3. INNOVATION, POVERTY AND INEQUALITY

Cause, coincidence, or co-evolution?

Susan E. Cozzens and Raphael Kaplinsky

3.1. Introduction

Innovation system research has long acknowledged the importance of the socio-economic context shaping the capability of organizations, regions or countries to develop, diffuse and use innovations. Innovation is embedded in specific social, political and economic relationships and it is largely influenced by the particular institutional context in which these relationships take place. As a consequence, innovation is considered to be highly dependent not just on epochs (Freeman and Perez 1988), but also on the particularities of specific countries or regions.

When considering the link between innovation systems and developing countries, one can not escape the problems of poverty and inequality so deeply embedded in the socio-economic context of these countries. Poverty and inequality are key issues for global society in the 21st century. Poverty – the long, low tail on the global income distribution that leaves half the world's population living on less than $2 per day – still characterizes far too many lives. Inequality – the distance up the cliff between the bottom and the top of the

distribution – is steep globally and getting steeper within most countries. Neither old nor new affluence is being broadly shared, but is instead accumulating among particular people and in particular places.

The functioning of systems of innovation and capacity building might either ameliorate or exacerbate poverty and inequality. In this chapter, we make a first attempt to provide a framework to analyse the relation between, on the one hand, innovation and capability building and, on the other, poverty and inequality.

After introducing some basic concept and dimensions of inequality and innovation in Section 3.2 and in Section 3.3, we turn in Section 3.4 to a detailed analysis of the dynamics that link various types of innovation with various inequalities. Section 3.5 concludes.

Box 3.1. Innovation, Poverty and Inequality: main terms used in this chapter

Innovation = broadly defined, innovation encompasses the introduction of new or adapted products, produced with new or adapted equipment and in new or adapted forms of organisation, and utilises new or adapted organisational procedures. Innovation provides the private producer with competitive advantage or allows the social producer to better meet the needs of consumers with a given resource cost.

Product innovation = a new or adapted good or service which enhances consumer surplus through either a reduction in price, or an increase in utility, or both. Product innovations may meet the needs of private or collective consumption, and may be appropriable or be a public good.

Process innovation = a new or adapted organisational procedure for the production of goods or services which may be resource-saving, enhancing of product quality, improving of working conditions, be beneficial to the environment. or provide for a combination of these benefits. This may involve the introduction of new embodied technologies, or new forms of organising production. It may involve single actors or a group of producers.

Functional Innovation = a reconfiguration of a value chain leading to individual links in the chain assuming new functions or outsourcing existing functions – for example, original equipment manufacturers producing to their own designs and/or brandnames. Functional innovation involves insourcing, or outsourcing, or a combination of the two.

Value-chain innovation = moving to a new sector of activity based on the accumulation of historic competences.

Vertical inequality = unequal distribution of a valued good among a whole population, e.g., overall income distribution for a nation.

Horizontal inequality = unequal distribution of a valued good among culturally defined sub-groups of a population like genders, ethnicities, and religions, e.g., lower average income among women.

Absolute poverty = income below an absolute cut-off point, e.g., $1 per day.

Relative poverty = income below a cut-off point determined by its relationship to the overall distribution, e.g., two standard deviations below the mean

3.2. Why is important to analyse the relationship between innovation, poverty and inequality

If the relationship between innovation and inequality were simple, we would not have needed to write this chapter. For example, if innovation had no effects on poverty or inequality except through growth, we could stop writing here and refer the reader to the literature on that relationship (Dollar and Kraay 2001; Verspagen 2005; Collier 2007). At the aggregate level, while results are mixed on the relationships between income inequality and growth (Lopez 2004), inequality has been shown to have a negative influence on growth: the economies of countries with higher levels of inequality tend to grow more slowly than those with more equal income distribution (Deininger and Squire 1998; Birdsall and Londono 1997). Furthermore, growth does not necessarily reduce inequality: about half the time inequality decreases with growth and about half the time it increases (Fields 2001). However, growth is important in reducing absolute poverty (Ravallion 2004), although it does not do so in every case (cf. the recent experiences in China, India, and South Africa). Whatever the links between growth and inequality, they may not be directly affected by innovation since growth may be extensive, that is, affected by the use of more inputs in unchanged from, or via a change in relative prices (for example, through the terms of trade).

Likewise, this chapter would not be necessary if the whole relationship between innovation and inequality were mediated in a simple way through globalization, characterized by the increase in the global flows of factors, knowledge, products, and values. Like the growth-poverty relationship, the relationships between globalization and inequalities are widely agreed, although more complex. Globalization moves jobs to the lowest wage economies where they can be performed well. It thus restricts income-growth at the bottom of the scale, and hollows out the middle of income distributions in higher-wage economies (and increasingly the upper middle as well). At the same time, in the receiving economies, the movement adds jobs in the middle of the wage distribution and in some cases inflates incomes at the upper end of the income scale. With regard to between-country inequality, then, globalization has allowed some high-skill, low-wage economies to close income gaps with the leaders while leaving a large number of other countries stuck at the bottom of the scale (Ghose 2003). In short, in conventional economic terms, globalization has been stimulated by technological change (that is, functional innovation in the global value chain), but had uneven effects on inequality.

