisms. Such factors can give firms a margin which allows them to survive in the market even if their productivity and innovativeness are below those of the leaders.
- Difficult market conditions may deter firm entry and thus strengthen the position of incumbents. In India, for instance, massive amounts of red tape magnified differences in firm productivity within sectors as unproductive firms were protected (*e.g.* Banerjee and Duflo, 2005; Datt and Ravallion, 2011). Small firms in particular may be unable to meet such challenges so that large firms survive together with an inefficient informal sector.
- Businesses with much lower productivity can exist alongside high-productivity firms if they serve specific markets and offer lower-priced, lower-quality goods than their higher productivity competitors. Such products will be profitable since cheap unskilled labour is widely available.

In summary, even though less productive establishments would reap obvious benefits from increasing productivity and innovation, they may not catch up because they are insulated from competition. And while competition may stimulate innovation and raise competitiveness, the idea that competition alone will suffice is probably mistaken. While competition alone may result in the exit of inefficient producers, it will not necessarily generate entry. In fact, if there is a substantial informal economy and underemployment, labour will not necessarily be put to more efficient use as inefficient businesses exit.

Lack of production factors

- **Lack of skills and managerial capabilities** across the economy can inhibit overall upgrading. Firms need managerial capabilities, organisational practices and decision-making processes if their innovations are to succeed (Bloom and Van Reenen, 2010; Faggio *et al.*, 2010). The dispersion of productivity across firms may therefore be due to the limited availability, heterogeneity and allocation of managerial capabilities. A lack of qualified workers able to deal with changing technologies and new innovations can also mean that some firms adopt new technologies while others do not (Faggio *et al.*, 2010). Moreover, if new sectors do not absorb labour and old sectors are destroyed, workers may find themselves in second-best employment, *e.g.* low-productivity self-employment (Rodrik and McMillan, 2011). Skills development and retraining will be necessary to improve the match of skills to new technologies and processes, an investment which not all firms may be able to undertake.
- **Lack of financing** for the necessary investments, which is related to the capital market imperfections that can be substantial in developing countries, can hinder adoption of technologies and/or innovations. There is ample evidence that smaller and young firms in particular are disadvantaged in this regard. This can widen the productivity gap. The investments needed to obtain licences or adjust production processes to take advantage of innovation can be strongly affected. Paunov *et al.* (forthcoming) look at the impacts on firms with and without access to bank finance of Indonesia's trade liberalisation, which substantially increased firms' exposure to foreign competition and their opportunities to benefit from foreign knowledge.
- **Lack of information** is also important. Firms may simply lack information about a technology that would be useful to them or, if such knowledge is available, about how to implement it. Distance might inhibit knowledge flows and also explain strong regional differences in performance to some extent.
- **Institutional weaknesses** can also make upgrading difficult. For instance, firms with high marginal returns may underinvest because weak institutions engender a great deal of red tape (Banerjee and Duflo, 2005). Red tape can slow down investment plans and/or increase their costs so as to potentially even discourage some investments firms would otherwise engage in to catch up with leading firms.
- **Lack of suitable business conditions.** Indirect costs (related to infrastructure and services) account for a relatively high share of firms' costs in poor African countries and place a competitive burden on African firms (Eifert *et al.*, 2008). The manufacturing sector uses inputs such as logistics and infrastructure more intensively than agriculture or extractive industries, so poor infrastructure and public services slant comparative advantage away from secondary activities. Only large firms may effectively be able, through internalisation, to face high costs and be ahead of the pack.

Structural factors

- Structural factors related to the sector of activity, *i.e.* the way "islands of excellence" develop may constrain knowledge spillovers. The primary resource sector is a well-known example of an industry with limited connections to the rest of the economy, although a revisionist literature (discussed in OECD, 2012) argues that in some cases opportunities to provide knowledge-intensive services create development opportunities. This explanation is sector-based but could equally apply to industrial hubs in certain areas and/or of certain types which might lend themselves less to spillovers to the rest of the economy.
- Structural factors related to foreign participation. Trade and foreign direct investment (FDI) facilitate access to foreign know-how and technologies, but structural conditions can affect productivity gains differently. These conditions include the way foreign companies operate in the local economy and their relationship with national suppliers, competitors and customers, and the capacities of the local economy. Lach *et al.* (2008) argue that the failure of Israel's ICT sector to generate benefits for other national firms was its strong export orientation, which restricted domestic linkages. This meant that few national consumers and/or firms were direct clients of ICT firms and benefited from their technology and knowledge.
- Scale is also an important factor of productivity in innovation-intensive activities. Large firms are important players in innovation systems. As a result, certain economies will have a small number of large, high-productivity, innovative firms surrounded by many small, low-productivity firms, often in the informal sector. Inequality sometimes seems effectively to be the price to pay for competitiveness because of the advantages of scale, but it is by no means inevitable (Box 2.2). However, market power, which is often associated with scale, can also reduce incentives to innovate. Moreover, scale may play a different role for different types of industries and innovation projects. Certain small firms may have a much larger innovation potential than larger businesses, which may face greater internal resistance to change. With insufficient market competition, large firms may rely on rents (notably in extraction industries) rather than innovation.
- Available labour capacity is an important issue for growth sectors. It is particularly crucial for certain high-technology sectors in which the dominant technology or mode of production requires a type of labour that is scarce within the economy but does not require unskilled labour. It can equally be a factor in within-industry differences across firms, some of which use advanced technologies that require qualified labour only whereas others, including large number of informal firms, rely on "surplus" labour that cannot work with new technologies.

Box 2.2. Scale constraints and inclusive development

There are examples of inclusive and exclusive industrial development. Bangladesh's food processing sector is increasingly based on large-scale processing industries at the cost of home-based businesses. It is the lack of scale which makes the adoption of technologies less useful to small businesses and constrains their efficiency. Since big firms do not absorb large numbers of workers the industry is not inclusive.

By contrast, Malaysia's efforts to develop successful palm oil exports were part of an economic restructuring effort aimed at alleviating poverty and inequality. They took place following a land scheme which allocated land to small-scale producers. To ensure efficiency (which in this case also required substantial scale) centralised management of the production processes of the various small-scale producers was implemented. The process has therefore been much more inclusive than in Bangladesh's food-processing sector, with joint operations the response to the scale constraints of smallholders.

A similar type of distribution characterises the cultivation of medicinal plants, which became, at the end of the 1990s, with the rise in international demand for herbal products, an increasingly attractive export sector for Indian producers. The structure of the sector is a pyramid: tribal communities in forest areas do most of the planting and count on a few alternative livelihood opportunities; at the bottom, small, family-owned businesses manufacture and sell the products locally. Only a small number of large pharmaceutical companies in India operate in international markets. In this case ensuring that all groups share in the industry's growth is a challenge.

Source: World Bank (2006).

Innovation-based growth and its impacts on inequality: a transitory phenomenon?

According to Kuznets (1955, 1963), rising inequality is a consequence of development, *i.e.* the relationship between inequality (on the vertical axis) and average income (on the horizontal axis) has an inverted U shape. The rationale is simple: with industrialisation there is a growing gap between urban and rural populations as the latter are employed in less productive pre-modern agricultural sectors while the former profit from working in the "modern" economy. Eventually, inequality declines since an increasing share of the rural population migrates to cities and joins the modern sector. This argument implies that during a period of transition, which may be considered to characterise catch-up growth in developing and emerging economies, inequality is necessary and, in any case, no cause for fundamental concern as it is not expected to last.

Several studies have attempted to explore the empirical validity of the Kuznets argument, but have faced many methodological challenges so that no final conclusions can be drawn. Recent growth experiences do not provide a simple picture: Korea followed a growth path that did not expand inequalities while most Latin American countries continue to exhibit substantial, albeit decreasing, inequalities (OECD, 2011). There is no evidence that inequality is a more or less unavoidable by-product of rapid economic growth (Ravallion, 2005). Moreover, growing inequality in developed economies (*e.g.* the United States and the United Kingdom) points to more complex growth-inequality relations than those associated with development transitions. Finally, the growth trajectories of the past may be fundamentally different from those of the future, especially because countries that are industrialising today often specialise in activities of global value chains. The increased importance of knowledge-based service activities may also affect growth trajectories of emerging and developing countries, resulting in potentially different inequality patterns.

2. Innovation and Productivity Gaps: Evidence, Causes and Their Importance

Generally, developing and emerging countries – but probably also developed economies (in the case of information technologies and their impacts) – are exposed to multiple transition periods, as they move not only from agriculture to industry but then face other sectoral adjustments (*e.g.* a shift from sectors with low-technology production to higher-technology activities) or adjustments within sectors towards more high-end products (given substantial heterogeneity even within narrowly defined sectors). Transition dynamics can produce structural effects very different from those of less "disruptive" growth scenarios. Building absorptive and learning capabilities for innovation is an essential part of the development process. In the early stages, large parts of the population lack access to the education and financial markets that are necessary to the modern sector; the transition process will then involve only a small part of the entire population. Consequently, initial economic growth will produce higher initial returns for the relatively well-off in terms of capital and skills. The adoption of new technologies requires time and is costly, and the diffusion process is slow; the initial stages of development are therefore not inclusive. The build-up of specialised industries that compete in world markets creates a greater need for skilled labour, and the supply of labour must adjust through investment in education and familiarisation with new production structures. Therefore, many technological innovations tend initially to raise inequality. As more workers leave the traditional sector and adopt the most recent technologies, income inequality declines over time as relatively few workers are left behind and newcomers can catch up more quickly.

Inequality can be expected to diminish as the transition process come to an end but a variety of factors can affect this:

- First, the transition to more innovation-intensive activities will depend on workers acquiring sufficient skills in the process.
- Second, entrepreneurs' limited access to financial resources hinders their adoption of innovations and slows the transition process.
- Third, the transition process differs in its impacts on lower-income workers and entrepreneurs' opportunities (*e.g.* new sectors may offer limited employment for workers from lower-income groups since skills requirements are high).
- Fourth, the transition is quicker if labour and capital resources are efficiently redeployed. Competition can play a role in determining the speed of such changes as can the provision of training opportunities and capital markets.
- Fifth, the nature of economic growth may determine what happens to inequality; there is evidence to suggest that the sectoral composition of economic growth matters substantially for poverty alleviation. Success in tackling poverty is greater with growth in unskilled labour-intensive sectors (agriculture, construction) (Loayza and Raddatz, 2010).
- Sixth, job destruction processes in "old" sectors can have very different effects on inequality. If these dynamic effects affect the development process they may have longer-term impacts. It has been argued that a gradual phase-out and a combination of incentives that support new sectors can be optimal for transition processes (Caballero and Hammour, 1996). This will also have implications for inequality. The Czech and Estonian transitions after the collapse of communism are interesting in this respect; both countries achieved similar levels of sectoral reallocations. However, in the process the Czechs "paid" for lower unemployment with subsidies (taxpayers' costs), whereas in Estonia many jobless workers received little welfare support (Jurajda and Terrell, 2008).

How does this matter for growth and inequality?

Costs of productivity gaps across firms

Diffusion and widespread adoption of technologies and innovations will improve overall performance by reducing the productivity gap across firms. Hsieh and Klenow (2009) show that if the dispersion of total factor productivity across Indian and Chinese manufacturing plants could be reduced to the level of dispersion in US manufacturing plants, between a third and a half of the gap in aggregate TFP between the United States and these economies would be reduced. Therefore, stronger spillovers would improve the overall economic performance of emerging and developing countries.

