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Innovation, Poverty and Inequality: Cause or coincidence? A Synoptic Overview

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ABSTRACT

This paper examines the inter-relationship between Innovation Studies, poverty and inequality in the context of a rapidly globalising economy. It begins by summarising the nature and extent of global poverty, inequality and globalisation, and follows this with a disaggregation of different components of inequality. A number of potential causal links between innovation, poverty and inequality are discussed, before we attempt to map the extent to which different streams of Innovation Studies address issues of poverty and inequality. This is followed by a discussion of the nature and direction of causality in this inter-relationship, as a prelude to drawing conclusions for the agenda of individual studies of innovation, for the methodology used to explore the innovation-welfare nexus, and for policy makers concerned with reducing poverty and inequality.

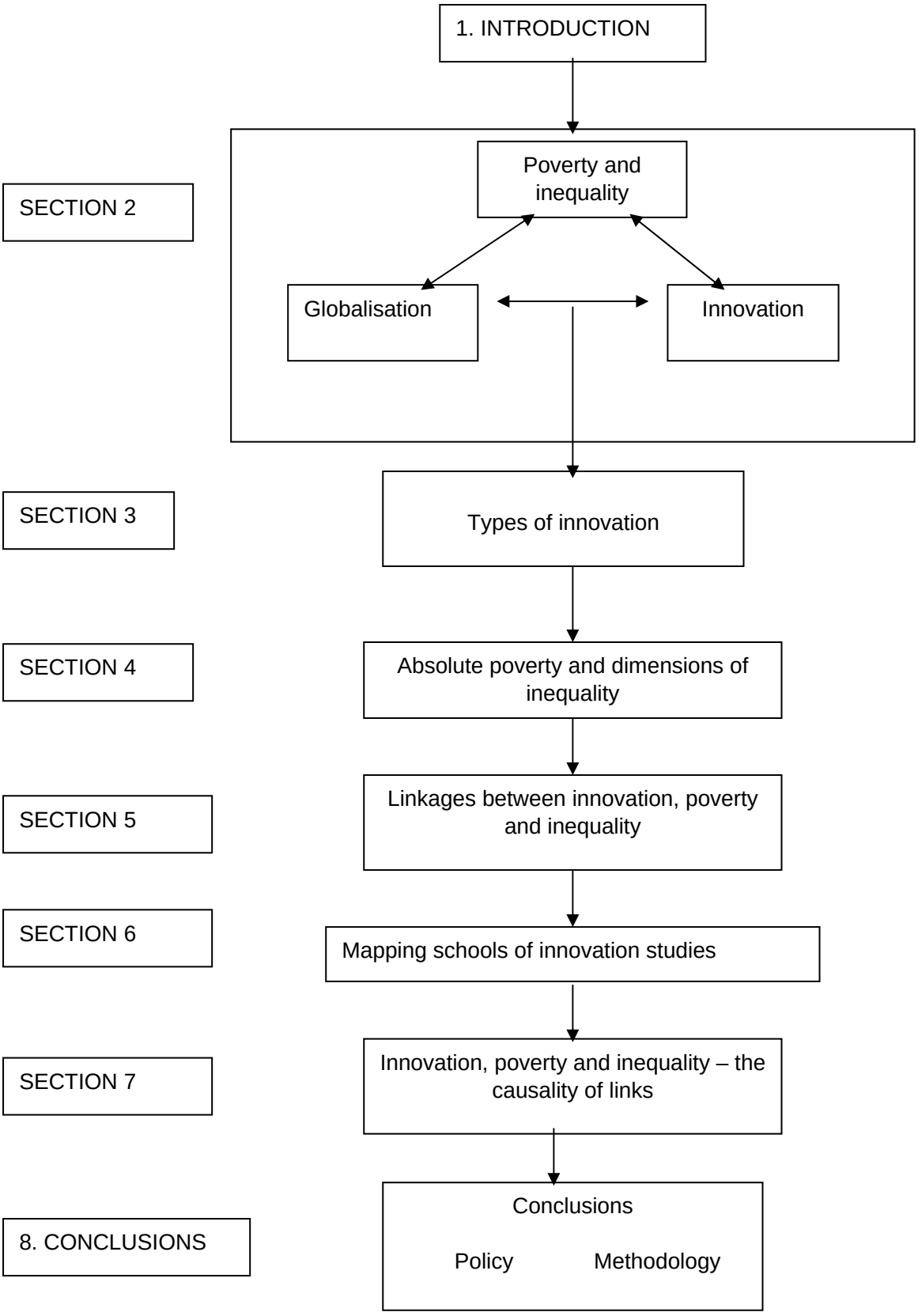
Keywords
Innovation
Inequality
Income distribution
Poverty
Globalisation

1. INTRODUCTION

We live in a world of rapid technical progress, persistent and widespread levels of absolute poverty, and complex patterns of income and wealth inequality. At the same time, production, consumption and exchange are taking place at an increasingly global level. The centrality of these developments naturally leads to the question addressed in this paper – to what extent do increasingly global structures of innovation ameliorate or exacerbate patterns of intra- and international poverty and inequality?

Figure 1 provides a road-map of the discussion. We begin in Section 2 by setting the context. This is followed in Section 3 by a brief review of what we mean by innovation. Section 3 addresses patterns of poverty, inequality, rates of innovation and globalisation. This is used to set the scene for the discussion in Section 4 which opens up key categories of poverty and inequality and in Section 5 which identifies key linkage mechanisms between innovation and poverty and inequality. Section 6 uses this framework to locate various schools of innovation discourse, and then in Section 7 we return to the link between innovation, poverty and inequality and address the possibility and direction of the causal relationships between innovation, poverty and inequality. The paper concludes by focusing on methodology and policy implications.

Figure 1. Road-map of discussion: Outline of paper



2. PRODUCTIVITY GROWTH, POVERTY AND INEQUALITY IN AN ERA OF RAPID GLOBALISATION?

Here we briefly summarise some of the characteristics of productivity growth, poverty and inequality in the recent era of deepening globalisation. Whilst each of these domains is the subject of contestation with regard to both the domains of measurement and the resultant numbers, in most cases there is general agreement about the overall trends and it is these which are reported below. Where there are major issues of interpretation, these are noted. We focus on the post-1970s period, marking the end of post-war reconstruction in Europe, and the onset of deepening globalisation accompanied by the increasing liberalisation of factor and product markets.

2.1. What has happened to innovation?

Typically, innovation is measured as a combination of knowledge inputs and outputs – for example, R&D and patents respectively (Griliches, 1990; Arundel, 1997; Smith, 2005) . These measures show increasing levels of investment in innovative activities and rising levels of innovative output. The literature on systemic change – in production paradigm (Piore and Sabel, 1984; Best, 1990) and techno-economic paradigm (Freeman and Perez, 1988; Freeman and Louca, 2001) - similarly suggests a period of increasing, and indeed radical, technological change in the last decades of the 20th century.