This chapter would also not be necessary if technology behaved the way neo-classical economists expect it to behave, following its own dynamic.[1]; or if inequality arose as an outcome of autonomous processes – for example, reflecting the political play for power or changing social mores (Krugman 2002). Any connection between the two processes would then be purely accidental. Finally, we would not have written this chapter if the distributional effects of technological change were inevitable by-products of the process of

change itself, just part of the price to be paid for the benefits of new technologies. From this perspective, other institutions need to respond, but not innovation policy or practice.

We are instead convinced that a better understanding of the dynamic relationships between innovation and inequality can open up different options for shaping technological change in ways that move towards greater equity, equality, and social cohesion. In contrast to the simple explanations, our major argument is that while innovation is of course not the only or even main influence on inequality, it is nonetheless often causally linked to poverty and inequality through many different economic, social, and political processes - but not in just one direction. Innovation and inequality co-evolve, with innovation sometimes reflecting and reinforcing inequalities and sometimes undermining them. The causality is also bimodal, with inequality sometimes influencing the nature and trajectory of innovation itself. Our analysis illustrates the variety of those connections, within a framework that we hope will stimulate future research and policy analysis.[2]

The next section of the chapter lays some necessary conceptual groundwork, exploring the different types of innovation, different forms of inequality, and possible causal connections. Section 3.4 then turns to the heart of the analysis, mapping the dynamic processes through which innovation and inequality are linked – the transmission belts, so to speak, that lead between them. The final section outlines possible policy responses to the analysis and an agenda for research into these issues.

3.3. Basic concepts

3.3.1. Dimensions of innovation and competence building

Innovation encompasses the introduction of new or adapted products, produced with new or adapted equipment and in new or adapted forms of organisation, and utilises new or adapted organisational procedures. Innovation provides the private producer with competitive advantage or allows the social producer to better meet the needs of consumers with a given resource cost.

Historically, the primary forms of innovation were in product and or process (Freeman, 1988, drawing on Schumpeter, 1942; Pietrobelli and Rabellotti in this volume). *Product innovation* refers to incremental or radical changes in the nature of goods or services and *process innovation* refers to changes in the organization of production, that is, producing the same or different goods or services in different ways. However, in recent years, the increasing fragmentation and globalization of value chains has focused attention on two relatively new forms of innovation (Humphrey and Schmitz 2000): functional innovation, that is acquiring new or superior functions in the value chain and value-chain innovation, that is, diversifying to a different sector based on competences acquired in a specific activity.

Functional and value chain innovation reflect the changes in the organization of production and innovation over the last two decades. The 1990s saw a wave of corporate reconfiguration as firms sought to identify their unique core competences, and to outsource those activities in which they were unable to protect themselves adequately from competition (Hamel and Prahalad 1994). As Gereffi and the subsequent body of global value chain research documented, this outsourcing took an increasingly global form, with the development of fragmented, "disarticulated", globally-dispersed and globally-coordinated value chains (Gereffi 1994; Hummels, Ishii and Yi 1998; Feenstra, 1998; Morris and Kaplinsky 2001).

The rise of Asian manufacturing competences, first in the Asian Tigers and most recently in China, meant that the non-core competences jettisoned by northern firms increasingly involved the physical transformation of inputs into outputs, notably in manufacturing. The rents in these activities tended to be difficult to protect, and much more difficult than intangible rents arising in knowledge-intensive activities such as design, branding, marketing and chain-coordination. Many northern firms such as Nike, Levi-Strauss and even auto companies such as GM and Ford thus reconfigured their operations, outsourcing their historic manufacturing functions to badge-engineering suppliers in lower-income economies. At the same time, in pursuit of intangible knowledge rents, many of these same lower-income economy suppliers sought to develop their own brand names (Samsung), or to acquire them through strategic purchases (Lenovo).

The consequence of this process of globalisation and reconfiguration is that the established categories of innovation – over processes and products - proved to be inadequate.

Until the early 1990s, the arena of innovation was predominantly characterised as occurring within the firm, or within not-for-profit institutions. However, the increasingly competitive success of the Japanese Production System from the early 1980s added to this framework the coordinated processes of invention and innovation in chains of firms and institutions through concurrent engineering and other processes of linked technological development (Monden 1983, Cusumano 1985).

In contrast with earlier science-based notions of innovation, the Innovation Systems literature (Freeman 1987, Lundvall 1992, Nelson 1993, Braczyk, Cooke and Heidenreich 1998, Asheim and Gertler 2005) is fundamentally concerned with the process of learning inside the firm or service provider and in its interaction with the other organizations in the system of innovation. Since learning is the core of the concept, the innovation system literature is concerned not only with innovation as an output but also with competence building (Lundvall 2007; Lundvall et al. 2002). *Competence building* refers to the processes of learning and renewal of skills necessary to innovate (Lundvall and Borrás 1998).

Here it is helpful to distinguish between capabilities and competences. Capabilities refers to the endowments available to facilitate innovation over time, whereas capabilities addresses the effective utilisation of these capabilities. This distinction between capabilities and competences is analogous to that between invention and innovation. Hence enhancing capabilities by, for example, retraining a labour force, introducing teams and quality circles or acquiring new equipment in itself does not enhance innovative performance. It is the ability of the firm or service provider to utilise these capabilities effectively which underlies effective innovation. Here trajectories and path-dependency are crucial, as is the

capacity of systems of producers (whether in value chains or systems on innovation (Nelson and Winter 1982, Dosi 1984, Wang and von Tunzelmann 2003). These processes are particularly important in developing countries (Bell 2006).