Inequality across firms and income inequality

Chapter 1 discusses the relationship between innovation and income inequality, while this chapter looks at inequalities across firms and focuses mainly on differences in productivity. The relation between the two is complex but a number of points are worth making. It is not necessarily the case that more productive firms employ only higher paid workers (in fact, they pay low wages to some employees), but they do, on average, pay higher wages to those that use technologies. Introducing innovations is also likely to raise returns to labour and to entrepreneurs. It is true that a share of the higher wages is related to higher returns to education, given the skill-biased nature of technological change. Yet, this does not fully explain differential payments across more and less-productive firms. To the extent that using new technologies in more productive firms raises skills through on-the-job training, working in those firms can raise wage returns compared to those in less productive firms. An important condition is the extent to which workers and entrepreneurs share in firm revenues. Firms in growing sectors are more likely to invest in education for their employees. There is also a correspondence between productivity gaps and income gaps in the informal sector. Entrepreneurs in the informal sector have great difficulty obtaining machinery (owing to financing constraints) and/or recruiting skilled managers. This lowers their productivity and thus reduces wage payments to workers who, under better management and with the right tools, could produce much more and have wages that are closer to those of workers in firms with access to machinery and adequate management.

Inequality at the macro level

While reducing productivity gaps across firms can improve overall performance and help reduce income inequality, this raises the question of whether these reductions in inequality interfere with growth. A classical argument for wider income inequality has been that concentration of resources will encourage saving, hence needed investments. Such arguments, however, do not have much theoretical or empirical support. Rather, the evidence suggests that there is a negative inequality-growth relationship (Box 2.3).

Supporting "islands of excellence" and the lagging segments of the economy

What should be the economic development targets in the presence of scarce resources, notably skills but also financial constraints and challenging framework conditions? One type of strategy seeks to focus on "islands of excellence" by channelling a substantial share of resources to leading sectors. Pragmatically, scarce resources might make this strategy optimal and in fact the only feasible option. If resources were spread evenly across all types of activities, there could effectively be no returns to investment. Hausmann and Rodrik (2003) point to the important role of venturing into new sectors of activity to discover what an economy is good at producing. To raise productivity, governments can stimulate investment in earmarked sectors to create "islands of excellence" that will allow the country to compete on world markets. This will require even more effort. India's Bangalore district is one of the most important ICT clusters located in a developing country. The combination of a skilled workforce and the presence of multinationals with strong links to local firms boosted the development of local dynamic capabilities and formed an innovation system that outcompetes ICT hubs in other countries.

Box 2.3. A macroeconomic perspective on inequality and its impact on growth

The main argument for considering inequality good for growth is that it can spur growth-enhancing investments which require savings. If the rich have a higher marginal propensity to save than the poor, transferring income from the poor to the rich can encourage capital accumulation and lead to a higher steady-state level of capital and output per worker. This might be particularly important in early stages of development (Galor, 2011). However, this argument does not hold if the rich do not invest in capital to build up "modern" sectors but instead spend on consumption, including of luxury goods which contribute little to economic development (Arocena and Sutz, 2012).

Several arguments suggest instead that inequality negatively affects innovation-based growth. One is that in the presence of credit market imperfections the lack of access to capital can reduce investments in human capital (Galor, 2011). Talented individuals who would benefit from further education are excluded; only those with financial resources are educated. Also, if talented but low-income entrepreneurs have limited access to financing, potentially successful projects cannot be realised. If there are production externalities such as learning-by-doing effects and knowledge spillovers, and production is characterised by decreasing returns to *individual* capital investment, then lower inequality fosters growth (Bénabou, 1997). Since capital market imperfections are greater in emerging and developing countries, the downsides to inequality described here are likely to be much more important than in developed countries and to persist over time. Moreover, inequality can lead to conflict, corruption and crime and therefore to policy making that focuses less on fostering growth. Inequality also produces greater scope for discrimination across gender, ethnicity or other criteria and when resources are not allocated according to ability there are costs to the economy.

In addition, it has been argued that inequality is bad for growth because growth-enhancing institutions cannot be developed without a broad middle class (Easterly, 2007). It is also argued that a strong middle class fosters growth and innovation through demand for mass-produced innovative manufacturing goods which the poor cannot afford. The middle class plays a central role in creating domestic markets (Birdsall, 2010). Other contributions of the middle class include fostering entrepreneurship, shaping demand and making it politically more feasible to engage in policy reforms and implement institutional changes and public investments for growth.

Finally, the empirical, largely cross-country, evidence generally tends to deny a negative inequality-growth relationship (*e.g.* Bénabou, 1997; Berg and Ostry, 2011). An interesting case study of Korea and the Philippines suggests the advantages of lower inequality for growth. These countries had similar macroeconomic indicators in the early 1960s (GDP per capita, investment and savings), but substantial differences in inequality. Korea was a much less unequal society in terms of income and grew much faster than the Philippines.

However, this chapter has emphasised that another important issue also involves how leading sectors interact with the rest of the economy. These interactions can vary. One hypothesis is that spillovers from the leading sector will be taken up by the rest of the economy. Another is that the concentration of resources will further depress performance in other sectors, thereby reducing rather than improving performance (as key resources are used up by the modern sector or firm which may not employ workers or entrepreneurs from less productive sectors or firms). The question is what can be done to support interactions among sectors, perhaps including support for sectors that provide more spillover opportunities (*e.g.* sectors that can also give employment opportunities to medium-skilled workers). In practice the dissemination of innovation from "islands of excellence" is often problematic and can lead to a dual economy with huge productivity differences (*e.g.* Lach *et al.*, 2008). Zajac and Baláž (2007) look at the pharmaceutical industry in the Slovak Republic. They show that after the transition to a market-based economy in the 1990s, domestic firms adopted low technologies and were often very inefficient. In contrast, newcomers from abroad had high productivity levels and took over R&D facilities and created "islands of excellence". Only a certain number of domestic firms, such as Zentiva, were able to participate with these more advanced partners. Lach *et al.* (2008) describe how Israel's booming ICT sector failed to reach other sectors and remained an island of excellence. Similarly, the Slovak pharmaceutical industry adopted world-class standards, while other parts of the Slovak economy lagged behind. As the Slovak government did not have an inclusive innovation policy the result was huge regional disparities in employment rates, education and income levels (Baláž, 2007). Finally, a country's position in global value chains may also affect catch-up to the technology frontier.

Conclusions

Emerging and developing countries often have "islands of excellence" which are very innovative, world-leading businesses, sectors, regions and research institutions or universities. These coexist with a large group of unproductive firms, not only in the informal sector. In consequence, productivity gaps across firms even within narrowly defined activities are much larger than in developed countries. Competition certainly plays a role but will not alone resolve challenges, as substantial informal sectors and high levels of underemployment show. Difficulties associated with access to skills, information, institutions and finance are as much a part of the explanation as more structural factors, such as the limited capacity of lagging segments of the economy to connect to high-growth sectors and/or firms. In the transition towards modern sectors, firms or activities that are more innovation-based and help achieve international competitiveness are particularly important but may lead to temporary increases in inequality. In fact, the evidence suggests that there are ways to affect inequalities that might have longer-term impacts. Facilitating dissemination can help increase overall performance, have an impact on income inequality and stimulate growth. When fostering "islands of excellence" it is necessary to consider the trade-off between pragmatic policy approaches aimed at supporting "islands of excellence" and the benefits of dissemination.

Chapter 3

Innovation for and by Low- and Middle-Income Groups

Introduction

The aim of "inclusive innovation" is to harness science, technology and innovation know-how to address the needs of lower-income groups. The prospect of improving the welfare of society's most disadvantaged groups has generated much policy interest. If profitable business models can be designed to cater for lower-income markets, lower-income groups would benefit more. Not-for-profit initiatives also play an important role. A difficulty for "inclusive innovation" is that it is not simply a question of price: lack of information and community involvement reduce rates of adoption and must be addressed. Innovation by lower-income groups (often called "grassroots innovation") can also make a difference and may in fact be particularly important for the wider uptake of innovations by lower-income groups.

Examples of innovations for the "bottom of the pyramid"

Inclusive innovation can boost the welfare of the poorest by providing innovative products and finding innovative ways to address their needs. One approach is to provide cheaper, simplified and possibly lower-quality versions of more sophisticated goods and services. However, their quality must be sufficient to achieve welfare benefits but quality raises cost and can therefore lower uptake among lower-income groups. Box 3.1 provides several examples.

Box 3.1. Examples of inclusive innovation

Eye care. Through the use of "workflow innovation" India's Aravind Eyecare Hospital has saved over 2 million patients so far from blindness. Cataract surgery, which costs around USD 3 000 in advanced countries, is done for USD 30-300, the price being determined by the capacity to pay. The quality compares with international benchmarks. Aravind Eyecare performs 200 000-300 000 operations a year.

Computer-based functional literacy. People are poor because they are illiterate, and they are illiterate because they are poor. An Indian company has developed a technique called computer-based functional literacy (CBFL) to teach an illiterate individual to read a newspaper with only 40 hours of training at a cost per individual of only USD 2. There are 800 million illiterates in the world; this technique could make them all literate for less than USD 2 billion.

Bici-Lavadora. The Bici-Lavadora (a MIT D-Lab project in the United States), is a portable, pedal-powered washing machine. With an estimated prototype price of USD 127, this innovation stands to increase greatly the productivity of washerwomen and bring some of the benefits of an appliance often taken for granted elsewhere in the world at low cost and without reliance on electricity.

MoneyMaker Irrigation Pump. The MoneyMaker Irrigation Pump designed by KickStart International (NGO) in Kenya helps poor families become self-sustaining through small-scale farming. These low-cost (USD 100) pumps are sold in local shops and enable poor farmers to move from rain-fed agriculture to irrigated commercial farming. On average farmers increase their annual incomes by over USD 1 000, an increase which raises families out of poverty. The pumps are foot-powered and have a maximum pumping height of 46 ft. and a daily irrigation capability of 1.25-2 acres. They can significantly increase the yield and crop diversity available to small farmers. With over 153 000 pumps sold (by January 2010), and 97 500 business created, KickStart estimates that the pump has lifted 488 000 people out of poverty.

Source: R. Mashelkar and V. Goel (2010), "Inclusive Innovation: More from Less for More", draft.

Types of products for lower-income groups

Products aimed at high uptake need to reflect lower-income groups' consumption preferences and conditions, which differ from those of higher-income groups: the types of products that will matter most for those with small budgets relate to health and food as well as agricultural production (a main occupation for many lowest-income groups). Other categories are products aimed at improving basic living conditions and education (*e.g.* mobile telephony services for communication and access to basic information, sanitation-related measures, access to baseline electricity, etc.). For middle-income groups, cheap cars and laptops will also be part of their consumption priority lists along with products and services offering business opportunities.

Consumption differs for different income segments. Aside from middle-income groups, Rangan *et al.* (2011) define three sub-groups of low incomes: a daily income equivalent to USD 3-5, USD 1-3 and less than USD 1. The richest of the low-income groups have basic education and often steady incomes. They will purchase basic products but are also potential customers for affordable innovative products and services to support small business activities. For the mid-level low-income group educational levels are lower and job stability is less likely. Their main priority will be to secure basic access to services and products for daily life. They lack the resources to explore options for building a business. For the poorest group access to even the most basic products and services is a challenge.

Demand-side factors for uptake by lower-income groups

High sensitivity to price is the most obvious characteristic of lower-income markets. For those with less than USD 1 a day most innovative products will probably only be within reach if they are free. There is evidence that price sensitivities play a crucial role for uptake. Based on several random evaluations across four countries, for example, Bates *et al.* (2012) find that even small fees cause big reductions in the take-up of education and health products. Similarly, based on a randomised experiment of uptake of antimalarial insecticide-treated bednets by pregnant women, Cohen and Dupas (2010) found that uptake drops by 60 percentage points when the price of the bednets increases from zero to USD 0.60 (*i.e.* from a 100% to 90% subsidy). Moreover, evidence from randomised experiments in Kenya to estimate the relative importance of subsidies for new antimalarial bednets shows that temporary subsidies to a subset of households considerably increase short-run adoption rates among both subsidy recipients and their neighbours, and subsequently increase willingness to pay for bednets through income and learning-by-doing effects (Dupas, 2012). This points to the importance for uptake of knowledge about products and their application (discussed below). Price constraints are probably only the most obvious obstacle to adoption.

Products must be adequate for the specific user context. Box 3.2 provides examples of different types of product adjustments for lower-income users. Without such adjustments, uptake would have been much lower, since lower-income groups often lack some of the conditions needed to use innovative products (*e.g.* access to electricity).