Yet it is difficult to conclude from these measures on innovation inputs and outputs that there has been an increase in the pace of innovation, whatever may have happened to its nature (Dosi et al, 2007). R&D inputs may be invested inefficiently and/or may experience diminishing returns (Verspagen, 1995; Bell, 2002); patents are unreliable indicators of "success" since they only address parts of the innovative spectrum (Arundel and Kabla, 1998) and in some cases may serve primarily as an obstacle to innovation rather than a reflection of positive outcomes. Thus, if we focus on one key reflection of innovation – GDP/head - we can conclude that whatever the outcome of innovation in particular sectors, at systemic levels (at least for the major industrial economies) there is little evidence of a speeding-up of technical change in recent decades (Figure 2), a view shared by Acemoglu "There is little direct evidence that the decades between 1970 and 1995 have been a period of [unusually] rapid technical change" (Acemoglu, 2002: 34).
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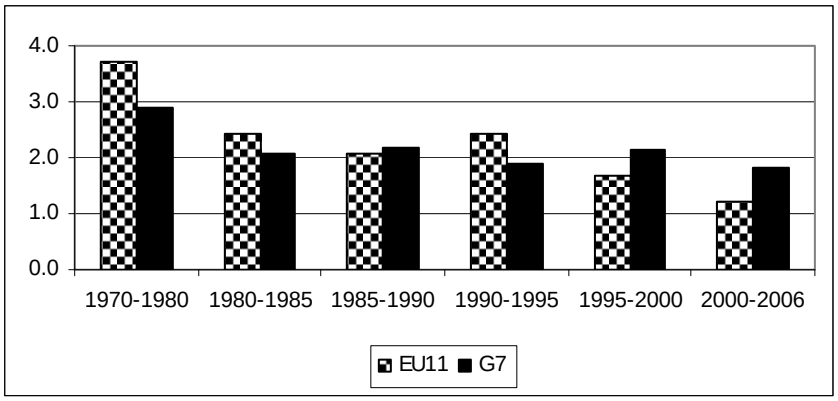
Figure 2: GDP per hour growth rates



EU11 is EU15 excluding Austria, Greece, Luxembourg and Portugal
Source: Calculated from http://www.oecd.org/dataoecd/14/41/39549318.xls, accessed 13th November 2007

2.2. Poverty and inequality[1]

Analysts of poverty distinguish between absolute and relative deprivation, routinely referred to as “poverty” and “distribution”.

In recent years attention has been focused on a particular cut-off point for the measurement of absolute global poverty– the $1 per day criterion (reflecting the purchasing power of a US$1 in 1985) – with a global commitment to halve the numbers living in absolute poverty in 2000 by 2015. Table 1 below shows that, in aggregate, considerable progress appears to have been made, with the headline count dropping from 1.25bn in 1990 (28 percent of the total global population) to 969mn (18 percent of the population) in 2004 (Chen and Ravallion, 2007). However, closer examination shows a more complex picture, with almost all of the reduction taking place in China. (The poverty headcount in India and Latin America is largely unchanged, whilst that in SSA has increased). But even here the picture is less impressive than it seems. This is because the $1pd poverty measure depends crucially on purchasing power parity (PPP) adjustments to exchange rates. For many years it was recognised that China’s competitive exchange rate was undervalued and did not reflect true purchasing power, and hence the size of the economy (and thus real standards of living) has been uprated, diminishing the number of absolute poor as reflected in official exchange rates. However, rises in food and housing prices, and falling healthcare and other non-traded service delivery in recent years have meant that the World Bank’s PPP rate for China and India is now significantly overstated (World Bank, 2007). The World Bank has revised these PPP conversion rates, and the implications for absolute poverty rates are significant, since the GDPs of both China and India have been downrated by around 40 percent. This raises the numbers in real poverty in China to around 330m rather than 128m (Keidel, 2007). Ceteris paribus in other countries (although many other countries have seen PPP readjustments), in terms of aggregate global poverty, this means that the global headline figure for 2004 is around 1. 17bn.

[1] There is a voluminous literature on the different dimensions of equality (see, for example, Dworkin 1981a and 1981b; Sen, 1973 and 1980). The discussion in this section is largely confined to the issue of income and wealth inequality. 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

Table 1. Estimates of global absolute poverty

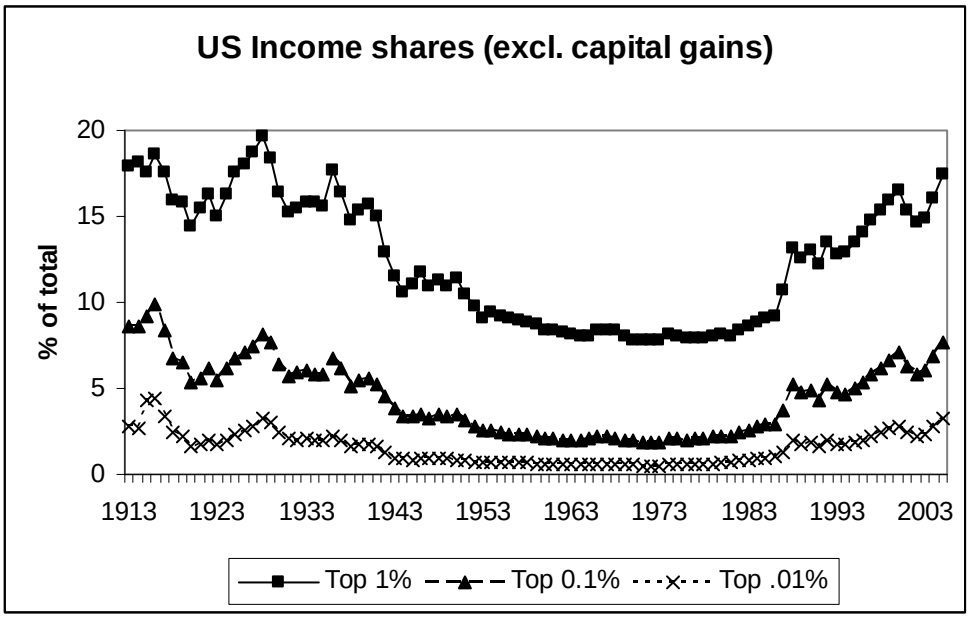
	$1.08 per day at 1993 PPP					
	Number of Poor (1,0000,000)			Poverty Rate (% of Population Below…)		
	1990	**1999**	**2004**	**1990**	**1999**	**2004**
East Asia	472	277	169	29.6	15.5	9
China	377	223	128	33.0	17.8	9.9
China rerated PPP*			328			25.4
Europe and Central Asia	2	18	4	0.5	3.8	0.9
Latin America and Caribbean	49	49	47	11.3	9.7	8.6
Middle East and North Africa	6	6	4	1.6	2.1	1.5
South Asia	462	463	446	40.1	34.9	30.8
India		376	371		37.7	34.3
Sub-Saharan Africa	227	296	298	44.6	45.8	41.1
Total	**1,219**	**1,109**	**969**	**27.9**	**22.1**	**18.1**
Total – rerated China GDP*			**1,169**			**21.8**

* If China PPP rate downrated in 2007 (v. Keidel, 2007)

Source: 1999 and 2004 data from Facts and Figures from World Development Indicators 2007, http://siteresources.worldbank.org/DATASTATISTICS/Resources/reg_wdi.pdf, accessed 16 November 2007; 1990 data from http://www.developmentgoals.org/Poverty.htm#povertylevel

The second element of poverty relates to distribution. Here there is less dispute over the numbers. In the key high income markets, inequality has grown very rapidly, most notably in the US. Figure 3 shows the historical picture there over the 20th century, illustrating a reversion to levels of inequality last seen just before WW1. Much of this unequalisation has been evidenced in the last three decades of the 20th century, with astonishing trends in this distributional pattern. Between 1966 and 2001, in the US the median real wage grew by only 11 per cent in real terms, rising at 0.3 per cent per annum. This compares with an increase of productivity growth of 1.57 per cent per annum, and a growth in real incomes of the top one-tenth of the top one per cent (ie the 99.9th percentile) of 5.6 per cent per annum - “More of the income change [between 1966 and 2001] accrued to the top one percent than the entire lower 50 percent, and more accrued to the top 1/100 percent than to the top 20 percent” (Dew-Becker and Gordon, 2005: 36). Unequalisation is also evidenced in the class distribution of income. Figure 4 shows how the distribution of returns moved in favour of capital during the last decades of the 20th century in high-income economies.

Figure 3: US Income shares (excluding capital gains), 1913-2003.



Source: Piketty and Saez (2003); Series updated to 2005 (personal communication Emmanuel Saez, 8th November 2007).

