…to each according to his (or her) needs:
WHERE ARE THE POOR IN INNOVATION STUDIES?

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Abstract

The poor hardly feature in innovation studies. Very little work is dedicated to catch-up – let alone take-off – of low-income countries (LICs) or regions. In some sense, therefore, those that most need our insights, are least likely to get them. This paper first reviews major recent works broadly dedicated to the role innovation plays in development and discusses possible reasons for the marginal role accorded low-income countries. It then reports insights from a systematic review of the literature since the late 1990s that addresses innovation in the poorest areas of the world. The point here is that most of this research was *not* done by innovation scholars and focused on rural livelihoods, especially issues of agriculture and health. The paper discusses conceptual overlaps between these different literatures that largely seem to ignore each other and postulates that research on LICs would benefit from a synthesis of the economic analysis of technological learning and the sociological analysis of innovation diffusion.

Introduction[•]

Innovation is en vogue, and those that study the phenomenon no longer wear diapers. As a field of scientific enquiry, innovation studies has been around for roughly half a century and is now being pursued by several thousand researchers all over the world (Martin 2008). These researchers identify themselves as innovation scholars and recognize one another because they agree on which thinkers most influenced the field, what the most interesting conferences are to air one's ideas, and what the most influential outlets to (try and) publish them. There are various sub-sects of true believers, some of whom tend to reside more in one part of the globe than in another, but on the whole it is fair to say that these groups do not deviate from the true path and constitute an – albeit broad – church (Fagerberg and Verspagen 2009).

Insofar fields of scientific enquiry prosper in relation to the interest societies or even just influential groups within them express in their subject matter, innovation studies would appear to be slated for further growth. "Innovation" has replaced "competitiveness" as one of the more faddish terms on the planet. The two are of course related, but "innovation" comes across as the nobler concept compared to the bareknuckledness of competition where firms "beat" other firms and where countries covet the upper reaches of competitiveness league tables punted by the likes of the World Economic Forum, envying everyone above them and making faces at everyone below them in the rankings. The term is intimately linked to feel-good sermons delivered by the UN and others that no one can possibly disagree with. For example, the Millennium Development Goals are clearly informed by the belief that innovation can unleash the transforming power of science and technology in the interest of lifting large parts of the world's population out of misery.

In some sense, it is all about achieving one happy planet through creating the global knowledge economy. Smart people, supported by proper incentives, sufficient finance, and world-class infrastructure and embedded in extensive knowledge networks, work out solutions to the world's problems, and once everybody has adopted them we will be in a position to deal with hunger, disease, climate change, and so on.

But even if one strips such discourses of their ideological baggage, there remains a conundrum. The conundrum is that the poor hardly feature in innovation studies. The large majority of innovation research focuses on how to make high-income economies keep their place in the sun and how to make middle-income economies knock them off it. Very little work is dedicated to catch-up – let alone take-off – of low-income countries (LICs) or regions. In some sense, therefore, those that most need our insights, are least likely to get them.

This paper first reviews major recent works broadly dedicated to the role innovation plays in development and discusses possible reasons for the marginal role accorded low-income

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countries. It then reports insights from a systematic review of the literature since the late 1990s that addresses innovation in the poorest areas of the world. The point here is that most of this research was *not* done by innovation scholars and focused on rural livelihoods, especially issues of agriculture and health. The paper discusses conceptual overlaps between these different literatures that largely seem to ignore each other and postulates that research on LICs would benefit from a synthesis of the economic analysis of technological upgrading and the sociological analysis of innovation diffusion.

LICs in innovation research: not on the radar

Almost a billion people live in LICs which are the currently 49 countries with a per capita gross national income below $938. Four out of five inhabitants survive (or not) on less than $1.25 a day and make up the world's poorest people (World Bank 2008). Adding in the very poor from middle-income countries swells their ranks. In fact, about half the world's population lives on less than $2 a day. So the poor are a sizeable constituency. International organizations exhort the transformational role science, technology, and innovation can and must play in changing their fate for the better by graduating into the global knowledge economy (e.g. NEPAD 2007, UNCTAD 2004, 2007, UNDP 2005, UNIDO 2009, World Bank 2008). These organizations conduct their own and commission outside research to support their annual reports.