Box 3.2. Product adjustments for low-income groups

Modified mobile handsets

Nokia offers mobile handsets with simplified menus for wider access, multiple phone books to allow for several users and integrated flashlights (power cuts are frequent in developing countries). Similarly, Motorola's Motofone F3 has a simple keyboard to make it easier for illiterate people to use, long-lasting batteries and robust design.

Modified water purifiers

The Tata Swach water purifier and Procter & Gamble's PuR Purifier of Water are robust, portable and cheap.

Modified automated teller machines (ATMs)

Prodem FFPs and CICI Bank's Smart ATMs, provide low-cost solutions, with digital fingerprint recognition to scan customers and make it easier for illiterate customers to use the ATMs. These are also designed to withstand difficult conditions, such as extreme weather and power shortages.

Modified household items

The USD 70 refrigerator developed by Godrej & Boyce Manufacturing runs on batteries. The wood-burning stove produced by First Energy consumes less energy and produces less smoke.

Information about innovative products is essential. Low-cost innovations are often available but not taken up to deal with certain needs (*e.g.* energy-efficient cook stoves, water purifiers, protein supplements or certain vaccines). One important reason is that low levels of education and often high rates of illiteracy among lower-income groups lessen opportunities to gain knowledge about potentially useful products and about how best to use them. There are two dimensions to the information challenge. The first is simply the need to provide information about the innovation's benefits. A second, more complex issue is that benefits may not be well understood. For instance, Duflo found that even when a local non-governmental organisation (NGO) helped ensure free, regular and well-publicised visits in Udaipur, only about 18% of children received vaccinations. The "soft networks" strategy adopted by some projects (described below and in Table 3.2) as part of a cost-reducing business process strategy also helps to address demand challenges. These networks often rely on trained community members to explain the benefits and use of products. This helps build credibility and, as a side effect, empowers lower-income groups by including them in the value chain (Karamchandani *et al.*, 2009).

Demand has to reflect needs. Low-income groups generally spend to address short-term needs and lack the resources and access to instruments necessary to save. The result is that poor individuals' consumption and investment decisions tend to be persistently inefficient, thereby lowering demand for innovative products in spite of their potential for improving well-being (Mahajan and Tarozzi, 2011). This points to the limitations of profit-driven inclusive innovation projects unless these are complemented by credit, savings and insurance services or alternative public involvement.

Community involvement and social conditions strongly affect uptake. Miller and Mobarak (2011) found that the lack of trustworthy information about new cook stoves in rural Bangladesh led to limited uptake. Community leaders have often been identified as potential help in reducing such problems, especially when the costs and benefits of a given innovation are not clear. Social innovations can also play an important role for uptake. In Kenya, for instance, information sharing on agricultural production techniques was limited because social norms prevented technology adoption that would have required people to alter their behaviour significantly (Duflo *et al.*, 2003). Various social factors can also limit adoption. For instance, one reason for lower adoption of cook stoves in Bangladesh was women's lack of intra-household bargaining power since women are the main users and, thus, direct beneficiaries (e.g. health benefits) of these new cook stoves. In addition, lack of perceived ownership of innovations can also reduce uptake and is a reason why grassroots innovation (discussed below) is quite relevant.

Profitable supply-side business factors for uptake by lower-income groups

"Inclusive innovation" stands a higher chance of reaching a large group of low-income groups if it provides opportunities for profitable business models. Several innovative approaches have been developed: one focuses on pricing and financing and another on innovative business processes. This section draws on a variety of sources and in particular on Karamchandani *et al.* (2009) and CII-CESD (2011).[7]

Pricing and financing strategies

Some suppliers have focused on pricing and financing strategies that take into account the revenue constraints faced by low-income groups, *i.e.* limited access to credit, irregular cash flows and low savings (Table 3.1). A first successful pricing model includes "pay-by-use" services. It has been used to provide water, energy and mobile services and helps in particular consumers with irregular incomes and limited savings to pay for access to services. While useful, the model faces a financing ceiling imposed by the revenues of low-income groups. Several approaches have gone further: the tiered financing model, for instance, consists in recovering full production costs by segmenting markets, *i.e.* charging higher prices for higher income groups than for lower-income groups so that richer customers cross-subsidise consumption at the lower end. An alternative approach, chain financing, offers financing options jointly with the good or service. Other approaches provide credit, savings and/or insurance directly. By contrast, the failure to take financing constraints into account has resulted in project failures. The Nest Aishwarya Solar Lantern, for instance, was a cost-effective solution and its advantages were well understood and appreciated by potential users. However, the pricing scheme required high up-front commitments, which were close to two weeks of wages for most potential buyers.[8]

Modification of business processes

To attain financial sustainability businesses have also explored modifications in business processes. Table 3.2 describes different approaches. One business strategy, the "no frills" approach, has consisted in reducing product characteristics so as to diminish production costs. That strategy, however, creates a potential dilemma. The quality of the products or services still needs to be sufficient and may therefore be attractive to consumers able to purchase the more expensive product. In the absence of ways to discriminate prices for lower- and higher-income consumers, this approach could be rather costly for the company. Such a pricing approach can be a rational business opportunity in a product cycle dynamic, however: firms provide lower-income markets with older versions of their products at a lower price. While still innovative, these products are no longer sold on rich country markets but provide sufficient gains for low-end customers. Another business process strategy focuses on efficiency gains by re-engineering processes. One strategy has consisted in exploiting specialisation in a way that maximises the use of a widely available and much cheaper lower-skilled workforce. Interestingly, this has also been applied to medical services which typically rely on highly skilled professionals. A related approach has consisted in increasing specialisations to obtain cost gains through economies of scale.

A further set of business process innovations has focused on improving product value chains. Lower-income markets are often characterised by higher market access costs because transport is often difficult and because of monopolistic structures in intermediary services; transporters, traders, commission agents and wholesalers may take between 30% and 45% of final market values (Karamchandani *et al.*, 2009). Cutting out intermediaries by directly sourcing from lower-income producers and/or relying on them for distribution can be an effective and profitable business model. More fundamental changes along the value chain can allow for further gains; India's Aravind Eye Care is based on a comprehensive modification of the entire ecosystem of the core activity, with a lens manufacturing joint venture, research and training institutes, and civil society groups that organise patient screening events in rural areas.

Table 3.1. Pricing and financing strategies

Strategy	Examples
Pay-as-you go: users can pay in small units for service access instead of high fixed costs	• In India the Byrraju Foundation has provided water purification services at half the price of alternative ways to obtain clean water through community filtration plants. The business model is pay per use. • In Laos the Sunlabob windfall energy initiative has provided windfall energy in remote rural areas using a pay-per-use approach. • In Medellin, Colombia, the main electricity provider EPM has developed a pay-as-you-go pre-paid card for customers whose service was cut for non–payment. A percentage of the pre-paid card pays the debt. This initiative has "reconnected" these customers to the system.
Tiered-pricing: price discrimination whereby higher-income users cross-subsidise lower-income users in exchange for extra services or via other forms of market segmentation	• In India Ziqitza operates the 1298 programme, a network of fully equipped advanced and basic life support ambulances. 1298's business model uses a sliding price scale based on a patient's ability to pay, which is determined by the kind of hospital to which patients choose to be taken. Financial sustainability is assured through cross-subsidisation.
Micro-leasing: potential customer purchase use rights rather than ownership of product	• In India SELCO provides solar power to the rural poor. To overcome the big one-off cost of a solar panel it treats it as a service rather than a product. SELCO acts as a credit guarantor for a middleman to purchase some of its solar light on credit and then lease out the light to customers such as farmers or vegetable sellers for one night of use, distributing them in the evening and collecting them in the morning.
Chain financing: provides not only goods or services but also financial solutions to purchase them	• CEMEX Patrimonio Hoy operates in various countries in Latin America. It stimulates the use of savings of poor households for housing. The programme provides access to construction goods but also financing and counselling services. • Pride Africa's Drum Net in Kenya helps farmers to buy farm inputs by providing chain financing. • In Colombia, Pavco Colpozos promotes efficiency in agricultural production by selling to farmers technological solutions for water management using flexible payment models. • Mexico has a partnership between Bimbo, a producer of bakery goods with a big distribution network, and Fincomun, a microfinance institution. Fincomun agents take advantage of transport by Bimbo supply trucks to reach potential clients, small low-income shop owners. Access to the payment history of the small shop owners of purchasing Bimbo products serves as a first filter for future credit candidates. Bimbo also benefits as its consumers have higher access to credit and are more likely to pay on time for Bimbo's products.
Credit, savings and insurance opportunities for low- and middle-income groups	• Microfinance is perhaps the most important contracting innovation for reaching the poor. Starting with the successful example of the Grameen Bank in Pakistan it has been successfully replicated in a variety of contexts. Many microfinance experiences around the world testify that this contracting innovation, through joint liability, changes the behaviour of borrowers, reduces monitoring costs, and enforces payment through peer pressure, all of which helps making credit more available for the poor. Dynamic incentives that base the possibilities of credit on previous credit performance are an interesting case. • By indexing insurance to measurable scenarios that cannot be manipulated by customers, monitoring and inspection costs decrease and insurance solutions can be offered to lower important risks for the poor. An example is the BASIX index-based weather insurance, which reduces monitoring and farm level inspection to confirm crop losses.

Table 3.2. Modifications of business production practices

Strategy	Examples
No frills: focus on the uses that are truly valuable for the poor	• Tata Nano, the world's cheapest car, priced at around USD 2 500 in 2012, is based on various business innovations of which the most important is the no-frills approach. It is a very simple car with few of the extras of modern cars.
Deskilling and standardisation: divides processes into simple tasks that can be done by low-skilled workers after some training, and uses high-skilled workers only for the highly specialised tasks	• Narayan Hrudayalaya (NH) Cardiac Care Centre, a private corporation located in Bangalore, charges patients USD 1 500 for heart surgery that would cost USD 4 500 in the Indian market and USD 45 000 in the US market. Profits are achieved through internal process innovations: i) specialisation based on deskilling some processes so they can be performed by low-skilled workers; and ii) identifying the complex processes to be performed by specialists rather than general doctors. By training low-skilled workers, mainly women, to perform simple tasks, the poor are integrated in the value chain. • The Well-Family Midwife Clinic Partnership Foundation of the Philippines (WFMC) saves on costs by having doctors on call and not on staff and by relying on a network of registered midwifes.
Specialisation: standardise processes to make them easily scalable and traceable	• LifeSpring, a public-private joint venture between Hindustan Latex Ltd and the Acumen Fund, is a network of maternity and child healthcare hospitals that reaches poor women and children with no-frills, low-cost services. By specialising in maternal and childcare, LifeSpring relies on a narrow range of drugs, which can be purchased in bulk at lower cost. Also, LifeSpring has identified 90 standard clinical procedures and protocols which are used for process innovations. Doctors devote their time to the tasks for which their expertise is needed, while other workers do less demanding tasks. • The NGO Gyan Shala provides primary education at low cost by using standardised curricula and lesson plans to exploit economies of scale. The approach has also made it easier to monitor the quality of the education service provided.
Soft networks: use community networks and their knowledge (including door-to-door distribution and advertising strategies) to address low demand that is due to limited access to information	• VisionSpring is network of women selling eyeglasses at a low price through the Vision Entrepreneur programme. • Hindustan Unilever through the Shakty Initiative trains women to become micro-entrepreneurs by selling personal care products. Consumers benefit through better personal hygiene and prevention of illness, and the women improve their bargaining positions inside their households and their communities. • The Arogya Ghar Clinics for Mass Care is based on a system of mobile kiosk-based clinics operated by women with high school education who deliver care door-to-door. • Under the Grameen Village Phone initiative women in Bangladesh and Uganda sell retail phone services in their villages.
Value chain inclusion: leverage the poor for producers' access to resources and knowledge (contract production, deep procurement and demand-led training)	• Tata Nano used different cost-reducing strategies such as an innovative distribution system that lowers costs. Reaching consumers in distant areas was made easier by establishing assembly units closer to customers. This allowed Tata to eliminate one step in the distribution chain. Moreover, local production helped improve the relationship with customers and enhance the corporate image. • The Aakash Ganga River initiative has helped 10 000 villagers access clean water by renting rooftops from the poor to collect rainwater, channel and sell it. • Nestle Pakistan has developed a deep procurement model that collects milk directly from 160 000 small farmers. • Indupalma in Colombia integrates farmers in the supply chain of palm oil production and helps them become landowners, create associations, buy inputs and machinery, and gain access to credit to improve the overall business process.