Figure 4 Functional distribution of income

Source: IMF World Economic Survey, 2007

This process of unequalisation is not limited to the US. Similar, but less extreme trends have been experienced in almost all the high income countries. In general, income distribution in these economies tended to become more unequal during the 1980s and 1990s (particularly in the Anglo-Saxon economies – Dunford, 1994), and then to stabilise (Gottschalk, Gustafson and Palmer, 1997; Streeten, 1998). Inequality has also grown markedly in the transition economies (UNDP, 1999).

But it is in China that the changing pattern of internal income distribution has been most marked and which has the greatest impact on global income distribution. In the context of a very rapid pace of economic growth and integration into the global economy there was a sharp rise in inequality. This was between urban and rural areas, coastal and interior provinces, and within urban and rural areas; the only indicator which did not worsen was that between rural areas (Khan, 1999). Since the 1990s China has moved from being one of the most equal to one of the most unequal economies in the world.

The only exception to these trends of income unequalisation has been in regard to the global distribution of income. Here China's rapid economic growth and its very large size (20 percent of global population) has meant that the population-weighted distribution of income has become more equal, ironically at the very time that China's internal distribution of income has worsened so dramatically (Milanovic, 2002). (However, the rerating of the Chinese PPP currency, involving a 40 percent decline in GDP, may significantly affects this exceptional conclusion. As a consequence the population-weighted global distribution of income is higher than that within any individual country, including South Africa and Brazil – Milanovic, 2007).

2. 3. Deepening globalisation

The abovementioned stickiness of global absolute poverty numbers and the growth in inequality has occurred in the context of deepening globalisation. This reflects a systematic process in which the global barriers to the exchange of factors, products, finance and migration have been lowered (albeit unevenly). It has also affected global flows of technology and technological capabilities, not least through the two-way flow of skilled people, including in the reverse brain-drain which has been a source of considerable learning and technology transfer for low-income countries in general, and for China and India in particular (Saxenian, 2006; Kale and Little, 2007).

Here there is little dispute over the trends. Although uneven, global integration has been extending rapidly. The aggregate trade/GDP ratio, for example, has risen steadily since 1960, and at an increasing pace from the early 1990s. Beginning at 19 percent in 1960, it rose to 24 percent in 1970, 29 percent in 1980, 34 percent in 1990, 50 percent in 2000 and to 56 percent in 2004 (data from WDI accessed 16 November, 2007).

3. WHAT DO WE MEAN BY INNOVATION?

At the highest level of aggregation, innovation is viewed as the “commercial” exploitation of inventions, that is, the introduction of a new product, process, method or system (Freeman, 1986, drawing on Schumpeter, 1942). 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). The boundaries of innovation were shifted further to embrace the role played by research and technology organisations in national (Freeman, 1987; Lundvall, 1992; Nelson, 1993) and regional (Braczyk, Cooke and Heidenreich, 1998; Asheim and Gertler, 2005) systems of innovation.

This evolving process of inter-firm innovation was complemented during the 1990s by 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 brandnames (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, albeit adding the inter-firm and inter-institutional dimension and taking account of both embodied and disembodied technologies – proved to be inadequate. Two additional categories of innovation have had to be added to make for a comprehensive overview of innovation processes (Humphrey and Schmitz, 2001). The first is functional upgrading, that is, increasing value added by changing the mix of activities conducted within the firm (for example, taking responsibility for, or outsourcing accounting, logistics and quality functions) or moving the locus of activities to different links in the value chain (for example from manufacturing to design). The second is chain upgrading, that is,: moving to a new value chain (for example, Taiwanese firms moved from the manufacture of transistor radios to calculators, to TVs, to computer monitors, to laptops and now to WAP phones).

In the discussion which follows below, all four categories of innovation will be considered - in process, in product, in function and in 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 will also often involve close interaction between firms and institutions which have little or no equity links.

4. OPENING THE POVERTY/INEQUALITY BOX

Our quest in this paper is for the link between innovation, poverty and inequality. In pursuing this it is necessary to open-up these indicators of poverty and inequality, since they are both complex and multidimensional, particularly with regard to the measurement of inequality.

There is no unique set of distributional categories – Figure 4 lists a variety of classifications which reflect income groups, temporal, sectoral and locational categories. The choice of which categories are to be considered is therefore a matter of judgement, reflecting both an *a priori* view of those which are most clearly inter-related with patterns of innovation, and those which are contextual, reflecting a particular line of enquiry.[2]

Figure 4: A selection of the many dimensions of relative poverty

Dimension of inequality	Who is involved – some examples
Inter-personal	Comparison between *all* individuals
Inter-percentile	Between different percentile groups of population
Intra-percentile	Within different percentile groups of population
Inter-class	Labour and capital; farmers and landless labour
Intra-class	Financial capital and industrial capital; large farmers and small farmers
Inter-sectoral	Agriculture and industry
Intra-sectoral	Within agriculture and industry
Inter-generational	Adults and children; working adults and the retired
Inter-gender	Males and females
Intra-gender	Within gender groupings
Inter-temporal	Over time
Intra-temporal	Within time periods
Inter-regional, intra-national	Town and country-side; between cities; between provinces and districts
Intra-regional, intra-national	Between towns within a region
Inter-regional, inter-national	Between continents; between country-types
Intra-regional, inter-national	Within continents; within country types
Between countries – unweighted	Comparing country averages and ignoring population size
Between countries – weighted	Comparing country averages taking account of population size

[2] For example, in what follows I have not flagged the gender distribution of income since in my view it is not primarily related to patterns of innovation, even though there are links which can be identified (Mitter and Rowbotham, 1997).

4.1. Absolute poverty

Before we engage with distributional issues, we begin with absolute poverty. At the current juncture this is measured most frequently at the global level by the Millennium Development Goals $1pd and $2pd, adjusted for purchasing power parity. However, since even absolute poverty is contextual, most countries and communities have their own independent measures of this index. Typically in the high income countries, the accepted level of absolute poverty will be much higher than they $1pd or $2pd figure, reflecting increases in expectations arising from per capita income growth. In the EU, for example, absolute poverty is defined as those earning less than 60 percent of the median annual wage.

The classification of distributional indicators is more arbitrary. We flag four clusters of sub-categories as being of particular relevance to the discussion of innovation and distribution:

4.2. Relations of ownership

There are a number of sub-categories which can loosely be grouped under the heading “relations of ownership”. The most obvious of these is the functional distribution of income, that is between capital and labour (see Figure 4above). But there are others which are also important and relevant to issues of innovation, notably the distribution between skilled and unskilled labour, between the employed and the unemployed, between different types of holders of capital (for example, finance and productive capital) and between consumers and producers. This is not a unique list, and in some respects (see below) distributional concerns addressed in terms of other major classifications of distribution (for example, the size-classification – see below) can also be grouped under this heading.

4.3. Locational distribution

Distribution has important spatial components. At the highest level of aggregation this encompasses continental regions (for example, SSA, Latin America) and continental sub-regions (for example, Eastern Africa, Central America). At lower levels it includes groups of countries. Some examples here are the G7/G24/G77 groupings; the OECD; the BRICS (Brazil, Russia, India, China, South Africa); World Bank income groupings (high/upper middle/lower middle/low income); and the UN less developed/least developed groupings. At an even lower scale we can identify individual countries, provinces/states within countries, urban/rural divides, and specific towns and even villages.

4.4. Size composition

Although the size-composition of distributional outcomes is often subsumed in the locational sphere discussed above, there are a number of size-categories which are relevant to the discussion of innovation which reflect the size-composition of producers and income recipients. At the producer level the key size distinction is the operating unit (farm or firm, but sometimes division or plant), reflecting (sometimes a combination of) sales, capital assets, number of employees and physical attributes (for example, size of farm). On the consuming side, the most widely-considered sub-categories are

quintiles/deciles of population groups, households and age-groupings. The gini-coefficient provides an aggregate indicator of the size distribution of income by comparing shares of population groups with shares of income.