In the discussion that follows, competence building as well as three categories of innovation will be considered - in process, in product, and in function/chain. These will involve a mix of technologies some physically embodied in machinery and equipment, and others which involve changes in institutional design, routines and work organisation. They may involve private or public sector actors, or a combination of them, and may produce private or public goods. Improvements may lead to a combination of falling product prices, enhanced product quality, lower costs of production, better conditions of work and more beneficial impacts on th environment.

3.3.2. Dimensions of inequality

Since innovation studies researchers seldom stop and think systematically about inequalities, we begin by mapping the conceptual territory encompassed by the term, focusing on the distribution of incomes and capabilities.[3]

The term *inequality* most commonly refers to the unequal distribution of income or wealth. Some income inequalities are defined by averages within a geographic area, as in the discussion of urban-rural differences or the low income levels of African countries. Inequality between countries in their average incomes per capita has either been growing or

declining, depending on whether one weights for population. Since average incomes in China and India have been rising, and these are both huge countries, when population is taken into account, inequality between countries appears to be shrinking (Milanovic 2005).[4]

However, the between-country statistics mask a general pattern of rising inequality between households or individuals within countries. Galbraith's decade-by-decade analysis shows the trend clearly (Galbraith 2001). As Milanovic (2005a) reports, the same level of inequality can take different shapes in different countries. The U.S. and China, for example, have similar Gini indexes (the most common measure of inequality). But in China, the differences are largely between the affluent east coast and the poor interior, whereas in the United States, the differences are among households rather evenly distributed regionally. Global inequality, as Milanovic (2005b) names it, is *inequality among households* when all the world's households are considered together. This distribution is highly unequal; the differences are so steep that there is essentially "no world middle class," according to his analysis (Milanovic 2002).

Poverty is the name given to the lowest end of the distribution of income among households. Even rich countries define poverty within their own contexts – a concept called "relative poverty." By definition, relative poverty cannot be eliminated – there has to be a lower end of any income distribution. However, *absolute poverty* can be eliminated, that is, households with incomes below a fixed level. The World Bank uses the figure of household income of $1 and $2 per day to set an absolute poverty level on a global scale.[5] As we

mentioned earlier, about half the world's households survive on less than $2 per day, and those households are overwhelmingly located in developing countries.

Differences in household incomes and poverty are examples of *vertical inequalities*, those that characterize a whole population. In contrast, *horizontal inequalities* are differences between culturally-defined groups such as gender, ethnicity, or religion (Stewart 2008). Horizontal inequalities are often expressed as differences in averages, for instance, the large difference in life expectancy between black and white Americans; but the average is of course just one measure of a whole distribution, as in the fact that there are average differences in income between men and women is connected to the fact that female-headed households live disproportionately in poverty. Technological change often benefits one culturally-defined group more than another. For example, Korea's export-led growth which reduced the gap between its GDP/capita and that of the US, was made possible not only by increasing innovative capacity, as the story is often told, but also by maintaining a large gap between the wages of female and male workers in emerging export industries (Seguino 1997).

So far we have drawn distinctions among income inequalities. But inequality is in essence the unequal distribution of anything people value, not just money. To take other examples, health outcomes are unequally distributed (Wilkinson 1996), and unequal educational experiences are major contributors to persistent income inequalities (Li, Squire, and Zou 1998). In this chapter, we will use the unequal distribution of *environmental risks and benefits* as an example in this broader category because of their close relationship to production processes.

In addition, inequality can be reflected in economic and social structures as well as in the distribution of tangibles. For example, the sectoral structure of an economy often embodies inequalities in productivity that may be linked to other forms. *Firm size* is another structural feature of inequality, with large firms enjoying advantages analogous to those of affluent households. Likewise, the *distribution of economic activities across regions* is another basic structural feature of an economy that may shape and be shaped by technological change.

Finally, there are *class and power relations*, which in the Marxist tradition would be termed inequalities in the "relations of production." These have historically been intertwined with the technologies of production, and will surely continue to be so. Both workers and managers strive to shape workplace technologies in ways that benefit them, both materially and in power. New technologies provide opportunities for new firms to grow and displace others, shifting not just economic but also social and political relationships.

Table 3.1 illustrates the intersection between the dimensions of unequal distribution and the valued items that may be unequally distributed.

Table 3.1 Dimensions of inequality

Inequality in…	Vertical (rich-poor)	Horizontal (gender, ethnicity, religion, etc.)
Income		
Health		
Education		
Environmental goods		
Economic and social structures		
Power		

The discussion so far has focused on cross-sectional concepts, the state of a distribution at a specific point in time. But the direction of change is even more important. Most social and economic analysts agree that horizontal inequalities should be eliminated while vertical inequalities, although they can never be eliminated, should be diminishing rather than polarizing. There are no particularly good terms for these processes, so we refer in this chapter either to concentration and dispersion of valued items, or to equalisation and unequalisation of distributions.

Table 3.2 depicts the intersections between some of the major forms of inequality and types of innovation and competence building.

Table 3.2 Innovations and inequalities – Potential Linkage Areas

	Competence building	Process innovation	Product and service innovation	Functional and chain innovation
Household income inequality				
Absolute poverty				
Horizontal inequalities				
Environmental inequalities				
Inequalities by firm sizes				
Inequalities by place (region, country)				
Inequalities in power relations				

3.4. Innovation, Poverty and Inequality – key linkage mechanisms

Table 3.2 uses the types of inequality arrayed against competence building and the three types of innovation to display a set of places where innovation and inequalities might intersect. But it does not imply a causal direction. As we discussed in the introduction, we do not see the dynamics of the two dimensions as completely independent of each other.