Another approach seeks wider inclusion of lower-income groups in the value chain. Methods such as the "soft networks" strategy have not only allowed cost reductions but also addressed demand constraints, as discussed above. Other ways of including lower-income groups include: **contract production** which introduces small suppliers into production chains and provides them with the necessary inputs; **deep procurement** which enables input purchases from large networks at lower prices as well as training; and **demand-led training** which introduces a third party to identify, train and help in the process of job matching (Karamchandani *et al.*, 2009). Such methods can also generate employment and diffuse knowledge and technology, so that local entrepreneurship can be further promoted.

Finally, successful initiatives have often combined several of the approaches described here. Comprehensive business process innovations have been at the heart of successful product offers to lower-income groups. Since, as is often the case for innovative activities, experimentation is necessary for success, a **real options** strategy, in which businesses are flexible and implement feedback mechanisms that allow for rapid scaling up or down of experimental product lines, is generally a useful approach.

Contributions of multinationals

Foreign knowledge and innovations are an important source of technological progress in developing countries. Many inclusive innovations are in fact based on adaptations of innovations developed in advanced economies. Beyond trade, multinational corporations can be potentially important players by providing lower-cost versions of their products.

One motivation for catering to lower-income markets is the promise of accessing new growing markets, such as India and China with their enormous populations. Because even the middle class in such countries has comparatively low incomes, efforts to provide lower-cost alternatives can be attractive. Immelt *et al.* (2009) describe General Electrics' development of a handheld electrocardiogram (ECG) unit, a simplified smaller and easier to use version of a normal ECG unit that can be used with batteries and costs less than half the price of a regular ECG unit. The authors argue that this innovation allows the company to profit from the growing markets of developing countries and also prevents companies in these countries from developing the low-cost innovations. They also suggest that such innovations will matter for defending markets in rich countries, as these goods can also create new markets in the developed world. Moreover, strategies aimed at lower-income markets can help raise overall profits. Harman International, which produces automobile-infotainment, is one example; it produces luxury goods but also low-end goods for emerging markets in India and China where it has R&D centres. The company has incorporated innovations developed in its emerging market R&D centres in high-end products sold in the West, and has dramatically reduced production costs and increased profits (Govindarajan, 2012).

At the same time, such trends are not universal as the well-known case of pharmaceuticals illustrates. The United States, Europe and Japan are the largest markets for this sector and the bulk of research has concentrated on addressing rich-country diseases rather than those affecting low-income countries (with very little investment in diseases such as African sleeping sickness, trachoma or Chagas disease). However, the growth of the middle class in developing countries has already somewhat altered the bias and may continue to do so. Access to existing drugs depends also on the extent to which pharmaceutical firms in developing countries have increased production of generics through imitation and reverse engineering.

A second motivation is that many multinational corporations with international brands have given increasing attention to corporate social responsibility, and support of inclusive innovation initiatives is in some cases an attractive option. Sanofi's Dengue Vaccine Development Initiative is an example. The Business Call to Action (BCtA) Results Reporting Framework, the Oxfam Poverty Footprint and the World Business Council for Sustainable Development (WBCSD) Measuring Impact Framework have been developed to evaluate the contributions of such private initiatives towards poverty alleviation. Some examples are mentioned above and others on ICTs are included in Chapter 4.

Is there a need to go beyond profit-driven approaches?

While there are opportunities for for-profit initiatives, many inclusive innovation initiatives to date are based on innovations from developed countries which are supported in developing contexts by non-profit endeavours. Private initiatives will only to a very limited extent serve the poorest groups and help create entrepreneurship opportunities for them, as low budgets often constrain investment opportunities. Not only the substantial revenue constraints but also distortions due to lack of information hinder private efforts. NGOs' expertise and public initiatives with local communities can be particularly relevant. Non-traditional partnerships enable access to information on local resources and needs but also help reduce costs by leveraging established distribution channels. Moreover, markets for disadvantaged groups often involve higher costs because of the costs imposed by intermediaries and other distortions. Here, public-sector intervention can be effective. For instance, the successful business model of the Aravind Eye Clinic was based on a substantial reform of the entire ecosystem. However, individual companies or a wider set of industries might not always be able to undertake such a reform and would require public intervention to address co-ordination failures. This might create a need for new organisations, such as intermediary organisations or training institutes, which are often lacking (Gradl and Jenkins, 2011). These are reasons why relatively few companies have so far managed to realise the potential of inclusive innovation for business growth and development impact at larger scale, at least for very low-end customers (Gradl and Jenkins, 2011). This has not been for lack of effort: the UNDP database identifies more than 1 000 inclusive business initiatives, and Karamchandani *et al.* (2009) have identified more than 600 in India and Africa. Few have achieved financial sustainability following a pure for-profit agenda. This is also the case for many of the ICT-based applications discussed in Chapter 4.

What are the overall impacts?

So far discussions of inclusive innovation have explored specific cases and opportunities but overall impacts are difficult to assess. The discussion above highlights many for-profit opportunities which, if aimed at supporting entrepreneurship among lower- and middle-income groups, would benefit from partnerships of public and private initiatives. Many of the new cheaper versions of products have focused on the provision of health and education technologies and promise to improve living conditions. Technological progress, notably ICT-based applications (discussed in Chapter 4), offer further opportunities. Other interesting trends might also offer promising approaches (Box 3.3). However, access to products will have a limited impact as it does not alter the participation of lower-income groups in economic activities. It would be important to look at the extent to which such groups are involved or can, based on such innovations, gain opportunities for engagement.

Box 3.3. Solar lighting as the next mobile phones

Mobile phone subscriptions have increased substantially in emerging and developing countries, reaching near ubiquity even in poor countries. The initial evidence suggests that applications based on them can strongly enhance the welfare of lower-income groups (Chapter 4). The benefits are strongest for those with no prior access to communication tools. Electricity is another, and to some extent even more fundamental, challenge.

Mera Gao Power (MGP), in Uttar Pradesh, is a promising initiative which suggests that solar power might have an effect similar to mobile phones. Taking advantage of the falling cost of solar panels and LEDs, the company aims to build and operate low-cost solar-powered microgrids that can provide clean light and charge phones. The company installs solar panels on roofs of houses and batteries inside the houses and connects wires to other houses in the village to provide power. Costs compare very favourably to the prices of lower-quality alternatives such as kerosene which, at a similar price poses health risks that are absent in the case of solar panels.

The company hopes to recoup investment costs of about USD 2 100 per village within 18 months of setup, with a return on investment of 15% over three years. The profit proposition suggests that private firms can make a profit by providing the service and that scale effects might be similar to those of mobile phones. Beyond the price dimension, the direct benefits might lead to strong uptake (as was the case for mobile phones) among consumers and small businesses.

The initiative has received donor support. USAID's Development Innovation Ventures is supporting the MGP with a USD 300 000 grant that will allow the firm to build 40 village microgrid lighting facilities reaching 4 000 households. Its first commercial microgrid was deployed last summer, and eight more villages have been added since. There are plans to expand to another 40 villages this year with the help of the USAID grant.

Source: Charles Kenny, "Could Solar Lighting Be the Next Mobile Phone?", Center for Global Development, 31 January 2012.

Is there anything "distinctive" about inclusive innovation?

Because it holds the promise of improving welfare, the "inclusive innovation" or "frugal innovation" concept has become very popular. It is worth considering how it relates to more traditional concepts of innovation and to familiar innovation processes. A first observation is that inclusive innovations are by nature broader than technical innovations, the group of innovations that is probably easiest to measure. While innovations such as the Tata Nano are indeed innovative goods – innovative in terms of their lower-quality lower-price ratio – innovations are often not so much the product itself as the business process established around it, as is clear from Tables 3.1 and 3.2. A second observation is that when targeting lower-income markets businesses' products and processes have to be adapted quite substantially. For instance, they need to take account of the complicated "demand conditions" described above. This means, once again, that inclusive innovation is not simply about getting the price right. Supply-side challenges also call for substantive modifications. Another dimension is the substantive re-engineering needed to serve lower-income markets because of the many market obstacles that arise. A third observation is that not all types of inclusive innovations necessarily reflect a very different concept. Mobile phones are an example; the fact that lower-income groups can now afford mobile phones does not necessarily mean a radically different innovation process was in place. In fact, mobile phones and computers are innovations that only a small group could initially afford; later, with technological progress and competition, prices dropped and wider uptake was possible. This is product cycle dynamics rather than a radically different type of innovation.

Grassroots innovations: a description of the evidence

"Grassroots innovation" is innovation by low-income groups. Inclusive innovation is distinct from grassroots innovation; in the latter case, lower-income groups are the innovators while in the former they are the target consumers. "Grassroots innovation" does not include innovations developed by middle-income groups that are part of activities in the informal economy (discussed in Chapter 2). These innovations involve a lot of diversity, in terms of technologies used, people involved, purposes and contexts. Other related terms are also used: user innovations, social innovations and indigenous knowledge. Importantly, Smith *et al.* (2012) argue that grassroots innovations are very different from mainstream innovations in that, like many inclusive innovations, they do not imply high technology and large-scale industrialisation.

An additional characteristic of grassroots innovations is that they often emerge from and are directed towards local development. They often involve either traditional knowledge (agriculture, craftsmanship) or an adapted use of modern technology that most people can afford (mobile phones are the archetype). There is potentially large value in local innovations that are born out of necessity and can help improve living standards for the local community. Gupta (2006) emphasises such processes in the context of the Honey Bee Network in India, which collects these innovations and connects scientists, researchers and other farmers who might benefit from them directly for joint learning and support.

Box 3.4. Grassroots innovation networks and some of their innovations

- The Honey Bee Network in India helps innovators by documenting and developing their knowledge, ideas and products
  - Pedal-powered washing machine
- Practical Action in Peru, which works with communities to develop innovations
  - Homemade refrigerator
- The Social Technologies Network in Brazil
  - Potable water storage, bio-digesters for home energy, seed fair for exchange of traditional varieties between rural areas in Argentina and Paraguay
- Grassroots Innovation Augmentation Network (GIAN), an incubator of grassroots innovations linked to Honey Bee
- Centre of Science for Villages, which links scientists and communities in India through training
  - Rainwater harvesting, plant-based pesticides
- China Innovation Network, which involves universities and provinces
  - Simple lift to bring agricultural products to a rooftop for drying
- The National Grassroots Innovation Databank of Malaysia
  - Bioethanol produced from starch extracted from cassava
- Social Technologies Bank in Brazil
- Uruguayan Centre for Appropriate Technology
- Grassroots Invention Group MIT
- Ashoka

Source: Smith *et al.* (2012).

A lot of discussion around grassroots innovation has emphasised the importance of these innovations for empowering local communities to find solutions that meet their needs. One of the main steps is to form a local network of individuals that can help determine how innovations can effectively meet local needs, for example by deciding on the most appropriate materials, techniques and designs. Organisations engaged in promoting grassroots innovations often do not simply transfer knowledge. They focus on fostering a process of learning and collective creation in local communities, which ideally generates entrepreneurship and employment. Box 3.4 summarises various initiatives.

Assessing the socio-economic value of grassroots innovations and traditional knowledge

What is the aggregate value of grassroots innovations? Do they, as some critics would point out, contribute marginally and compare poorly to the contributions of technological innovations, and therefore justify focusing innovation policy on the latter? While it is difficult to assess value, three forms of value would probably be of interest in this context: the contribution to economic value as measured by export success, the value to low- and middle-income groups in specific circumstances/ location, and their value in terms of adoption of innovations across lower-income groups. An obvious challenge for such an assessment is the fact that grassroots innovation might have below-potential effects because of market failures and lack of support.