4.5. The environment

It is only relatively recently that the environment has risen high up the policy agenda. It may seem somewhat surprising that this is seen as an issue of distribution, since because in many respects the environment displays the characteristics of a public good. That is, the presence of environmental externalities suggests a generalised rather than a series of specific impacts. Yet, in most cases environmental spillovers are characterised by segmented outcomes – more like “club goods than “public goods” – and consequently their uneven incidence has clear distributional outcomes. These distributional characteristics may be locational (see 4.3 above) or affect different income groups adversely. They may also affect genders differentially – for example, persistent droughts may place pressures on women responsible for fetching water and fuel from increasingly distanced and scare water-sources and forests.

4.6. Contingent categories

Sections 4.2-4.5 reflect this author’s judgement of the key distributional outcomes associated with the pace and nature of innovation. However, there are other categories which may be of a less generalised nature, but which may be of concern with particular interest groups in mind. This may include issues of gender (see footnote 3 above), age profile (innovation and its impact on and relevance to the elderly) and ethnic groups (for example, the presence or absence of innovation in relation to sickle-cell anaemia). It is hoped that the analytical structure presented below will allow the analysis to be directed to any one of these, or other contingent categories of distribution which are the subject of specific enquiry or policy decisions.

Figure 6 summarises these poverty and distributional categories. As can be seen from the discussion above, each of these primary classifications can be sub-divided into finer classifications.

Figure 6. The primary poverty and distributional categories of relevance to the pace and structure of innovation.

	Relative poverty – distribution/inequality				
Absolute poverty	Relations of ownership	Location	Size composition	Environment	Other - contingent

5. INNOVATION, POVERTY AND INEQUALITY – KEY LINKAGE MECHANISMS

In this section we address the ways in which innovation may feed into, or be fed by, the categories of poverty and distribution discussed in the previous section. At this stage we do not consider the nature and direction of causality (if any) of these links – this will be the subject of discussion in Section 7 below. Six types of linkage are identified, informed by the augmented understanding of innovation (Section 3 above) – through the link between innovation and growth; through innovation in processes; through innovation in product; through command over innovation rents in value chains; in the process of capability-building for innovation; and in the relations of power and social capital

associated with innovation. As will be shown in Section 6 below, each of these mechanisms of interaction are addressed by different families of innovation studies.

5.1. Innovation and poverty

The primary link between absolute poverty and innovation occurs indirectly through the linkage between innovation and growth (Dollar and Kraay, 2001; Verspagen, 2005; Collier, 2007). As we saw in Section 2 above, the most striking reduction in the headcount of poverty reduction is to be seen in the experience of China. There, growth rates averaging more than nine percent a year since 1979 have led to many hundreds of million of people being pulled out of absolute poverty, despite worsening inequality. (The actual numbers, as we have seen, are currently subject to disputation).

Three qualifications to this innovation-growth-poverty nexus are important however. The first is that innovation is only one source of growth ("intensive growth"). Another source of growth is changing terms of trade (for example, OPEC economies gaining from rising energy prices) and yet another is when growth arises out of the augmentation of productive inputs ("extensive growth"). For example, rapid Chinese growth is to some extent a reflection of high rates of investment (currently at historically unprecedented rates of nearly 50 percent of GDP) and in the UK migration has expanded the labour force with a positive impact on growth. The second qualification is that the extent to which growth reduces absolute poverty depends on the relationship between the rates of growth and the rate of income unequalisation. For example, the Indian economy has grown rapidly in recent years, but not rapidly enough to counter growing inequality so that the numbers remaining in absolute poverty have been static. In 2003, despite achieving a growth rate of nine percent, for the first time in many years the number of people living in absolute poverty in China rose by 800,000 (China Poverty Alleviation Office, the Guardian, July 20th, 2004). And, third, innovation understood as the introduction of processes or products or functions which are new to particular producers or countries, does not necessarily deliver growth or a reduction in poverty. It is the *relative rate* of innovation which is important since if other producers are innovating at a faster pace, innovation may be associated with a declining economy and perhaps increasing levels of absolute poverty.

Hence, insofar as we are concerned with absolute poverty, we can conclude that innovation – understood as relatively rapid innovation - may be an important potential contributor to poverty reduction, but it may play only a small role. It may also be, as we will see in Section 7 below, that the primary poverty-growth-innovation linkage is to be understood as the role played by poverty in limiting or promoting innovation and hence growth, rather than the more widely-argued causality implicit in the paragraph above.

5.2. Innovation and distribution

5.2.1. 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 or) 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 some cases, process innovation may be neutral, underwriting an existing static picture of distribution. In other cases it may involves biases – for example towards skill intensity (Wood, 1994 and 1998; Acemoglu, 2002) or capital intensity (Eckaus 1955. Marx, 1876). These 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). At this current juncture we are witnessing a change in the bias of technical change away from energy-intensive towards energy-saving processes.

How might bias in process innovation relate to distributional outcomes? Clearly there is a very strong link between process innovation and *relations of ownership*. Consider each of the elements of distribution in this cluster discussed in Section 4.2 above. Starting with the capital–labour-land divide, this is affected by factor intensities. The distribution between skilled and unskilled workers has already been noted as a key element of process innovation, and there is a strong link between the employed and unemployed arising out of the capital-intensity of process innovation. Less relevant is the link between process innovation and the producer-consumer divide, and that between different elements of capital (finance and productive capital, Perez, 2002).

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 existence of scale economies in process innovation provides a close bridge to the *size distribution* of income. 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. Similar, the scale of processes, and more particularly the nature of process innovation has important links with the distribution of *environmental* externalities.

In all this we need to absorb the importance both of 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 these 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.

5.2.2. Innovation in product

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 examples. 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). 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 pharma industry and to the challenges of meeting the health needs of consumers with restricted purchasing power 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. 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 to the poor, or the health systems backing the provision of new drugs to the poor in the high-income economies).

There are thus important linkages between product innovation and distribution. With regard to *relations of ownership*, 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. *Location* is a key distributional issue affected by product development, as is the related issue of the environment. To what extent do products operate effectively in different locations, and with what types of *environmental spillovers*? To what extent do new products or services address environmental challenges as a key objective, rather than being designed to minimise environmental externalities? Product innovation also affects issues of *size distribution* (notably income groups), since scale considerations surface not only in relation to processes of production, but also in relation to the scale of consumption and the skills and "technologies" required to be an effective user. Most importantly, here, 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.

5.2.3. Reconfiguring the value chain: Command over innovation rents

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 (although it is of course prefigured in other schools of innovation studies) (Kaplinsky and Morris, 2001; Gereffi, 2005). 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 (which is the essence of rent). 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 Coco 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

1982). 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. The links to *relations of ownership* 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). 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 pharma 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. 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 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.

5.2.4. Capability building for innovation

The major contribution of evolutionary economics to theories of innovation was 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 sharpened the understanding of the innovation process in three important respects. First, by highlighting capabilities (rather than outcomes), it 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 and this 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 capabilities is 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). With regard to *relations of ownership*, 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? Capability-building may also be unevenly distributed and/or affected between capital and labour, between skilled and unskilled labour, and between employed and unemployed labour.

Typically, innovation capabilities may also be unevenly distributed *spatially*, both within countries and regions and between countries. An example 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 capability building. Similarly, the *uneven size-distribution* of capability-building often reinforces processes of income concentration in large-sized units of ownership, although in some cases and periods, the more effective innovative capabilities of small-sized producers may have the effect of mitigating the unequalising outcomes of innovation processes.