Our analysis instead calls attention to a number of other possibilities, which may in turn differ among cells of the table and even between instances within each cell. The first is that innovation causes the inequality in question by leading to *altered patterns of capabilities and income distribution*, for example, the wealth accumulated because of the temporary monopoly created by new technologies (e.g., the Bill Gates phenomenon).

A second type of relationship is that inequalities shape innovation, for example, in the new forms of work organization that embody the drive by capitalists to limit the power of labour. Each of these possibilities involves a one-way causal arrow.

A third possibility is that the link is co-evolutionary, that is, interactive and bi-causal. On one hand, the direction of technological change reflects existing income and power relations and on the other, it acts to reinforce or undermine these power relations. This complex interaction is most powerful in explaining trajectories that intensify existing patterns but can also explain how less powerful actors can use new technologies to create

new political orders. The co-evolutionary perspective tends to dominate the innovation studies discourse in sociology, political economy and development studies.

A final possibility is that the link between innovation and inequality may be contingent. In some contexts there may be a causal association, for example, when innovation occurs in the context of factor and product mobility, ie with deepening globalization. In other cases, where factors are confined within national boundaries, there may be little causal inter-relationship with innovation. Along with national conditions such as educational levels and the strength of patriarchy, policy interventions are particularly important to consider in this regard.[6] For example, in a closed economy, neutral technological process may lead to stable patterns of income distribution, with labour markets clearing and low rates of unemployment. But in an open economy, the global reserve army of unskilled labour acts to bid up the wage of skilled labour and to result in a race-to-the-bottom with regard to unskilled wages.[7] Similarly, when product markets are open, the "superior attributes" (in the economic sense of the term, meaning better in some respects and no worse in others) of products manufactured for high income consumers drives out innovation focusing on the needs of low income consumers. This is a perspective deriving from much of the material focusing on the distributional implications of globalisation, in the Global Value Chains, International Political Economy and World Systems Theory frameworks.

In the following sections, we address the ways in which innovation may feed into, be fed by, or co-evolve with the types of inequalities discussed in Section 3.3. Four types of linkage are identified, informed by the augmented understanding of innovation as the

building of competences; process innovation; product innovation; functional and chain innovation.

3.4.1. Inequality and competence building for innovation

The major contribution of evolutionary economics to theories of innovation has been to recognise innovation as a dynamic process involving the cumulative building of capabilities within system-specific technological trajectories (Nelson and Winter 1982; Dosi 1984; Wang and von Tunzelmann 2003). This has sharpened the understanding of the innovation process in three important respects. First, by highlighting competences (rather than outcomes), this line of work emphasised the importance of purposive behaviour designed to address sustained accumulation over time, as opposed to particular innovation events.

Second, evolutionary economics problematised the construction of structures which were appropriate to the accumulation of innovation capabilities over time. This move has spawned a particularly rich body of analysis concerning the organisational forms backing capability, including the most effective routines required to achieve timely and efficient outcomes (Nelson and Winter 1982; Teece, Pisano and Shuen 1992; Tidd, Bessant and Pavitt 2005; Lam 2005).

Third, from the outset, evolutionary economics' emphasis on capability-building recognised that this was a systemic process, sometimes occurring within single-plant firms (Hollander 1965), but more typically in multi-plant and multi-divisional firms (Lazonick

2005), increasingly global value chains (Kaplinsky and Morris 2001), local systems of innovation (Braczyk, Cooke and Heidenreich 1998, Asheim and Gertler 2005), national systems of innovation (Freeman 1987, Lundvall 1992, Nelson 1993) and sectoral systems of innovation (Pavitt 1984, Malerba 2002 and 2004).

The building of competence is thus essential for income generation over time, and this affects not only growth, but also the distribution of income in a variety of ways (Lall 1992). Competence building begins at individual and household level, and is there called "human capital" accumulation. Education is the easiest part of human capital development to measure and is therefore a commonly used indicator. Educational achievement and quality vary widely among income groups in affluent countries and are one of the main factors differentiating the conditions for economic development of low-income countries. There is a pattern of under-investment in education for women in low-income countries. Ethnic groups often vary widely in their educational achievement as well, since the provision of quality education is part and parcel of the advantaged social status of certain groups. In turn, the process of technological change created through innovation inexorably requires higher and higher levels of skills, from individuals, households, regions and countries. In order not to be left behind, all these groups must invest in human capital.

There are important links between competence-building and the distribution of *environmental returns*. In the current era these surface most clearly with regard to the energy sector. Here the systematic development of hydrocarbon-based technologies (in processes and products) has reflected and favoured not just the owners of these

technologies (auto companies, petrochemical companies, countries with oil-deposits), but also the nature of the environmental externalities which result. Alternative patterns of competence building – notably in regard to renewable energies – would significantly alter the environmental footprint of production and consumption, with very different associated distributional outcomes, affecting the relations of production, and the size and locational patterns of income returns.

Firms must also engage in competence building to keep up with technological change, but large firms have more resources to invest in this process than small ones. The *uneven size-distribution* of competence-building often reinforces processes of income concentration in large-sized units of ownership, although in some cases and periods, the more effective innovative competences of small-sized producers may have the effect of mitigating the unequalising outcomes of innovation processes.