In terms of the value of grassroots innovation, a first argument points to grassroots or social innovations as valuable sources of innovations which, if provided with substantial support, can contribute significantly to improving the welfare of lower-income groups and others. The challenge is the need to move away from a bias towards technological innovations. Traditional knowledge, which examples such as India's Aryuveda have shown to be of substantial value, is frequently cited as an example. However, it is difficult to assess its relevance fully from an aggregate economic perspective and in many cases the economic value tends to be low. Among the cases examined by the Honey Bee network, few have been patented and few have become export successes.

This is not to say that grassroots innovation might not make local contributions. A product might not be able to compete in terms of scientific progress but may provide a substantial contribution in a specific context or circumstance because of lower cost, as is generally the case with traditional medicines. The contribution in that context might be far from negligible. Cost-effective approaches that ensure wider accessibility may be particularly useful. Smaller types of adjustments might also – while not patentable – be well suited to specific circumstances and provide another useful measure even though they are not scalable. In some circumstances, however, potentially wider benefits may exist.

A final observation is that technological innovations may not be guaranteed adoption as much can depend on social acceptance and practices among the groups concerned. In this respect, grassroots innovation might be an essential part of the process and possibly a way to deal with some of the gaps in adoption. Local empowerment can help to address demand beyond price constraints and has led to certain business models (as, for example, the "soft networks" approach discussed above). This points to the role of "familiarity", which can ease the difficulties in adopting innovations by both households and businesses.

Conclusion

Many examples illustrate how innovative products, particularly in the areas of food, health and basic livelihood, can contribute to lower-income groups' welfare. However, demand-side factors beyond high sensitivity to price play an important role, such as the need to adjust products to specific user contexts and the challenge of providing information about product use. Entrepreneurs have used pricing and financing strategies and more substantial business process innovations to serve lower-income markets profitably. Some multinationals face incentives to serve middle-income markets. At the same time, not-for-profit actors support many initiatives not only financially but also from the demand perspective and are therefore essential. The increased importance of corporate social responsibility and support by foundations can lead to joint efforts to address some of the issues. Finally, many examples show that grassroots innovations can be beneficial but also that there is a great deal of underemployment with few opportunities for moving up the social ladder in the medium term.

Chapter 4

Information and Communication Technologies

Introduction

The Internet and information and communication technologies (ICTs) constitute the most transformative innovation of the recent past. They are interesting in the context of the inclusive development debate because of their ability to strengthen connectivity not only of higher-income groups but also of those at the lower income level. Indeed, a variety of ICT-based applications are geared at bringing fundamental changes to disadvantaged groups. At the same time, the Internet and ICTs are not an obvious integrating factor as policy debates about the "digital divide" illustrate. Not only are lower-income groups at a disadvantage with respect to access, they are also likely at a disadvantage for reaping the benefits of ICTs, notably because skills help exploit the opportunities ICTs offer.[9] This chapter first describes the extent to which ICT infrastructure creates favourable conditions for inclusive development. Second, it discusses specific ICT-based inclusive innovations and their success in helping improve lower-income groups' welfare and success in business activities. Third, it looks at aggregate impacts of the Internet and ICTs on firms across developing countries and explores the extent to which they have provided opportunities for lagging firms to reduce gaps in productivity.

Access to ICTs and the digital divide[10]

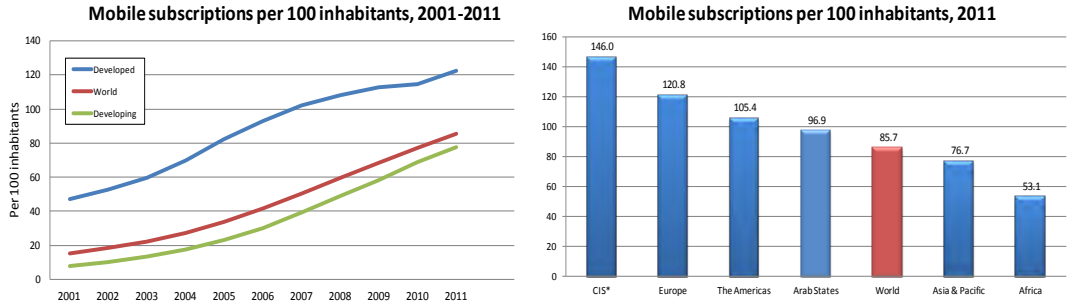
Increasing interconnection at the international level

International interconnection is fundamental for linking emerging and developing countries to the global Internet. Satellite, land-based or submarine fibre cables can carry data over long distances and ensure connectivity to other countries. In 2008 many Sub-Saharan coastal nations were not connected to submarine cables. However, by 2012, owing to substantial investments, all coastal nations in Africa except Somalia were connected and only 21 states and territories still lack international fibre connectivity. A crucial remaining challenge for a number of countries is to provide fair and open access to the submarine fibre systems and landing stations so that multiple operators can use the international interconnection and offer competitive prices for end users.

Developments in mobile communications

It is mobile communications rather than the Internet and computer use that have seen the most uptake in developing and emerging countries. From 2005 to 2011, the number of mobile phone subscriptions worldwide nearly tripled to more than 6 billion. Whereas in 2000, developing countries represented 35% of overall mobile subscriptions, in 2011 they accounted for three-quarters.[11] Mobile subscriptions per 100 inhabitants in developing countries reached 77.8 per 100 inhabitants in 2011 (Figure 4.1). Overall, the gap in mobile subscriptions between developed and developing countries has shrunk since 2007, following the familiar S-shape of the diffusion of inventions. However, some differences in uptake remain; Africa is currently the region with the fewest mobile subscriptions per 100 inhabitants.

Figure 4.1. Mobile subscriptions per 100 inhabitants



* Commonwealth of Independent States: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine, Uzbekistan

Source: ITU World Telecommunication /ICT Indicators Database.

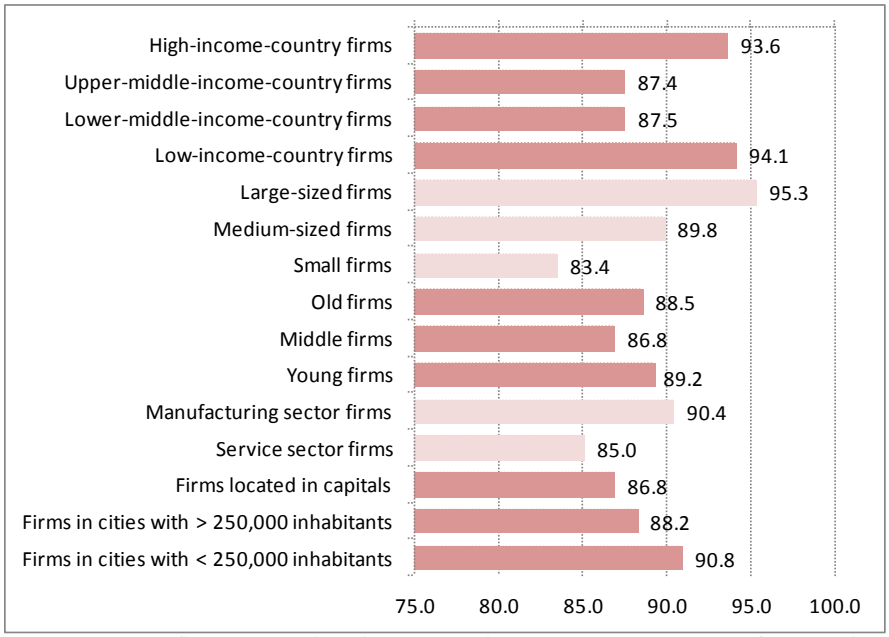
The developed/developing country classifications are based on the UN M49, regions are based on the ITU BDT Regions; see: *www.itu.int/ITU-D/ict/definitions/regions/index.html*.

Uptake among businesses has also been substantial. Based on a sample of firms in 38 developing countries, Figure 4.2 shows the percentage of businesses that use mobile phones. Interestingly, the data do not point to the existence of a "digital divide" based on country, location or age; 94.1% of firms in low-income countries, 90.8% in remote locations and 89.2% of younger firms used mobile phones in their operations. Uptake was also substantial in the informal sector. Table 4.1 shows, based on a sample of informal businesses in 14 countries, that for African businesses, the uptake of mobile phones was even greater than uptake of electricity. For the subset of informal firm surveys that have information on the use both of e-mail and mobile phones, use of mobile phones far outweighed use of e-mail. In fact, hardly any businesses used e-mail in their operations. This suggests a lot of potential catch-up opportunities would rely on simple mobile phones rather than on computers.

Overall, the growing number of subscriptions in developing countries is an indication that people and organisations are willing to spend often scarce resources to get "connected". Mobile service offers based on the pay-per-use model have contributed by facilitating purchase by lower-income groups (see the discussion on business models in Chapter 3). Attention is needed to ensure that users are offered competitive prices. More high-speed mobile networks are required, especially in more remote and rural areas where access often remains rudimentary. A major impediment to the use of smartphones and, for that matter, of computers among lower-income groups and informal firms is a lack of electricity, which continues to be a major challenge (Table 4.1). Finally, it is worth pointing out that the devices used, especially by low-income groups, are often simple handsets which do not require advanced skills which users from lower-income groups often lack. It is therefore mobile telephony that raises expectations for the contribution of ICTs to inclusive development.

Figure 4.2. Share of firms using mobile phones for business, 2009-2011

Percentages



Note: Statistics are based on 16 777 firm observations in 38 countries. See Paunov and Rollo (forthcoming) for further detail.

Source: Paunov and Rollo (forthcoming) based on World Bank Enterprise Surveys.

Table 4.1. Statistics on technology use in the informal sector, 2009-2010

	Overall		AFR		LAC	
	Firm nbr.	%	Firm nbr.	%	Firm nbr.	%
Use of electricity						
No	553	24.9	369	29.7	178	20.7
Yes	1668	75.1	873	70.3	681	79.3
Connection to the grid						
No	145	8.7	130	14.9	13	1.9
Yes	1522	91.3	745	85.1	665	98.1
Experienced power outages						
No	765	46.1	275	31.8	489	72.0
Yes	894	53.9	591	68.2	190	28.0
Use of cell-phone						
No	1026	40.7	295	23.8	674	58.0
Yes	1495	59.3	943	76.2	489	42.1
Use of e-mail *(only for Cote d'Ivoire, Madagascar, Mauritius)*						
No	.		347	94	.	
Yes	.		22	6	.	
Use of cell phone *(only for Cote d'Ivoire, Madagascar, Mauritius)*						
No	.		87	22.8	.	
Yes	.		294	77.2	.	

Note: Information is based on firm observations for 14 countries: Angola, Argentina, Botswana, Burkina Faso, Cameroon, Cape Verde, Democratic Republic of Congo, Côte d'Ivoire, Guatemala, Madagascar, Mali, Mauritius, Nepal and Peru.

Source: Paunov and Rollo (forthcoming), based on World Bank Informal Firm Surveys.

Cloud computing for development

Cloud computing can be understood as a service model for computing services based on a set of computing resources that can be accessed in a flexible, elastic, on-demand way with low management effort. Users of cloud computing infrastructure and services do not have to make capital-intensive upfront investments in IT infrastructure and software. Instead, they access computing resources when needed through various fixed and mobile devices and pay for them on the basis of a flexible pay-as-you-go model (OECD, forthcoming).[12] In addition, these services are in most cases more developed and of higher quality than the infrastructure and software they could afford (*e.g.* in terms of the quality of service, regular updates and security measures provided by the cloud services). Ushahidi (which means "testimony" in Swahili), an open source cloud computing platform (Box 4.1), is an example of a successful platform in a developing country. Businesses stand to benefit, especially small firms and start-ups. In India, start-ups such as Sparsha Learning (educational services) or Whitesharkk (web apps services) rely entirely on cloud computing services.