There are important links between capability-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 capability 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 ownership, and the size and locational patterns of income returns.

5.2.5. Relations of power and social capital in and for innovation

Closely related to the building of innovative capabilities are the social and power relations associated with patterns of innovation. This is not just a reflection of the technical and organisational skills and routines which are involved in innovation (that is, the dynamic capabilities), but also the extent to which innovation is associated with the power to determine innovation paths and to appropriate the fruits of innovation. There is also an interaction between the nature and pace of innovation and the character and durability of social networks (loosely described as “social capital” – Putnam, 2002).

These social and political factors are expressed at a variety of levels in the innovation chain, in each case with significant implications for distribution over time. With regard to *relations of ownership*, at the micro-level they surface in power relations in production – the ways in which labour processes reflect or determine innovation outcomes within the firm or farm; the extent to which the social milieu allows for cooperation in work. At a higher level of aggregation they may reflect power and associational relations between different divisions of a firm, or different links in a value chain in which core firms exercise chain-governance (Gereffi, 2005). And, at even higher levels, patterns of innovation will be associated with the power of different categories of ownership (foreign vs. domestic; finance vs. productive capital), in each case reflecting or reinforcing and undermining the appropriation of returns from innovation.

Relations of power and association are often also *locationally-specific*. For historical reasons, empowered or disempowered groups will characteristically reside in different areas, perhaps regions within countries, or countries in a regional or global economy.

Similarly, insofar as innovation outcomes reflect social cohesion, they too might be affected by the geographical spread of "social glue" (for example as in the Sinos Valley shoe industry in Brazil involving German migrants to the region – Schmitz, 1999). Paths of innovation may both reflect and reinforce or undermine these locational patterns.

The interaction between *relations of power, innovation and size* – particular the size-distribution of ownership – is widely documented and understood. It finds particular expression in the collective power of size groups. For example, in India in the post-Independence period, the political power of the small and medium firms sector was reflected in the allocation of inventive resources to meeting the needs of the small-scale sector; more recently, as the political balance has swung in favour of large-scale capital, it is the needs of large firms (especially in the IT sector) which more significantly determines investment by the Indian state in education and training capabilities. Similar battles have been fought in almost all economies, reflecting the power and associational strength of different size-groupings of firms. It is a battle also fought in the allocation of innovation resources in the agricultural sector (Clark, 1985; Lipton, Sinha and Blackman, 2002; Hall et al, 2001; Clark, 2002).

Finally, there is a clear link between political and associational power and innovation directed towards the *environment*. The growing political power of consumer groups, often reflecting particular pockets of associational affiliation, is having a major impact on the development and use of technologies which have environmental impacts. In the current era this includes not only contestation with regard to energy technologies but also with regard to the nature and direction of innovative activities in biotechnology, affecting innovation inputs into the health (for example, stem-cell research) and agricultural (for example, GM crops) sectors. The allocation of these innovative resources will clearly have distributional implications over time.

5.3. Linkage mechanisms in summary

Figure 7 summarises the discussion on the links between innovation, poverty and inequality. It utilises the poverty and inequality categories identified in Section 4 above, and relates them to the five possible causal links between poverty and distributional outcomes and innovation processes discussed in this section above. These are the factor intensity of innovation, the product composition of innovation, the distribution of returns to innovation in the value chain, the distribution of innovative capabilities, and the linkages between innovation and power and associational networks. Note that at this stage there is no discussion of causality – for example, do labour processes determine innovation paths, or do innovation paths create labour processes?. This will be the discussed in Section 7 below.

Figure 7 should be read with care. The extent to which there are strong links in any one of these cells will depend on the context of innovation, and this will change over time. Figure 7 suggests areas of particularly strong linkage, but this is an judgement of overall impact, rather than of specific cases. Whether it is a correctly weighted judgement or not is much less important than that whether it *provides a framework for assessing the poverty and distributional impact of any one innovation event (or linked innovation events)*. It provides a taxonomy of possible impacts which then allows for an analysis of the significance, nature and direction of causality. It also provides a template for policy-makers who might use this framework to enhance policy design and delivery or be more demanding of responses from relevant stakeholders. (We will consider these issues at greater length in the Concluding Section below).

The key summary conclusions are:

- With regard to *innovation and absolute poverty*, the clearest connection is to be found with regard to the interaction between growth and absolute poverty. Hence the innovation linkages which are most prominent are those involving process efficiency, product innovation and capability-building, each of which feeds directly into the rate and direction of growth. But since growth is only in part a reflection of innovation, these linkages are only two-starred.

- The patterns of distribution relating to *relations of ownership* 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 ownership.

- 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 *size* and distributional patterns in regard to all five 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.

Figure 7: Innovation, poverty and inequality – Primary linkage mechanisms*

	Absolute poverty	**Relative poverty – distribution/inequality**				
		Relations of ownership	Location	Size composition	Environment	Other - contingent
Innovation in process	XX	XXX	XX	XXX	XXX	
Innovation of product	XX		XX	XXX	XX	
Distribution of rents		XXX	X	XXX		
Capability building	XX	XX	XXX	XXX	XX	
Power and social capital		XXX	XXX	XXX	XXX	

* Number of asterisks reflects intensity of linkage

6. LOCATING THE STRANDS OF INNOVATION LITERATURE

In the preceding section we discussed, in the abstract, a framework for considering the potential links between innovation and poverty and distribution. In the discussion around Figure 7 we observed that this was only a notional and aggregated framework, and that the actual linkages will vary contextually. In this Section we attempt to locate some of the important strands of Innovation Studies Research within the same framework. We do this for two reasons. First, in large part the objective of most innovation studies has not been with poverty and distribution. Thus, the individual schools of enquiry within Innovation Studies only partially address the whole agenda of impacts, and we need to map and recognise these biases and gaps. Second, we utilise a comprehensive poverty-distribution template in the hope that it may stimulate future research on innovation to be more explicit in its treatment of these issues, and thus perhaps to extend their analytical and empirical compass to incorporate a wider agenda of poverty and distributional issues.

In pursuing this agenda, we group Innovation Studies into five main lines of enquiry – (1) studies of innovation rents, resources and epochs; (2) studies on innovation and technological choice; (3) studies on innovation and industry structure, (4) studies on the social relations of innovation; and (5) studies of innovation systems.

6.1 Rents, resources and epochs

The origins of the modern school of Innovation Studies can be traced back to classical economics in the late 18th and the 19th Centuries, and its concerns with growth and distribution. The division of labour and its impact on productivity were highlighted by Smith; Ricardo laid the grounds for role played by technological change in responding to diminishing marginal productivity, and explicitly related this to patterns of income distribution; Marx and Marshal sharpened the focus on the role of innovation in determining rents, and this was placed at forefront of the analytical framework in the mid-20th century by Schumpeter, and then by the neo-Schumpeterians in the latter quarter of the 20th Century (Smith, 1776; Ricardo, 1817; Marshall, 1890; Schumpeter, 1961; Freeman, 1974).

Building on this tradition, are a series of meta studies focusing on innovation epochs. This includes characterisations of production organisation ("organisational epochs"), such as the "American system of manufacture" (Hounshell, 1984), mass production (Tolliday and Zeitlin, 1987; Best, 1990), flexible production (Piore and Sabel, 1984; Monden, 1983; Kaplinsky, 1994) and mass customisation (Pine, 1993). A complementary approach, less concerned with production organisation than with production technology, focused on technological epochs, notably the various contributions of Freeman and colleagues (Freeman, Clarke and Soete, 1982, Freeman and Louca, 2001)). In some cases the focus on innovation epochs explicitly combines technological and organisational epochs (Perez, 1985; Freeman and Perez, 1988; Perez, 2002), although to a lesser degree this can be said of almost all of the literature on innovation epochs.