Typically, innovation competences may also be unevenly distributed *spatially*, both within countries and regions and between countries. Examples of this are the frequently-cited statistics on the global distribution of R&D (The Sussex Manifesto 1970; Lall 2001), even though we know that fiscal commitments to innovation are only a component of successful competence building.

With regard to *power relations*, the key link is the relative innovation success of different firms, and different groups of firms, often within the same sector, but sometimes in different sectors. To what extent are these different types of firms and groups of firms developing the capabilities to sustain innovation or, in turn, to what extent do particular

patterns of innovation reinforce or undermine the capacity of these different sets of firms to sustain innovation over time? Competence-building may also be unevenly distributed and/or affected between capital and labour.

3.4.2. Inequality and innovation in processes

All production, whether of goods or services, involves the assembly and coordination of discrete processes. Some of these processes may be tangible, involving the use of physical assets (machinery, land, labour); others may be intangible, involving forms of organisation and the use of financial or knowledge assets. Each of these inputs, tangible or intangible, used in isolation or as parts of sub-systems and systems, is subject to improvement. Can their individual productivities be enhanced and (or perhaps) could they be combined in different ways to provide better and more output with the use of the same or fewer inputs? This is the subject matter of process innovation.

In all this analysis, we need to notice the importance of both embodied process innovation (reflected for example, in new machinery, new materials, new seeds and the augmentation of land) and disembodied organisational innovation. In many respects the disembodied innovations – in global value chains (Gereffi 2005; Kaplinsky and Morris 2001), in production systems (such as the Toyota Production System, Monden 1983) and in routines (Teece, Pisano and Shuen 1992, Nelson and Winter 1982, Tidd, Bessant and Pavitt 2005) - may often have more significant linkages to distributional outcomes than the array of embodied technologies which are the subject of much of the investment in innovation.

Process innovations affect inequalities primarily through their effects on jobs. For example, a common explanation for rising household income inequality in affluent countries at the current time is "skill-biased technological change" (Wood 1994 and 1998, Acemoglu 2002). The argument here is that as more technology is introduced into the workplace, jobs demand higher skills and workers who have those skills are paid a wage premium. The argument also has its critics (Galbraith 1998). Introducing high-technology sectors into the economies of developing countries can create very strong versions of this phenomenon, with hyper-wages being paid to the few workers with the requisite skills (Cozzens 2006). However, skills biases may also change during historical epochs – for example, during the 19th century, technical change in the UK and the US was biased in favour of unskilled workers (Habakukk 1962); one hundred years later the bias has been in favour of skills (Wood 1998, Acemoglu 2002).

Capital intensity in process innovation (Eckaus 1955, Marx 1876) replaces people with machines in the work process. If its effects are not counter-balanced with the emergence of new industries (usually through product innovation, our next topic), unemployment is the inevitable result. Unemployment and poverty are of course closely related.

Both skill-intensive and capital-intensive process innovations can have differential results horizontally. For example, colonial powers sometimes built ethnic distinctions by giving one group more access to education than another; the divide between Hutu and Tutsi in Rwanda is an example. Those with better education are advantaged in skill-enhancing

process innovation. Capital-driven unemployment can also be spread unevenly. On the last-in, first-out principle, for example, female workers experienced less stable employment than male workers during the technology-led growth in Korea in recent decades (Seguino 1997).

Inequalities can be mediated through the *environmental externalities* of process innovations. At the current juncture we are witnessing a change in the bias of technical change away from energy-intensive towards energy-saving processes. Since industrial pollution is concentrated near poor communities, this shift should help clean up the air for them. However, it could negatively affect livelihoods in communities that produce energy sources; this problem has been seen as a possibility if nanotechnology produces the dramatic drops in energy demand that are sometimes projected (ETC Group 2006).

The scale of processes and more particularly the nature of process innovation has important links with the distribution of environmental externalities. The existence of scale economies in process innovation also provides a close bridge to the implications for *large and small firms*. Minimum scales of operation (Merhav 1969), or economies of scale in production, are closely associated with the size of innovating firms or systems of firms. When small firms cannot compete because of these minimum scales, wealth and employment tend to stay concentrated rather than dispersing.

Process innovation also affects *spatial distribution*. Primarily this is a relationship reflected in scale, with increasing returns in process often penalising distributed production systems. However there will also be locational implications of the skill-intensity of technical change, reflecting the spatial concentration of skills. Insofar as technological change involves processing-loss and or the temporal degradation in the quality of inputs, it will have spatial implications, favouring production proximate to raw material deposits. The need to build plants reflecting the latest processes is one rationale for multi-national firms to move production operations out of high-wage countries. But the pressure for efficient processes may also lead to further moves later, creating instability in labour markets in the country that initially received the production facility.

Clearly, then, there is a very strong link between process innovation and *power relations* (relations of production), making process innovation an arena of struggle between labour and management. A few decades ago, technological change in the workplace could be negotiated in a way that reinforced skill and provided fulfilling work, or that embodied skill in machines, eliminated jobs, and made those that remained repetitive and uncreative. But under globalization, firms that are able to move their operations can escape any one nation's labour regulations, clearly a shift in power.

3.4.3. Inequality and innovation in products

The nature of final products has very important implications for consumer welfare, and for the relative welfare of different groups of consumers. Perhaps the most celebrated recent examples are to found in Prahalad's account of market opportunities in meeting the needs of the newly emergent lower-middle class in India (Prahalad 2005), but these are by no means the only ones. In the development literature in the early 1970s there were a series of contributions around the nature of product technologies, and the fixes between product and process choice (Lancaster 1966; Stewart 1979 Langdon 1981, Kaplinsky 1980; Edquist, Hommen and McKelvey 2001).