ICT-based applications for inclusive development

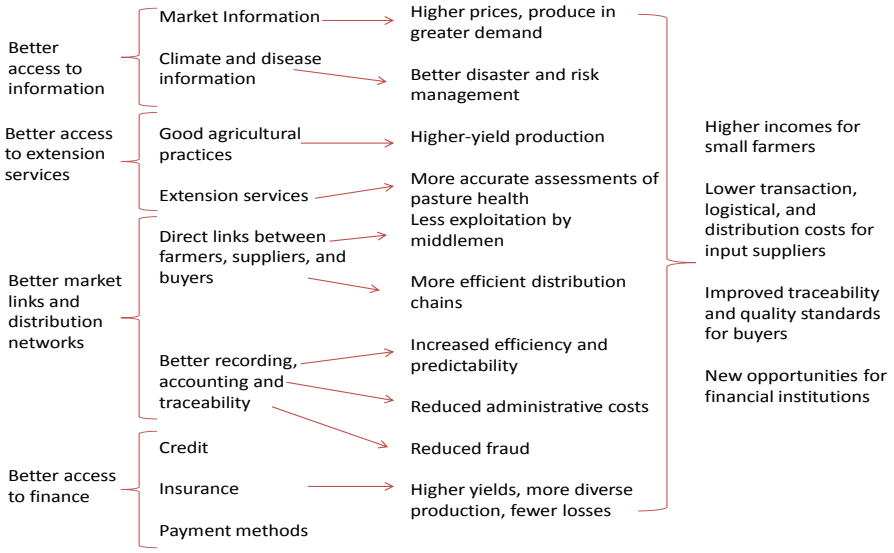
As access improves, ICT-based applications are increasingly important for inclusive innovations and offer possibilities for substantially improving welfare and facilitating business opportunities for lower-income groups. Among the many applications developed in recent years, this section focuses on four types: *i)* support for agriculture and fishing activities; *ii)* health services; *iii)* educational tools; and *iv)* mobile banking. The selection is based on two considerations. First, these applications have potentially strong impact on low- and middle-income groups. Agriculture and fishing are among the principal activities of low- and middle-income groups and wider availability of ICT applications gives better access to important information in dispersed locations. Health and education applications are important for welfare and for stimulating welfare improvements. Second, there have been substantial experimentation and developments in these areas in recent years.

Mobile applications for agriculture and fishing

Potential contributions of applications and examples

A basic role of ICTs and the Internet is to disseminate up-to-date and accurate information widely. Disadvantaged rural communities in developing and emerging countries often have much to gain from mobile telephony, and it has often provided them with access to such information for the first time. Such simple, often cost-effective functionalities (compared to more sophisticated applications) can support the activities of these communities (Box 4.1). Figure 4.3 summarises the sources of benefits from mobile applications for agricultural and rural development; these range from simple access to information functionalities, to access to services and connectivities across networks, to more advanced uses related to access to finance.

Figure 4.3. Sources of potential benefits from mobile applications for agricultural and rural development



Source: Zhenwei Qiang *et al.* (2011).

Box 4.1. Examples of mobile agricultural and rural development applications based on information provision

KACE, Kenya: Provides daily market information on 20 commodity prices, facilitates offers and bids to match farm outputs with demand from wholesalers, and facilitates links between farmers and buyers (*e.g.* for contract negotiations and commodity transport).

DrumNet, Kenya: Covers the horticultural and oilseed industry and provides information on market trends, weather, prospective partners and related topics. Includes finance, production, delivery and payment functions to smooth supply chain processes among various actors (producers, buyers and processing plants, transport providers, banks, and input retailers).

Virtual City, Kenya: Provides automated systems to major buyers of tea, coffee, cotton and dairy goods for collecting, recording, accounting and traceability/distribution of agricultural products. Farmers receive faster and more accurate price, quality and quantity information. Small and medium-size retailers can use phones to facilitate sales, deliveries, orders and payments.

Ushahidi, Kenya: A website initially launched in Kenya to collect eyewitness reports of election violence. Since its creation, it has been used across the world for various purposes. In India, for example, a software engineer built a disaster-tracking map on the Ushahidi platform when the city of Mumbai faced bomb attacks in July 2011. It was also used for other disaster tracking purposes during earthquakes in various locations. Other examples of how the website is used include geospatial visualisation services, *e.g.* on (human) trafficking, monitoring elections in countries such as India, Mexico and Afghanistan, observing medicine stock-outs in Zambia, building ICT knowledge bases (*e.g.* in the area of agriculture) and tracking business incubators and technology organisations in Africa.

Farmers Texting Centre, Philippines: Offers an innovative SMS-based service for answering agricultural queries mainly about rice production from farmers, extension workers and other actors. Also provides technological updates on rice production and a virtual network to facilitate interactions among farmers and clients.

b2bpricenow, Philippines: Provides current market price information to farmers and cooperatives. Its online marketplace links sellers to buyers and can process financial transactions using bank accounts (web) or debit cards (mobile phones).

1920 AgriExtension (also known as Govi Sahana Sarana), Sri Lanka: Toll-free hotline service that provides crop advisory and technology advice to farmers in Sinhala and Tamil. The aim is to help farmers solve problems related to technology, inputs and marketing. Users can call from anywhere in the country for immediate answers by call centre operators. Agriculture experts are available for more complicated questions.

Dialog Tradenet, Sri Lanka: Forwards agricultural commodity price information by SMS and USSD, reducing information arbitrage. Subscribers receive up to five price alerts for five fruits and vegetables from each of the three markets covered. Also provides a trading platform for farmers to identify potential buyers.

Fisher Friend, India: Provides timely information on local fish markets, weather, the sea, and timely and critical information for fishers. It "also increases their knowledge base by providing information on government schemes and entitlements, health services, directory services, and a marine toll-free helpline". Collaboration between the M.S. Swaminathan Research Foundation (MSSRF), Tata Teleservices in India, Astute Systems Technology, Wireless Reach, and Qualcomm.

Source: Zhenwei Qiang *et al.* (2011) except for Fisher Friend, India.

Impacts on users

The wide uptake of mobile technology by rural communities is an indication of the demand for access to information. Indeed, de Silva and Ratnadiwakara (2010) showed that 11% of the total production cost of a representative sample of 300 smallholders in Sri Lanka was spent on information search. A study of agricultural micro-enterprises and their use of ICTs found particular interest in receiving fertiliser and market price information (Lokanathan and Kapugama, 2012).[13] It also found, however, that face-to-face communication was still preferred to other modes of communication, an indication of potentially gradual uptake of mobile-based agricultural information services, because potential users have to adjust to using message-based systems over face-to-face communications to benefit fully from relevant mobile applications.

There is also evidence on the benefits of access to ICT-based applications. Jensen (2007) has shown that access to timely price information enabled fishermen to increase profits by an average 8%. In addition, consumer prices fell by 4% and waste, which had averaged 5-8% of daily catch in the past, was eliminated. The DrumNet application (described in Box 4.1) appears to have allowed Kenyan farmers to raise their incomes (Zhenwei Qiang *et al.*, 2011). Regarding the benefits of functionalities such as extension services, Sri Lanka's e-Dairy helps farmers earn up to USD 262 more a year for each of their calves by providing veterinary and extension services over mobile phones. Tea growers in Kenya have reported average income growth of 9%, or about USD 300 a year, by using Virtual City's measuring, recording and traceability functions (Zhenwei Qiang *et al.*, 2011).

Aggregate impacts and the financial sustainability of projects

There have been demonstrated benefits for users of such applications, but to have a substantial impact on the welfare of lower-income groups in developing and emerging countries they need to be available to many farmers and fishers. This is not yet the case. The study of agricultural micro-enterprises discussed above found that use of the Internet by the entire farmer sample was non-existent and that mobile-based agricultural information services were little used except in the Indian example.

Many applications operate on a relatively small scale because they are not profitable. For instance, a study of mobile applications for agricultural and rural development which reviewed 74 examples found that only 29% had enough revenue to cover operating expenses and most received at least some funding from governments, donors or corporate social responsibility (CSR) sources (Zhenwei Qiang *et al.*, 2011). The situation is worse for initial development costs: more than four in five projects relied on not-for-profit funding for their development and start-up phases. There are, however, some profitable services, such as the information service provided to Indian fishermen in Kerala, discussed above. Further experimentation with innovative pricing models (discussed in Chapter 3) may offer other options.

Health applications and education tools

Potential contributions of applications and examples

Health services are fundamental for welfare, and Internet and ICT-based applications can make higher-quality service available to a larger group of patients. For instance, mobile phones can be used to connect to health services or to allow health workers in remote locations to consult with experts and improve their services. Since disadvantaged groups, including in rural areas, have often been excluded from quality education and health services, the potential benefits are probably highest for these groups. The applications are particularly attractive as the cost of expanding health and education services in "traditional" ways has often been too high to allow developing and emerging countries to provide

universal health services. ICT-based applications make four types of contributions (Zhenwei Qiang *et al.*, 2012): *i)* better quality of and access to healthcare (*e.g.* treatment support through reminders, patient tracking, emergency services, improved training for rural health workers and other professionals); *ii)* more efficient human resources (*e.g.* record keeping, clinical decision support), *iii)* capture and real-time use of health information (*e.g.* disaster management, social accountability, disease surveillance); and *iv)* public health (*e.g.* disease prevention through public health advice and educational programmes).

Expected benefits of applications for education are similar to those expected for health, including improvements in quality and access. Several features of ICT-based applications are particularly attractive: they may make it possible to educate more people with fewer qualified staff, they offer an opportunity to tailor learning requirements to specific needs and circumstances, and they provide learning opportunities at flexible times and locations. Again, gains are likely to be particularly important for lower-income groups with limited access to educational services. This is a field in which there has been substantial experimentation; one example is the development of downloadable games to increase awareness of HIV/AIDS in India (Adler and Uppal, 2008).

Box 4.2 describes several examples of mobile health and education applications.

Box 4.2. Examples of mobile health and education applications

Child Count+, Kenya: Application registers pregnant women and children under 5 and collects basic information about their health to organise visits by health workers.

Sehat First, Pakistan: Social enterprise aimed at providing access to basic health care and pharmaceutical services across Pakistan through self-sustainable franchised tele-health centres. Founded in 2008 with an equity investment from the Acument Fund, Sehat First has served over 4 000 patients, mostly women and children.

Tamil Nadu Health Watch, India: Disease surveillance system introduced after the tsunami in 2004. Provides instant links between primary health centres in four districts to enable health experts and programme managers to co-ordinate activities more effectively and allocate resources more efficiently. Use of mobile phones allows health workers, even in remote areas, to report disease incidence data immediately to health officials, speeding up their ability to respond.

ReMeDi (remote medical diagnostics) Kiosks, India: Respond to various problems for providing health care to the poor and reaches areas otherwise difficult to access and where doctors are scarce. Basic sets of diagnostics tools can be used by low-skilled trained operators and run with very low and erratic energy supply and slow Internet connections.

Project Masiluleke, South Africa: Increases volume of patients screened for HIV/AIDS and receives information on prevention and treatment. Sends out about 1 million messages a day and covers nearly all country mobile phone users in a year. The project is supported by the Praekelt Foundation, the PopTech innovation network, LifeLine Southern Africa (the government-backed provider of the helpline), iTEACH, Frog Design and MTN.

Telemedicine support to promote maternal and newborn health in remote provinces of Mongolia: Aims at reducing infant and maternal mortality by improving rural health-care services. Project funding obtained through a joint venture among the Mongolian Mother and Child Health Research Centre, the government of Luxembourg (Lux-Development Agency), and the United Nations Population Fund (UNFPA).

SMS for Life, Tanzania: Uses a combination of mobile phones, SMS messages and electronic mapping technology to track weekly stock levels at public health facilities to eliminate stock-outs and increase access to essential medicines to reduce deaths from malaria.

WelTel, Kenya: SMS-based messaging system that supports antiretroviral (ARV) therapy by providing patients with reminder to follow prescribed treatments.