Closely linked to this concern with innovation epochs are a series of Innovation Studies addressing the inputs into innovation, and the resultant outputs (Smith, 2005). This is a literature which spans both the OECD economies, focusing on the measurement of R&D inputs, patent outputs, and trade-structures (Dosi, Pavitt and Soete, 1990; Kaplinsky and Readman, 2005), and the developing world (Sussex Manifesto, 1970; Lall, 2001; Bell, 2002).

During the 1970s and 1989s, this literature on resources tended to focus on fiscal outlays of resources, and aggregative measures of human capital inputs. But increasingly this was complemented by a focus on capability-building, addressing issues of skill acquisition, routines and innovation management as Innovation Studies developed strong crossover links with Organisational Development and Knowledge Management studies (Bell and Albu, 1999; Teece, Pisano, Shuen, 1992 Nelson and Winter, 1982; Tidd, Bessant and Pavitt, 2005).

A distinguishing feature of much of this literature on rents, resources and epochs is the focus on dynamics and capability building and its concern with macro and global innovation trajectories.

Figure 8 summarises the link between this stream of Innovation Studies, poverty and inequality. Isolated studies aside, in the main these links are weak. This literature has little explicit to say on absolute poverty although it centrally addresses the determinants of growth and hence, indirectly, relates to issues of living standards. Although the literature on rents provides the building block for the discussion of intra-value chain distribution (see Section 6.5 below), the explicit link to distributional issues is mainly to be found in Ricardo's analysis of the role of diminishing returns and static technology on the distribution of income between landholders and capitalists, and in Marx's focus on the capital-intensification of technological progress..

Figure 8: Innovation Studies on rents, resources and epochs, and their links to poverty and distribution

Absolute poverty	**Relative poverty – distribution/inequality**				
	Relations of ownership	Location	Size composition	Environment	Other - contingent
Through a focus on growth	Landlords vs capitalists Capital intensification of technological progress	National distribution of innovation inputs and outputs	MNCs vs local clusters		

6.2. Technological choice

Neoclassical economics assumed a spectrum of substitutable technological choices, with constancy of product. These restrictive assumptions were first challenged in the 1950s in the development literature with regard to the fixity of economically efficient processes (Eckaus, 1955; Stewart, 1979; Clark, 1985) and this was followed by a rich vein of empirical enquiry into the range of economically efficient techniques in a variety of sectors (Bhalla, 1975). Sen's contribution in distinguishing between surplus-, employment- and output-maximising choice was particularly influential, and clearly has significant linkages to issues of distribution (Sen, 1968). However, the challenge to neo-classical framework was not just limited to innovation and choice of process, but also to innovation and choice of product (Lancaster, 1966; Stewart, 1979; James and Stewart, 1981; Edquist, Hommen and McKelvey, 2001). This led to a clear recognition of the fixity of efficient products (as in the case of processes) and also the fit between particular products and the incomes of their consumers (Langdon, 1981). More recently, there has been a revival in the focus on the product-consumer link, and the implications this has for technological change, both in the context of high income economies (Pavitt, 1984; von Hippel, 1994 and 2005), and low income economies (Prahalad, 2005).

Also of significance with regard to process innovation is the rich seam of literature on skill biases in technological change, with its roots in the analysis of innovation patterns in 19th century England and North America (Habakkuk, 1962). More recently, this has become a central line of enquiry in attempts to explain the growing unequalisation of incomes in the US during the last decades of the 20th century (Acemoglu, 2002) and the interaction between trade-induced and technology-induced impacts on employment and factor returns, and how these changed over time (Wood, 1994 and 1998; Acemoglu, 2002; Pianta, 2005). Trade-induced innovation has also been an important line of enquiry in exploring the extent to which firms learn through exporting, or learn in order to export (Greenaway and Kneller, 2007).

Spilling over into this literature on choice of process and product, but with largely independent roots, has been the focus on appropriate technology. Although this is a central component of Ghandian philosophy, reflected in Indian industrial and technology policy in the post-independence period, the most widely-cited and comprehensive approach is to be found in the output of Schumacher and the Appropriate Technology movement (Schumacher, 1973). This combines a focus on economic, social and environmental impacts of technological choice and associated patterns of innovation (Carr, 1985, Kaplinsky, 1990).

A final set of related literature is that on the transfer of technology (Krugman, 1979). Although this concern is implicit in many lines of enquiry (for example, on FDI – Baranson, 1970; Mansfield and Romeo, 1980; Bell and Marin, 2004), the explicit focus on the transfer of technology has most clearly been expressed in the development literature (Cooper, 1970: UNCTAD, 1972; Enos and Park, 1998; Radosevic, 1999).

Unlike the literature on innovation epochs, much of the research on innovation and technological choice has been conducted at a micro level.

Figure 9 summarises the link between the stream of Innovation Studies focusing on choice, and poverty and inequality. In general, research in this stream of Innovation Studies tends to touch all of the main categories of distribution. However the links are particularly strong with regard to choice of process, and this tends to be clustered in concerns with regard to employment – its extent, and the distribution of returns between the skilled and the unskilled.

Figure 9: Innovation Studies on choice, and their links to poverty and distribution

Absolute poverty	**Relative poverty – distribution/inequality**				
	Relations of ownership	Location	Size composition	Environment	Other - contingent
Through a focus on growth	Capital vs labour; skilled vs unskilled; employed vs unemployed; producers vs consumers; local vs foreign owned	Decentralised vs. centralised	Small vs. large	Environmental externalities	

6.3. Industry structures

The pattern and pace of innovation is both a consequence of, and a determinant of industry structures. This surfaces in a number of ways. The first is a reflection of size – are small firms more or less innovative than larger firms, and does this vary by sector and over time (Schumpeter, 1928 and 1942; Jewkes, Sawers and Stillerman, 1958; Freeman, 1986; Rothwell and Dodgson, 1992; Mazzucato, 2000)? This has spawned a considerable literature (Geroski, 1994; Fai and von Tunzelmann, 2001), and attempts to generalise trends are hampered by contextual differences (for example, unlike Korea, Taiwan has a tradition of small firm led innovation even in the same sector – Mathews and Cho, 2000).

A second link to industry structure relates to ownership, and in particular addresses the question of foreign versus domestic ownership. The dominant framework used to analyse FDI (the eclectic paradigm) sees technology and innovative capabilities as being a core component of ownership-specific advantages (Dunning, 1981). More recently the eclectic paradigm has been challenged with a specific innovation focus – to what extent do firms operate abroad in order to augment, rather than to exploit innovative capabilities (Mathews, 2002)? Other ownership-related concerns are whether foreign-owned firms are more or less likely to innovate and in what distinctive ways when compared to locally-owned firms (Cantwell and Noonan, 2001; Martin and Criscuolo, 2005; Narula and Zanfei, 2005), and whether their command over technology provides them with the capacity to transfer-price rents between countries with different tax-regimes (Vaitsos, 1974).

A third industry structure related set of innovation studies addresses the role played by competition and regulation in the rate and direction of innovation. In particular, to what extent do regulation-induced barriers to entry such as IPRs interact with innovative activities (Chaudhuri, 2005; Granstrand, 2005)? But IPRs are not the only from of regulation which affects innovation – in the health and biotechnology fields, there are debates on the extent to which precautionary-principle based regulations may impede the pace and direction of innovation, with significant implications for product development and the geographical location of innovative activities (Tait et al, 2008).

Finally, there is the issue of the feedback from technology to industry structure. This was an important component of the innovation literature during the 1970s and 1980s, and was an influential component of the attack on industrial policy. Small markets in low income and under-populated markets meant that minimum-scale technologies led to monopoly and inefficiency (Merhav, 1969), and hence that the prospects for import-substituting industrialisation would be weakened as technology became increasingly scale intensive (Bhagwati and Desai, 1970; Little, Scitovsky and Scott, 1970). More recently, Christenson's influential work on disruptive technological change argues that it is in the nature of these non-marginal innovations that industry structure is fundamentally altered (1997), a view treated with some caution by Dosi et al (2007).