Product innovation is a place where inequality in incomes clearly shapes innovation, rather than the other way around. Products are aimed at particular income groups (as in deciles of population) – interactive satellite navigation systems (as in BMW cars costing more than $50K) meet the needs of auto consumers in high income countries, whereas the "1 Lakh cars" ($2.5K) recently introduced in India are more basic and are designed for ease of repair. Similarly, drugs may be developed to meet the relatively rare diseases in high income economies or to target malaria which currently devastates the low income population in developing economies.

The direction, funding and related industry structures in product development – what products are being innovated to fill whose needs? – is now crucial to the evolution of innovation in the pharmaceutical industry. Under considerable pressure from civil society and trans-national governance, that industry is facing the challenges of meeting the health

needs of poor consumers in the development of malaria, TB and HIV drugs (Chataway and Smith 2006). A similar agenda is rolling out in the development of a low-cost basic and solar powered laptop for the developing world,[8] which is designed to show that innovation can work for the poor. Again, as in the case of process innovation, this is not just a matter of developing new tangible products, but also the delivery of services (for example, the delivery of finance through microfinance schemes, or the health systems backing the provision of new drugs for those living below the poverty line in high-income economies). The statistical relationships among gender, ethnicity, religion and poverty in many countries mean that pro-poor technologies also help to counteract these forms of advantage. Micro-finance schemes, for example, are often aimed at women.

How are the *environmental spillovers* of products distributed spatially? Just as poor and communities and those of disadvantaged ethnic groups are more likely to experience the pollution created by production processes, they are also more likely to be located close to the sites of industrial waste (Bullard 2005). Affluent communities are paying poor communities to live with their toxic trash, shipping it around the world as needed (Neyland 2008). All these groups would be helped by an innovation process that created new products or services that addressed environmental challenges as a key objective, rather than being designed only to minimise environmental externalities.

Products are designed to be used in conjunction with certain complementary skills or systems. The distribution of those skills and systems then shapes who can benefit from the

product. So for example, open-source software for business purposes requires high levels of skills within the firm to maintain; *large firms* are therefore more likely than small ones to use it. Open-source consumer applications are useless without a computer, which is a considerable capital expense for families living in absolute poverty, even at the currently-projected $150 cost. As simple a drug as insulin to treat diabetes requires routines that very poor families cannot afford, and doctors therefore tend not to prescribe it in places where the population cannot sustain the treatment regime (Brito and Brouwer 2008). *Location* is a key distributional issue affected by product development because of its connection to these essential complementary conditions.

Finally, with regard to *power relations*, the key element here is the focus on the producer-consumer divide. That is, to what extent do innovations in product affect consumer and producer welfare differentially? This has been particularly an issue with regard to genetically-modified crops, since (some say) they offer significant benefits to some producers (e.g., farmers facing European corn borers in their fields) but (others say) no benefits and significant risks to consumers. To the extent that the producer benefits increase yields and lower food prices, the poor benefit – but not if their use is blocked by the preferences of middle class consumers.

3.4.4. Inequality and functional/chain innovation

Innovation is thought to create a temporary monopoly for the firm that introduces it. For a period of time, the firm can ask a high price for what it does, because no one else can do it. The additional income thus generated is referred to as “monopoly rents.” There are other ways to create a monopoly besides innovation, so we will refer to them as “innovation rents.” Innovation through functional and chain innovation provides the opportunity for the firm to generate rents by moving to less competitive links in the value chain, or to chains with higher barriers to entry.

The key to assessing the links between innovation and the distributional outcome arising out of rent appropriation is to be found within the global value chain analytical framework (Kaplinsky and Morris 2001, Gereffi et. al., 2005), which will be discussed in detail in Chapter 8 (Rabellotti and Pietrobelli in this volume). Value chain analysis does more than merely plot the physical flow of products from the conceptual and design stages through processes of input production, physical transformation and assembly, marketing, consumption and recycling (as in Porter’s 1990 description of the “value stream”; Porter 1990). It also identifies the key areas of rent in any chain – that is, those activities in the chain which are in some way or another relatively protected from competition and thus benefit from scarcity of access. In this the analysis is founded on the work of Ricardo, Marx and Schumpeter, all of whom focused on the role which innovation plays in constructing barriers to entry. These rents may be created within the firm or networks, or they may be exogenously determined (perhaps by governments or physical endowments) (Kaplinsky 2005). Whilst not all rents are the outcome of innovation (for example, privileged access to

low-cost hydrocarbon deposits; restricted competition through anti-competitive behaviour), most rents are.

The key to the distributional outcome of these innovative rents is the ability to appropriate the fruits of innovation (Papaioannou 2006). This appropriation may be legally reinforced through patents, copyrights, brand names, geographical indicators, or arise from secrecy (for example, the formulation of Coca Cola essence or Drambui) or from codified corporate or chain codified practices (for example, quality control procedures or systems for managing extended supply chains. as in the Toyota Production System (Monden 1983)). In the recent period, the most noteworthy global trend is the reduction in barriers to entry in the physical transformation of products as China and other Asian economies begin to command industrial processes (or indeed the sub-processes within service value chains, as in the role played by the Indian software sector). Concomitant to this lowering of barriers in production is the construction of barriers in the disembodied knowledge-intensive service links in the chain, such as in design, branding and marketing.