1298 Ambulance, India: Dial 1298 for ambulance service operated by Ziqitza in Mumbai, Kerala, Punjab and Bihar. Ziqitza is a network of fully equipped advanced and basic life support ambulances.

Project Mind, Philippines: Provides distance and informal education services by mobile phone. Students' performance is monitored through answers sent by SMS to multiple-choice maths and science questions. Exams are also administered this way.

text2teach, Philippines: Provides fast and timely educational content using mobile and satellite technologies. Content includes more than 900 multimedia materials in video, picture, text and audio formats. Also uses SMS to receive feedback and comments.

Text to Change, South Africa: Uses mobile phone technology, specifically interactive and incentive-based SMS messaging, to send out and receive information to educate, engage and empower people on issues related to well being, such as health care, education and economic development. Text to Change also has campaigns in South America.

Virtual University of Pakistan (VUP): Information-technology-based university currently offering 17 degree programmes. It uses the national telecommunications infrastructure and delivers lectures asynchronously through satellite broadcast TV channels with interaction provided over the Internet.

Source: Melhem and Tandon (2009) and (www.sehatfirst.com) for Sehat First; Adler and Uppal (2008) for Tamil Nadu Health Watch; Zhenwei Qiang *et al.* (2012) for Project Masiluleke; CHAI/HP, Zhenwei Qiang *et al.* (2012) for WelTel, Child Count+; CII (2011) for ReMeDi; Ziqitza Health Care Limited (http://zhl.org.in/) for 1298 Ambulance; Zhenwei Qiang *et al.* (2011) for ProjectMind and text2teach; Baggaley and Belawati (2010) for the Virtual University of Pakistan (VUP).

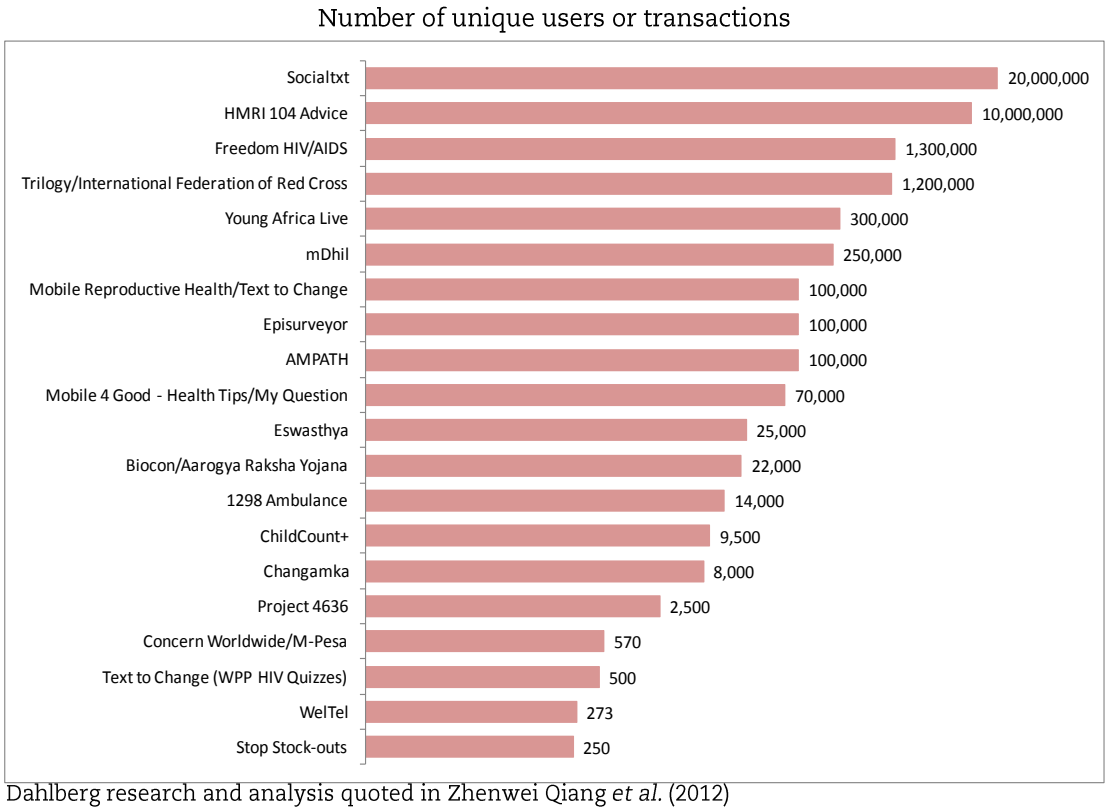
Impacts on users

Many Internet and ICT-based health services have had positive welfare effects. Medic Mobile, a project to support community health workers in rural areas, has saved time and transport costs for these workers and therefore made it possible to increase the capacity of tuberculosis treatment programmes (Mahmud *et al.*, 2010). WelTel's services (Box 4.2) have raised patients' compliance with antiretroviral therapy by 25% (Zhenwei Qiang *et al.*, 2011). There is similarly consistent positive evidence for educational projects. The Mobile Technology Initiatives for Non-formal Distance Education (MIND), an IDRC-backed initiative, focused on non-formal education for out-of-school youth, adult learners and others with no access to tertiary education and had positive impacts on users (Baggeley and Belawati, 2010).

Scale and project sustainability

While applications such as Socialtxt and HMRI 104 Advice have had broad impacts, the great majority are small (Figure 4.4) and have not had broad impacts on lower-income groups. An important reason is that few pilot projects have been self-sustaining once initial seed funding has ended, even those that have proven feasible, clinically useful and scalable. The often large costs of health services suggest that for-profit business models may be hard to implement.

Figure 4.4. Scale of mobile health applications in Haiti, India, Kenya, 2010



Source: Dahlberg research and analysis quoted in Zhenwei Qiang *et al.* (2012)

However, the private sector has engaged in several initiatives. Novartis, to provide an example, conducts the SMS for Life programme in Tanzania (Box 4.2). Moreover, in a few cases innovative pricing strategies have been successfully implemented. The 1298 (Box 4.2) business model uses a sliding price scale based on the patient's ability to pay, as determined by the kind of hospital to which the patient chooses to be taken. In this case financial sustainability is ensured through cross-subsidisation.

Mobile education applications face similar challenges with regard to scale and project sustainability. However, the Virtual University of Pakistan (VUP) has expanded its activities to a network of more than 100 associated institutions across 60 cities in Pakistan to cater for a wide student population.

Mobile banking

Potential contributions

In many developing and emerging countries, people have limited access to banking services. In Kenya only 19% of the population had a bank account in 2010 (AfDB, 2010). Establishing a wider network of formal "traditional" banking services is a challenge, especially for reaching the many small communities in countries such as India. If the wide uptake of mobile telephony helps extend banking services to previously unbanked users, its impacts can be substantial. Simple banking services help increase welfare by reducing the security risks incurred when transporting and storing cash. They also reduce transport costs (*e.g.* those incurred by migrant workers in urban areas to send money to their families in remote locations). Gains can be even larger if banking services support entrepreneurial activities of disadvantaged groups, and improve their savings behaviour. Savings can facilitate possibilities for income generation and asset creation (including investments in human capital or in business activities). Banking services can also provide credit for business activities to help finance start-up finance. More advanced insurance services can help reduce vulnerability to unexpected events such as accident, illness, theft or drought. Finally, there are potential gains in terms of transparency compared to cash-based transactions and this may help reduce corruption in the delivery of government services.

Mobile banking applications in practice

The most popular and successful example of mobile banking is Kenya's M-PESA. This mobile payment service, which was piloted in 2005 as a public-private initiative, was launched in March 2007 by Vodafone and Safaricom and became an instant success, with 2.37 million subscribers in its first year (Maurer, 2012). Coverage is now an estimated 15 million users, which corresponds to 70% of Kenya's adult population (*The Economist*, 2012). The service is a money transfer service that uses text-messaging on mobile phones and a network of retail agents as cash-in/cash-out points. An example of the potential for impacts on development is Grundfos Lifelink, an automated village well water supply system in Kenya, which relies on M-PESA for payment. Customers purchase an electronic pump key to access safe pumped groundwater. The payments are used to pay for maintenance and repay the community loan for the well.

Several other programmes have been developed based on M-PESA, and there are multiple mobile banking initiatives in other emerging and developing countries. A survey of 52 operators worldwide found a total of 60 million registered customers of mobile money services by mid-2011 (GSMA, 2011). However, the customer base was highly skewed towards 11 services. In addition to M-PESA they include SMART Communications and G-CASH in the Philippines with over two million users (Maurer, 2012). M-PESA has also stimulated mobile services elsewhere in East Asian countries such as Burundi's Ecokash, a mobile money service. Most services are small, especially if the actual use of mobile banking is taken into account. Estimates suggest that M-PESA accounts for more than half of the world's mobile money transactions (*The Economist*, 2012).

Large potential gains have attracted private and public interest in supporting mobile banking, including industry consortia such as the GSM Association (GSMA), which represents mobile network operators across the world, and the Bill and Melinda Gates Foundation. An example of such collaborations is the Mobile Money for the Unbanked competition for grants, created in 2009, which rewards mobile banking initiatives aimed at poor groups (Maurer, 2012).

Overall impacts and challenges for wider success of ICT-based applications

Users, particularly from lower-income groups, have benefited from these applications. However, because their scale is often small, they have helped only a few lower-income groups. Exceptions include M-PESA for banking and Socialtxt and HMRI 104 Advice for health applications. A main reason for the limited scale is that few initiatives were based on profitable business models. Further experimentation with business models aimed at lower-income groups (see Chapter 3) and various new public-private sources of financing offer opportunities for wider success, although various challenges will need to be overcome:

- First, as the technology standard for ICT access is often below that of developed countries, applications need to rely on simple functionalities. In parallel, further progress needs to be made on lower-income groups' access conditions so that more advanced services can be added.
- Second, it is necessary to generate and share local content and to share generic knowledge and materials where useful. The value of many applications to their users often strongly depends on local content (*e.g.* information on local weather and soil conditions is essential for agricultural applications). However, in some instances (*e.g.* health information) once materials are created they can be applied to other initiatives at substantial savings.
- Third, in terms of regulations, there is a trade-off to be found between providing opportunities for innovative applications and protecting end users (*e.g.* consumer protection and privacy provisions, legislation to reduce fraud and regulate competition among private companies). This applies to online and ICT-based applications as their often disruptive nature creates new markets with impacts on different market actors.
- Fourth, the lack of open and interoperable platforms (e.g. Nokia's Ovi Life Tools) has often been identified as a severe constraining factor. They can stimulate developments of applications by offering larger scale (as they offer access to an existing customer group) at much lower cost (as applications do not have to be created from scratch).
- Fifth, skills development matters. Evidence on specific applications for lower-income groups has shown that uptake can be enhanced by including training for end users. For instance, India's Fisher Friend (see Box 4.1) employs a "train the trainer" approach: a group of young local fishers were trained to use the application, and these "master trainers" show other fishers how it works. Also, many applications have suffered from low uptake because the professionals providing the service have had insufficient knowledge of how best to use the ICT-based applications provided them. Local Internet and ICT skills such as local web creation and software design skills can help build successful home-grown sites.
- Sixth, all of the applications discussed relate to major domains of public policy. The importance given to applications as part of these wider agendas will play a role in their further development.

Innovation and firm performance benefits from ICTs

The previous section focused on specific Internet and ICT-based applications. These are important for understanding trends, the contributions they can provide and the concrete challenges. It is also important, in terms of policy, to understand the aggregate impacts of ICTs for developing countries. This section discusses what is known about the contributions of ICTs to different businesses in developing countries. It provides new aggregate statistical evidence on the impacts of ICTs in these countries and explores whether ICTs have provided opportunities for catch-up to reduce gaps in productivity (Paunov and Rollo, forthcoming).