From Figure 10 it is clear that the major contribution of Innovation Studies on industry structure arises with regard to the distribution of returns to different sized firms and different modes of industry ownership.

Figure 10: Innovation Studies on industry structures, and their links to poverty and distribution

Absolute poverty	**Relative poverty – distribution/inequality**				
	Relations of ownership	Location	Size composition	Environment	Other - contingent
Through a focus on growth	Relations of ownership		Different-sized firms		

6.4. Social relations

The lineage of innovation literature on epochs, choice and industry structure is to be found in the disciplines of economics and economic history. By contrast, the focus on innovation and the social relations of production is more directly located in political economy, sociology, organisation development and development studies. These bodies of literature tend to be less uni-dimensional than the economics-related studies, with as much emphasis being placed on the impact of (equity in) social relations on the rate and direction of technological change as on the more common focus on the impact of innovation on equity.

A basic reference point in this area is the literature on labour processes. This derives from Marx and his concern with the subordination of labour (Marx, 1876). Class struggle in the sphere of production led capitalists to develop technologies to "subordinate labour", with mechanisation allowing the transition from the appropriation of "absolute" to "relative surplus value". In the second half of the 20th Century, there was renewed interest in the labour process (Braverman, 1974; Wood 1982; Levidow and Young, 1981 and 1985), and explicit attempts to develop technologies which augmented the power of labour in production (Noble, 1979; Cooley, 1984). The labour process literature also explicitly focused on the implications of technological change for gender (Cockburn, 1983; Mitter and Rowbotham, 1997).

From the 1950s, the Tavistock Institute for Human Relations played an influential role in the redesign of work organisation – that is, disembodied technology – particularly with regard to what came to be called human-centred work organisation (Trist and Bramforth, 1951). This spurred innovations in work organisation (Badham and Ehn, 2000), in factory organisation (Karwowski and Salvendry, 1994), and in the development of human-centred technology (Rosenbrock, 1980), interfacing closely with related work in the labour process literature. More recently, there have been a series of studies on the impact of "high-performance work practices" on productivity (Appelbaum, et al, 2000; Cappelli and Neumark, 2000).

A final stream of innovation studies related research focuses on the role of participatory work practices and forms of organisation in developing countries. Early focus in this area began with recognition of the importance of tacit knowledge in peasant agricultural systems (Schultz, 1964; Chambers and Howes, 1979, Juma, 1989). This mushroomed into a wider recognition of the innovative capacities of illiterate or poorly educated and poor people, and their ability to intelligently analyse their environments and provide innovative solutions to meeting the challenges of basic survival and process improvement (Fairhead and Leach, 2003; Leach, Scoones and Wynne, 2005).

From Figure 11 it is evident that the focus on social relations centrally addresses issues of power and distribution between capital and labour. But it does more than this, also focusing on issues of empowerment at the decentralised local level, the relative power of combinations of different-sized units of production and consumption, and in the response to environmental externalities and the fashioning of alternative technological and organisational responses.

Figure 11: Innovation Studies on social relations, and their links to poverty and distribution

Absolute poverty	**Relative poverty – distribution/inequality**				
	Relations of ownership	Location	Size composition	Environment	Other - contingent
Through a focus on growth	Capital vs labour.	Empowerment at the local level	Small vs. large	Civil society response to externalities	

6.5. Systems

Crudely-speaking, until the early 1980s, with the exception of some of the literature on innovation epochs, Innovation Studies focused predominantly on the plant and enterprise. But from the early 1980s it increasingly came to be realised that a chain is only as strong as its weakest link – island of efficiency find survival difficult when they were located in seas of inefficiency. Moreover, almost always, successful innovation events within plants and firms reflected an interaction between the firm and its external environment.

This led to a series of studies focusing on various types of innovation systems (Edquist, 1997). The initial focus was on the National System of Innovation (NSI) (Freeman, 1987; Lundvall, 1992; Nelson, 1993), in which the firm was seen to interact with other firms, but also with research and technology organisations in the wider national economy. The growing recognition of the innovation externalities involved in local “innovation millieux” (Regional Studies, 1979: Keeble and Wilkinson, 2000) is reflected in a series of studies focusing on the Regional System of Innovation (RSI) (Braczyk, Cooke and Heidenreich, 1998; Asheim and Gertler, 2005). More recently, research focus has been placed on Sectoral Systems of Innovation (SSI) which are seen to comprise sector-specific technologies, sector-specific firm structures and sector-specific institutions (Malerba, 2002 and 2004; Tait et. al., 2008).

Much of the NSI, RSI and SSI literature refers to the interactions between the private sector and research and technology institutions, much of which are funded in the public sphere. By contrast, the emerging literature on innovation in global value chains is more centrally focused on innovation within globally dispersed chains of private sector firms (Gereffi, 1994; Kaplinsky and Morris, 2001). The distinctive features of this literature is that it focuses on the governance of innovation in the chain between partners who might have no or little equity links (Gereffi, Sturgeon and Humphrey, 2007). The value chain literature also extends the realm of innovation beyond process and product, to changing function within the chain (ie changing links in the chain) and to shifting chains (Humphrey and Schmitz, 2001). Closely-related to the value chain literature, but focusing more specifically on horizontal innovation links between firms within particular chains is a body of research which is loosely labelled “Global Production Networks” (Ernst and Kim, 2002; Henderson et al, 2002)

The interaction between the systems literature and poverty and distribution is shown in Figure 12. The distribution of returns to ownership related categories and to different sized of firms is most clearly evidenced in the value chain and global production network literatures. By contrast, the literatures on national and regional systems in innovation most clearly relates to the geographical dispersion of innovation and the returns to innovation.

Figure 12: Innovation Studies on systems, and their links to poverty and distribution

	Relative poverty – distribution/inequality				
Absolute poverty	Relations of ownership	Location	Size composition	Environment	Other - contingent
Through a focus on growth	Role of different firms in the generation of technologies and in the appropriation of rents	The supportive role played by national and regional institutions	Role of different sized firms in the generation of innovation and appropriation of rents		

6.6. In summary

Figure 13 draws together the conclusions drawn with regard to the different streams of Innovation Studies discussed in Figures 8-12 above. It is necessarily crude, illustrating at a high level of aggregation the extent to which these individual streams address issues of poverty and distribution. In some respects Figure 13 is misleading since it suggests a wide coverage of poverty and distributional issues in Innovation Studies. Yet we know that in most cases, individual studies on innovation mostly make only passing reference to these welfare concerns. This illusion arises from the fact that there is a wide intra-stream dispersion of focus, and in some cases these intra-stream differences are greater than the inter-stream variation in focus.

Figure 13: Streams of Innovation Studies and their focus on poverty and distribution

	Absolute poverty	**Relative poverty – distribution/inequality**				
		Relations of ownership	Location	Size composition	Environment	Other - contingent
Rents, resources and epochs	Through a focus on growth	Landlords vs capitalists	National distribution of innovation inputs and outputs	MNCs vs. local clusters		
Choice	Through a focus on growth	Capital vs labour; skilled vs unskilled; employed vs unemployed; producers vs consumers; local vs foreign owned	Decentralised vs. centralised	Small vs. large	Environmental externalities	
Industry structures	Through a focus on growth	Relations of ownership		Different-sized firms		
Social relations	Through a focus on growth	Capital vs labour.	Empowerment at the local level	Small vs. large	Civil society response to externalities	
Systems	Through a focus on growth	Role of different firms in the generation of technologies and in the appropriation of rents	The supportive role played by national and regional institutions	Role of different sized firms in the generation of innovation and appropriation of rents		

This misrepresentation in reality arises from the grouping of innovation studies in five streams. If we were to adopt an alternative approach of assessing the extent to which any individual study of distribution related to concerns with poverty and distribution, we would draw a rather different conclusions about coverage. By way of illustration, Figure 14 locates individual authors (but not their individual works, which is another task) in this matrix, illustrating how few of them address centrally more than one component of poverty and distribution issues.