The appropriation of value chain rents has very significant links with distributional outcomes. At household income level, a small elite group usually benefits disproportionately from the wealth generated. Although some of the profits are spread more broadly through stock ownership, that broader band of ownership does not extend much beyond the OECD countries, whose citizens own 90% of global equity (Davies, Sandstrom et al. 2006). Poverty is unlikely to be affected directly by this accumulation of wealth,

although if the concentration of resources in a particular place lowers the unemployment rate there, poverty may fall and service jobs may be generated. Men are much more likely than women to own the patents that are used to maintain the temporary monopoly – a contextually contingent phenomenon that will be stronger in more patriarchal societies.

The *size distribution of returns* to innovation is also an outcome of the appropriation regime, as small producers may often find it difficult to protect their sources of rent, or by changing function in the value chain, break down barriers to entry protecting larger and more powerful producers. Where power is a reflection of state-power, this has an obvious overlay with the locational character of appropriation as different countries provide their producers with differential levels of support in the protection of innovation rents.

Important appropriation-related innovation links to distribution arise in regard to *location*. This includes different national regulatory regimes for property rights (see Chaudhuri 2005 and Chataway, Smith and Wield 2006 on the pharmaceutical sector) and the gains from proximity arising from externalities generated in industrial clusters (mostly achieved without any property rights being involved - Best 1990; Pyke and Sengenberger 1992; Schmitz 1999). Innovation involving Geographical Indicators (“champagne”, “feta”) may also be a source of rent appropriation. Chain upgrading is clearly quite dependent on local conditions, including the regulatory environment.

The links to *power relations* are mostly reflected in the distribution of profits between firms, including not only firms competing in the same activity, but in the distribution of rents amongst the different links in a global value chain. For example, virtually all of the fruits in product innovation in the coffee value chain have been appropriated by buyers in the high income countries, and the proportion of chain incomes accruing in producing countries has fallen over the past two decades (Kaplinsky and Fitter 2004).

3.4.5. Linkage mechanisms in summary

Table 3.3 summarises the discussion on the links between innovation, poverty and inequality. The strength of the relationships varies among the cells of the table.

- The patterns of distribution relating to *power relations* are most clearly linked to process choice, the distribution of returns through the capacity to appropriate rents through brand power and IPRs, and the capacity to influence the regulatory environment and the allocation of innovative resources as a consequence of the political power of different parties in the innovation process. Innovations in product appear to be only weakly associated with the relations of production.

- The *locational* causes and consequences of innovation, and the associated distributional outcomes, affect all of the potential linkage mechanisms, but are

particularly important in relation to capability-building, power and associational networks and the differential power of governments to determine the regime of intellectual property rights.

- There are in general strong linkages associations between *firm size* and distributional patterns in regard to all identified linkage mechanisms.

- The *environmental* determinants and impacts of innovation are primarily linked through the generation and choice of process technologies, and in the context of power relations and associational networks. Less important, although also relevant, are innovations in product and in the building of appropriate innovation capabilities. The distribution of rents along the value chain does not appear to be associated with environmental distributional outcomes.

- Relationships to *household income distribution* and poverty in both their vertical and horizontal versions are strongly mediated by the distribution of education and skill, which are in turn distributed in ways that are shaped by both cultural and policy conditions.

Table 3.3 Innovation, poverty and inequality – Illustrative linkage mechanisms

	Competence building (CB)	Process innovation	Product (and service) innovation	Functional and chain innovation
Household income inequality	Uneven CB among households	Skill bias	Luxury goods vs. bottom of the pyramid marketing	Elites benefit disproportionately from the accumulation of wealth, including across countries
Absolute poverty	Hard to break through poverty cycle to build human capital	Job loss associated with rising capital intensity	Drugs for malaria, TB, HIV/AIDS Low cost computer	Multiplier effects occur only where those rents are being appropriated
Horizontal inequalities	Women have less education than men on a global basis	Education is unequally distributed; affects skill	Pro-poor projects also often help disadvantaged groups	Ownership will often be held by traditional elites
Environmental inequalities	Dominant and alternative patterns of	Links to externalities	Environmental spillovers	Avoidance of responsibility for environmental

	capabilities			effects
Inequalities in firm sizes	Large firms often better at CB than small	Economies of scale affect size of innovating firm	Complementary skills and technologies required	Large firms like to gather up IP to help concentrate their rents; inter-country division of labour changes
Inequalities by place (region, country, continent)	Uneven distribution within countries and regions and between countries	Concentrated vs. dispersed Skill-seeking Proximity to natural resources	Local capabilities are often necessary for the absorption of new technologies that are otherwise affordable	High rents to only some links in the value chain[9] Gains from industrial clusters Inter-country division of labour in chain niches
Inequalities in power relations	Uneven building of capabilities between capital and labor	Strengthening position of management	Differential effects on producer and consumer welfare	High rents go to only some links in the value chain

3.5 Discussion and conclusions

The analysis we have presented implies a very rich research agenda for innovation studies. We have raised many questions and answered few and have only begun to scratch the surface of the role of globalization in these dynamics. Our analysis does not yet deal with innovation systems and inequalities, but offers insight into the relationships between innovation and inequality. This provides a first step in understanding how systems of innovation and competence building might affect inequality in developing countries.