ICTs and their impacts on innovation and productivity in developing countries

A variety of examples and industry and country case studies discuss the role of ICTs for firms' innovation and productivity performance in developing country contexts but there are only a few statistical analyses. There is relatively broad consensus about the contribution of ICTs to productivity and innovation. Much of the evidence, however, is based on developed countries.[14] The evidence on emerging countries is scarce. An early study of the impacts of ICTs on firms in Estonia, Latvia, Lithuania, Poland and Russia found a positive relationship between ICTs and firms' economic performance (InfoDev, 2007). Similar evidence has been found for Brazilian, Indian and Chinese firms with respect to productivity (Motohashi, 2008; Commander *et al.*, 2011).

Some findings suggest impacts may be larger for developing countries (Commander *et al.*, 2011). This may be due to the fact that Internet and ICTs may be particularly useful for addressing their more challenging framework conditions for businesses. They can improve access to and use of information, thereby reducing search costs, improving co-ordination and resulting in substantial efficiency gains. It can also foster innovation since knowledge is a central input in innovation processes. In addition, Internet and ICT-enabled communication can facilitate supply chain management, for example through interactions to respond to shocks without substantial transport costs. It may also give firms easier access to a range of business services, financial among others. It is easy to see how these mechanisms can help disadvantaged firms suffering from a lack of information and difficult business conditions.

Regarding the differences in impacts on firms in developing countries, case study evidence supports the hypothesis that mobile phones tend to benefit the business activities of smaller enterprises, including in the informal sector (*e.g.* Duncombe and Heeks, 2002, on Botswana; Donner, 2006, on Rwanda). Samuel *et al.* (2005) report that roughly 60% of the micro-entrepreneurs surveyed in South Africa, Tanzania and Egypt felt that mobile phones had increased the profitability of their business. A review of several case studies indicates that one of the main benefits of mobile phones for businesses was that they facilitated the expansion of trust-based networks with suppliers and clients (Donner and Escobari, 2010). An early survey of small and medium-sized enterprises (SMEs) in East Africa suggested that increased management efficiency was another gain from ICT applications (Matambalya and Wolf, 2001).

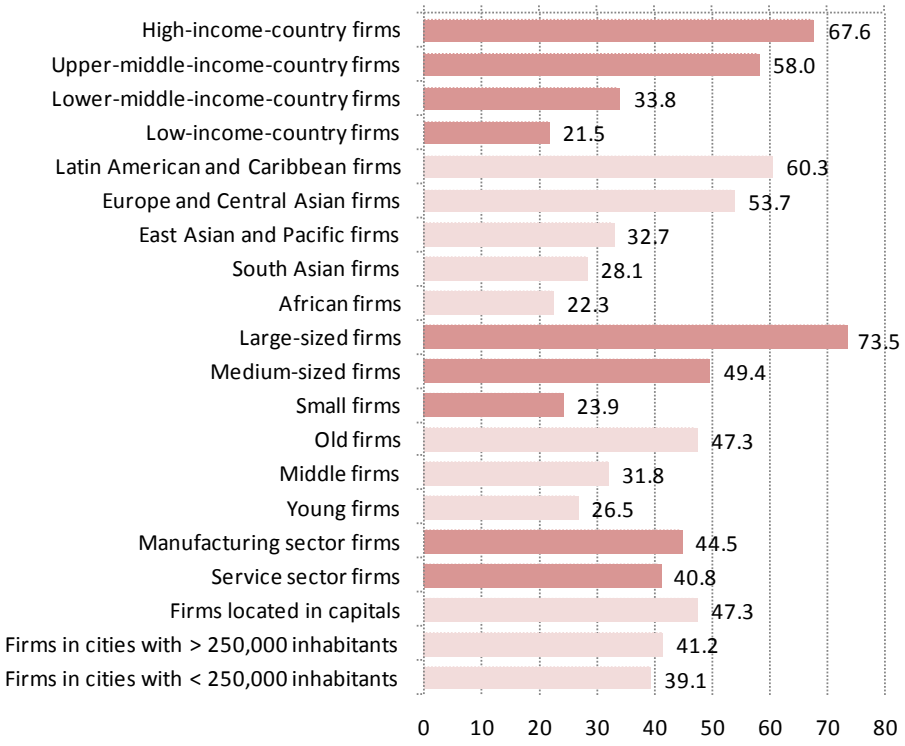
While less productive businesses might stand to benefit from ICTs, this does not mean that these will necessarily facilitate their catch-up with leading companies. ICTs can affect the distribution of firm-level productivity in a sector with a less skewed distribution and higher average productivity as their use increases. An important caveat is the need for complementary organisational reform but also for quality human capital and management to benefit fully from ICTs (Bloom *et al.*, 2006). This implies that firms will need to incur training and restructuring costs, among other adjustment costs. These factors potentially put firms with more access to finance and skilled workers at an advantage for reaping benefits from ICTs. The implication that the positive impacts from ICT only occur in the longer run might discourage some companies and particularly the least productive or those facing tough business conditions.

Innovation and firm performance benefits from ICT: new evidence

This section draws on information for 65 285 formal firms in 119 countries over 2006-11 and for 2 019 informal firms in 14 countries for 2009-10. Figure 4.5a shows the share of firms with their own website. Uptake is quite substantial for large firms and for firms in high-income countries. There is some evidence of a "digital divide" in terms of firm size (73.5% of larger firms but only 23.9% of small firms had their own website[15]), age (47.3% of older firms and 26.5% of small firms had a website) and geographic location (38.1% of firms in small locations had a website compared to 47.3% in capitals). Divides were also visible across countries, with large uptake by higher-income countries and differences among world regions: Latin American firms (60.3% uptake) led developing country firms while African firms (with 22.3%) were last. Regarding the use of ICTs, a basic application is use as a tool for communication with clients and suppliers. As in the case of websites, Figure 4.5b shows evidence of a digital divide across these dimensions.

Figure 4.5a. Share of firms with their own website, 2006-2011

Percentages



Note: 48 570 observations contain information on use of website for 119 countries. See Paunov and Rollo (forthcoming) for further detail.

Source: Paunov and Rollo (forthcoming) based on World Bank Enterprise Surveys.

Figure 4.5b. Share of firms communicating with clients and suppliers by e-mail, 2006-2011

Percentages

Note: 48 662 firm observations contain information on use of e-mail for 119 countries. See Paunov and Rollo (forthcoming) for further detail.

Source: Paunov and Rollo (forthcoming) based on World Bank Enterprise Surveys.

An analysis of the effect of ICT use on firms' labour productivity and innovation performance finds positive impacts.[16] ICTs also have positive effects on investments that support firms' innovation performance, including investments in equipment, foreign imports and use of foreign technologies. Interestingly, the statistical analysis does not suggest that small firms and firms in smaller locations – firms that are often among the less productive – benefited differently from the larger firms in bigger locations that are often more productive. However, smaller firms benefited more in terms of innovation-related investments, including in equipment and use of foreign inputs. ICTs may have helped them to overcome knowledge gaps which large firms did not suffer from, so that ICTs had less of an impact. Firms in smaller locations also benefited more in terms of imports from abroad. In the informal sector, mobile phone use was positively associated with labour productivity and capital-equipment ratios.

Conclusions

Substantial infrastructure improvements and uptake in developing countries now connect an increasingly broad group of users. The uptake of mobile telephony has been particularly "inclusive". This sets conditions for the Internet and ICTs to contribute to the inclusive development agenda. A variety of ICT-based applications – a set of "inclusive innovations" – developed to support agriculture and fishing activities, health and education and mobile banking have successfully improved conditions for the lower-income groups they have reached. Often, however, their scale does not allow to improve conditions more widely. Businesses in developing countries have taken up ICTs with positive impacts on their innovation and productivity performance. Smaller firms and businesses in smaller cities, which are often not among the leading firms, benefited as much as large businesses in capitals and large agglomerations and their benefits were larger in terms of access to foreign technologies, an important input for innovation in emerging countries. ICTs did not increase the gap between lagging and leading firms, contrary to what tenants of the "digital divide" might have expected.

Notes

1. See, for example, Cozzens and Sutz (2012) and Mashelkar (2012).

2. See *http://grassrootsinnovations.org/* for comprehensive information and references.

3. The challenge also applies in many ways to developed countries. An OECD study of inequalities concluded that "strategies focusing only on reshuffling income would be neither effective nor financially sustainable, especially in the constrained fiscal climate that prevails today. The most promising way of tackling inequality is more than ever by the employment route. More and better jobs, enabling people to escape poverty and offering real career prospects, is the most important challenge" (OECD, 2011).

4. Factors beyond policy that affect households' disposable incomes, such as changing family structures (*e.g.* an increase in single-parent households) and a greater earnings correlation among couples.

5. For instance, there are the much discussed differences between Anglo-Saxon and continental European labour markets. The stylised assessment is that the wage gap will rise in response to skill-biased technological change in the former, while in the latter case unemployment will result owing to the impact of labour market institutions (Acemoglu, 2003). Different job quality categories can affect not only employment relations but also innovation performance and growth, with potentially more opportunity to engage in risky activities if firms face less stringent labour regulations but also risks if employment durations are shortened in consequence.

6. A McKinsey Global Institute (2001) report on India examined the main sources of inefficiency in a range of industries. In some industries (dairy processing, steel, software) better firms were using more or less global best-practice technologies wherever they were economically viable. The latest (or if not the latest, relatively recent) technologies were available in India.

7. In addition to web searches, other sources of examples include :

   - UNDP (2010), The MDGs: Everyone's Business: How inclusive business models contribute to development and who supports them, UNDP, New York.
   - NESTA (2012), Our Frugal Future: Lessons From India's Innovation System, NESTA, London.
   - Zhenwei Qiang, C., Kuek, S. C., Dymond, A. and S. Esselaar (2011), "Mobile Applications for Agriculture and Rural Development", ICT Sector Unit, World Bank, December.

8. An initiative aimed at providing privately public access to the water supply in Jakarta, Indonesia which, in spite of its objective, was not a pro-poor initiative as the tariff pricing policy set by the government made did not allow the private firm in charge to connect a poor household to the network. See Bakker, K. (2007), "Trickle Down? Private Sector Participation and the Pro-Poor Water Supply Debate in Jakarta, Indonesia", *Geoforum*, No 38, p. 855-868.

9. See the discussion in Chapter 1 on skill-biased technological change and the role of ICT.

10. Further detail is provided in OECD (forthcoming).

11. ITU World Telecommunication/ICT Indicators Database. The developed/developing country classifications are based on the UN M49, regions are based on the ITU BDT Regions; see: *www.itu.int/ITU-D/ict/definitions/regions/index.html*.

12. Overall, a multitude of cloud computing services include software, platform and infrastructure services. The existing service models can be categorised as *i)* infrastructure as a service (IaaS); *ii)* platform as a service (PaaS); and *iii)* software as a service (SaaS). IaaS provides raw computing resources, such as storage, processing and networks and enables users to deploy their own applications and software. PaaS provides users a more structured platform and users typically rely on programming languages and further

tools of the cloud provider to deploy their own applications and services. SaaS cloud users directly access the application of the cloud provider. The spectrum of these applications ranges from e-mail applications to business applications such as customer relationship management tools. On top of the service models, there are several delivery models that include private, public, hybrid and community clouds.

13. The 2011 study, Teleuse@BOP4, conducted in Bangladesh, India, Pakistan, Sri Lanka, was based on 10 147 people interviewed during May-June 2011 who had used the phone to make a call in the last three months, were between the ages of 15 and 60 and belonged to the lower-income deciles.

14. Starting in the early 1990s with the increased uptake of ICT, several studies at industry and firm level have studied the relationship between ICT and productivity. While initial studies found limited impacts on productivity or output growth, the firm-level evidence across various countries found a positive relationship (*e.g.* Bresnahan *et al.*, 2002; Brynjolfsson and Hitt, 2003; Bloom *et al.*, 2006). There is also some evidence on the impacts of ICT on innovation (*e.g.* Hall *et al.*, 2012).

15. Larger (smaller) firms are those plants with more (fewer) than 25 employees three years prior to the survey.

16. See Paunov and Rollo (forthcoming) for technical details on the estimation techniques used.

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