Figure 14: Innovation Studies, poverty and distribution: Locating a selection of individual studies

	Absolute poverty	**Relative poverty – distribution/inequality**				
		Relations of ownership	Location	Size composition	Environment	Other - contingent
Rents, resources and epochs	Marx; Freeman; Schumpeter	Ricardo; Marx;	Sussex Manifesto; Bell, Lall	Piore and Sabel; Freeman and Perez; Pavitt		
Choice	Sen	Sen; Acemoglu; Wood; von Hippell; Bhalla	Cooper; UNCTAD	Langdon; Schumacher; Kaplinsky	Schumacher	
Industry structures		Dunning; Mathews; Vaitsos; Granstrand		Rothwell; Merhav; Dosi et al.		
Social relations	Appelbaum et al.	Braverman; Trist and Bramforth	Chambers;	Schumacher	Leech	
Systems	Nelson and Winter; Dosi	Gereffi; Kaplinsky and Morris; Henderson et al.	Lundvall; Nelson and Winter; Braczyk et al.	Humphrey and Schmitz		

7. CAUSALITY? AND IF SO, WHICH WAY?

Innovations studies, poverty and inequality? The most common reaction to this string of words is to address *the impact of innovation on poverty and inequality*. Yet the possible causal links are more complex than this, and five possible combinations can be identified.

The first is that there is *no causal link*. Inequality arises as an outcome of autonomous processes – usually reflecting the political play for power, or perhaps an exogenous factor such as a climate-induced disaster.[3] Technological change is seen to be independently driven and is "Harrod-neutral" in the sense that it has no impact on relative factor returns. In general, this is a perspective which dominates in mainstream neoclassical economics. To some extent the absence, or weakness, of causal links between innovation and unequalisation is also supported by the discussion in Section 1 in which we observed that, although there has been a close temporal correlation between deepening globalisation and deepening inequality, there is no convincing evidence of a similar intensification of the pace of technological change.

[3] For example, whilst conceding that skill-biased innovation has played an important role in deepening inequality in late twentieth century USA, Krugman argues that this is a subsidiary explanation; the dominant cause of inequality, her agues, is to be found in changing social mores (Krugman, 2002).

A second possibility is that *technological change causes changes in living standards* (for example, by raising the rate of growth) and/or leads to altered patterns of wealth and income distribution. Most often, the direction of technical change is explicitly or implicitly seen to be autonomously determined by "scientific laws" – for example, the increased knowledge-content in technology naturally induces scale economies, or production systems naturally result in localised environmental externalities. As a general rule, this perspective is implicit in much of the economics and technology literature on innovation.

A third possible line of causality is that technological change responds to patterns of income distribution, that is *the impact of poverty and inequality on innovation*. Thus, for example, new forms of work organisation or technologies which embody skills reflect the drive by capitalists to limit the power of labour. At the level of product innovation, the concentration of the pharma sector on diseases of the rich rather than malaria reflects the global market power of high income consumers in high income economies. This perspective is widely reflected in the treatment of innovation in political economy and development studies.

Both of these previous causal relationships are crude and unlineal. However, a fourth possible set of causal links is more complex in nature and sees the *link between innovation, poverty and inequality as being co-evolutionary* - interactive and bi-causal, On the one hand the direction of technological change reflects existing income and power relations, and on the other hand, it acts to reinforce these power relations. This complex interaction is most powerful in explaining trajectories which intensify existing patterns. It is less insightful in explaining how processes of innovation may lead to a reversal in relations of income and power distribution. This bi-causal explanatory perspective tends to dominate the Innovations Studies discourse in sociology, political economy and development studies.

Finally, the causal links between innovation, poverty and distribution are also addressed in the context of *complex interactions with third factors*. For example, in a closed economy, Harrod-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.[4] 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.

8. CONCLUSIONS

In this paper we have addressed the possibility and existence of links between Innovation Studies and poverty and inequality. This is a daunting task, both because of the extensive nature of enquiry in Innovation Studies and because of the absence of clear boundaries defining the area of study as a whole, and individual components within it.

We began by decomposing the various dimensions of poverty and inequality – it is surprising how seldom this is done – in order to show the variety and complexity of potential impacts. The categories we chose to highlight were the growth-poverty nexus, and a variety of distributional impacts (on relations of ownership, on location, on size and on the environment). We also noted that, depending on the lens, other dimensions of inequality can easily be added to the list (for example, gender or age).

[4] 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).

This was followed by a discussion of the possible causal links between innovation, poverty an distribution. Five transmission belts were identified – through the nature of production processes, through the nature of products, through the ability to command innovation rents by reconfiguring the value chain, through the building of capabilities and through the impact on relations of power.

We then grouped the myriad of individual Innovation Studies into five streams. The first reflect those focusing on innovation rents, innovation resources and innovation epochs. The second grouped various studies on choice, both of process and product. The third category of Innovation Studies are those focusing on industry structures. The penultimate grouping reflect studies which are concerned with social relations, and the final stream consists of studies of various types of innovation systems.

It is possible that there are no causal links between innovation, poverty and inequality. But if there are, these might go in either direction or, through feedback effects in both directions. It is also possible that the nature and degree of causality reflects the specific synergistic conjuncture with other developments, such as deepening globalisation (to the extent that it is independent of the nature and pace of innovation) and exogenous climate events (again, assuming that these are independent of the nature and pace of innovation).

Given the pitfalls and heroic assumptions involved in this exercise, why bother? Well, first, poverty and inequality are the ethical, social and political issues of our time. Moreover, in previous eras such as the early 20th Century, the failure to respond to growing inequality was one of the primary causes of global conflict, and ultimately was a major causal factor in the Depression during the 1930s (Williamson, 1998; Kaplinsky, 2005). The failure to address these issues is thus not just an ethical and welfare issue, but directly affects the sustainability of growth and innovation itself.

A second reason for undertaking this exercise is to provide researchers in Innovation Studies who are concerned with poverty and distributional outcomes with a framework which they can utilise to extend their enquiry into appropriate areas. It is hoped that this framework will be of assistance not only to research which explicitly and directly addresses poverty and distributional issues, but to related research which can easily be extended to cover these concerns. It provides a check-list to be utilised in methodological design for researchers interested in the relationship between innovation, poverty andinequality.

The same framework can be utilised by policy makers who are concerned with poverty and distribution and the role which innovation can play in providing for better outcomes. The framework enables these policy makers to focus both on distributional outcomes (the range of beneficiaries, and the trade-offs between them) and the causal links through which innovation leads to these outcomes. For example, a concerted approach to address poverty and distribution in poor labour-surplus economies through innovation may lead to policies which provide incentives to develop labour-intensive processes utilising local inputs in decentralised production units which have few environmental spillovers and which favour small scale producers focused on meeting the needs of poor consumers.

Finally, we are ware of the fragility of the framework which we have developed, and the perhaps arbitrary nature of some of the categories which have been used. For example, we have grouped innovation rents, resources and epochs together partly because we did not want a plethora of categories, producing unmanageable decision matrices. This pursuit of (relative) simplicity may however conflate different categories of thought and decision-making. In defence we would observe that any categorisation is arbitrary and will be subject to qualification. But, more importantly, we are less concerned that we have got this categorisation correct than that we have produced a framework which can (perhaps in modified form) be utilised systematically to explore the interaction between innovation, poverty and inequality.

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