Each row and each column of Table 3.3 offers a research agenda of its own. There is a great deal to be learned about how firms and other relevant actors in the innovation space approach issues of poverty and inequality. Likewise, we know little so far about the effectiveness of policy interventions in changing the pattern of relationships we have described.

The pattern of connections, however, suggests policy interventions that are more likely to reduce rather than increase inequalities in an innovating world. The multiplicity of actors involved in the global economy suggests a rich terrain for action, and this agenda is clearly too large to address in the context of this chapter. Some options are appropriate for leaders in the global South and some better suited to those in the global North, since the latter group is presiding over the motivating institutions and forces of the global economy, while the former are largely coping with their consequences.

For the global South, what is most clear is that investments in building capability to increase absorptive capacity are absolutely crucial, not just for growth but for distribution as well. These investments should of course start with households and individuals, to give regions and countries a base for building competitive businesses and attracting investment from abroad. These same investments, made on a universal basis with high equality education for all, are also the basis for reducing several other innovation-related inequalities, such as those related to skill. The capacity for households to use available technologies should be kept in mind, along with the ability of individuals to get and perform skilled jobs. At the same time, encouraging capacity building in local firms is an important policy goal, since they will be the mainstay of the regional and national economy. Small firms may need special attention. A key policy agenda for south-based firms is their capacity to change their position in global value chains and to command rent-rich niches such as design and branding. But to avoid the concentration of those rents among small elites, governments might take a number of steps to empower small and poorer producers to develop brand presence and marketing capabilities. There are a number of examples of this occurring through premium-branded coffees produced by Central American cooperatives, and of chocolate produced for a cooperative venture in Ghana and sold on European supermarket shelves.

For most countries, attracting foreign direct investment will need to be part of the mix of economy strategies, but we have seen many pitfalls in doing this from the viewpoint of

poverty and inequality. Policy makers must therefore concentrate on honing their instruments in such a way that outside businesses

- Invest on a long-term, stable basis
- Provide good working conditions
- Build local skills
- Do not off-load environmental costs
- Maximize good jobs, and
- Work as much as possible with local firms as suppliers.

None of these policy goals is achievable unless power relationships shift. The change can happen incrementally, but policy makers in the South must be alert to the opportunities to move an inch at a time, in order to change the nature of the race in the long run.

For policymakers in the North, the main message of our analysis is that their actions have consequences beyond their national borders. Likewise, what is happening elsewhere is important to the future prosperity of high-income countries. A polarizing world with wealth maintained at the top of the distribution is not sustainable. For any economy to grow, the global economy must be growing, and the more widespread that growth, the more stable the possibilities for all. Northern policymakers should therefore look beyond competition

among themselves, including competition among their sub-national regions, to find opportunities for mutual benefit through growth in developing countries.

It is not sufficient for development assistance to stimulate firms in the North to make products that solve the problems of the South, unless the relations of production and the nature of global value chains are altered as well. Leaving unequal power relationships in place is not a long-term option. In paying attention to empowerment, development assistance can also focus on building local capacity.

Finally, the countries of the North should be taking the lead in establishing rules of the game in international trade that encourage decent work and sustainable growth in the South. It is in their long-term interest to do so.

In conclusion, we commend this research topic to our fellow scholars in innovation studies. We are aware of the fragility of the framework we have presented and the many possibilities for other approaches. We are less concerned, however, with getting the categories right this time than with producing a framework that can be modified and used systematically to explore the interactions among innovation, poverty, and inequality.

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NOTES

[1] In this view, technological change is seen to be independently driven and is "Harrod-neutral" in the sense that it has no impact on relative factor returns.

[2] See Cozzens (forthcoming) and Kaplinsky (2008) for a similar analysis.

[3] There is a voluminous literature on the different dimensions of equality (see, for example, Dworkin 1981a and 1981b; Sen 1973 and 1980). See Kaplinsky (2005, Chapter 2) for an elaboration of this data on income and wealth, the methods involved in calculating poverty and inequality, and for a review of the detailed incidence of poverty and inequality

[4] However, recent revisions in calculations of GDP by purchasing power parity have dramatically reduced estimates of GDP for China and India. These changes have increased estimates of inter-country inequality both when population is taken into account and when it is not (Milanovic 2007). Inequality scholars await the retroactive recalculation of GDP per capita on a PPP basis to see whether the change also affects the trends.

[5] These $1 and $2 per day figures are a little misleading since they are based on the purchasing power of the dollar in the US in 1985, subsequently uprated in the 1990s. The current value of these $1 and $2 per day figures are somewhat higher than these numbers suggest. However, the point remains.

[6] Cozzens is exploring these interactions in other work. See Project Resultar at www.tpac.gatech.edu and Work Package Four at http://www.resist-research.net/home.aspx.

[7] This view is contested in mainstream economic theory by the factor price equalisation theoreom which argues that globalisation will lead to income equalisation. These differences in outcome hinge on whether global labour markets clear or are characterised by the existence of a "reserve army of labour" (Kaplinsky 2005).

[8] http://www.laptop.org/, accessed July 30, 2008.

[9] Mediated by intellectual property regimes.

ACKNOWLEDGMENTS

Kaplinsky is indebted to Norman Clark, Les Levidow, Marianna Mazzucato, Theo Papaioannou, Carlota Perez and Nick von Tunzelman for giving him the opportunity to talk through the structure of this paper at an early stage of its construction. Cozzens is grateful to the many colleagues and students who have helped in developing systematic approaches to this topic with her over the past decade