But that does not equal being able to rely on dynamic and productive research on LICs that is being performed by (some of) the many thousand researchers that study the determinants and the effects of innovation. For example, UNCTAD is relatively in a much stronger position to understand the role multinational companies (MNCs) play in the world economy because there is such a depth of research in international trade, international business, and strategic management that systematically addresses the relevant issues.[1] The same argument applies to the World Bank with respect to poverty. But who out there studies how innovation, whether technological or otherwise, can lift the bottom billion out of misery?

By and large, not the innovation research community. The introduction to one of the most important handbooks informing the field argues that innovation explains why some countries and regions prosper while others lag and concludes that those who want to catch up must increase their innovation activity (Fagerberg 2005, 20). Yet the chapter that specifically deals with catch-up only discusses the important historical cases of Europe's and North America's industrialization around the turn of the nineteenth and twentieth centuries, Japan and the Asian Tigers in the post-WWII period, and the EU latecomers in the final quarter of the Twentieth Century (Fagerberg and Godinho 2005). Low-income countries do not figure at all, perhaps because they are not really an example of having much caught up with anything or anyone, but also not even as an investigation of why they continue to be stuck in a rut.

To be fair, the *Oxford Handbook of Innovation* (Fagerberg, Mowery, and Nelson 2005) from which the above two chapters are drawn addresses innovation from various perspectives of

[1] In its *2007 Least Developed Countries Report*, UNCTAD commented on policies devoted to technological learning and innovation in LDCs and lamented that "the treatment of technological change as a source of economic growth is generally weak" (2007, 51).

which its role in development is just one. But a recent intellectual companion that focuses on innovation in developing countries also exhibits a bias in favour of the usual suspects. In the *Handbook on Innovation Systems and Developing Countries: Building Domestic Capabilities in a Global Context* (Lundvall et al. 2009) one chapter specifically addresses poverty, pointing out that the relationship between innovation and inequality is ambiguous (Cozzens and Kaplinsky 2009), and another includes a few LICs in a comparative analysis of middle- and high-income countries (Fagerberg and Srholec 2009). Of course, LICs are a subset of developing countries, but since most other research referenced in the volume refers to middle-income countries – and indeed within that group mostly to those that have been more or less successful with catch-up – and mentions LICs only en passant or anecdotally, it is not clear how relevant the volume is, certainly in policy terms, for those concerned with the very poor.

It would be ridiculous to fault the editors of these eminently useful handbooks for this. By definition, handbooks reflect the state of the art of a discipline which in the case of innovation studies tends to neglect LICs. Between 1997 and 2008, some of the major journals in the field published 849 articles of which only 37, or four per cent, were about LICs (see Table 1). High-income countries (HICs) accounted for two thirds of the total, and middle-income countries (MICs) for about a quarter. Although Table 1 does not show developments over time, we know that the share of articles devoted to MICs is on the increase. In fact, at the 6th Globelics Conference in 2008, approximately eight in ten papers discussed MICs – and 50 per cent BRICS plus Mexico alone – while one in ten was about HICs, but only seven per cent about LICs (Lorentzen 2008b).

It is presumably not controversial that such state of affairs is undesirable. That makes it pertinent to look for reasons why LICs have effectively been banned to the wilderness. One possibility is that there is simply no innovation in LICs and hence by implication nothing to research. For example, Lall and Pietrobelli (2002) argued that Sub-Saharan Africa has fledgling technology systems, but no innovation systems. In a similar vein, Viotti (2002) postulated that it made no sense to conceive of innovation in developing countries insofar all they were doing was adopting existing foreign technologies in the interest of upgrading. Implicit in this view is that innovation is the icing on the cake that takes place exclusively in advanced economies, whereas those countries at a considerable distance from the global technology frontier must contend themselves with learning and capability building. For a critique of this line of reasoning, see Bernardes and Albuquerque (2003) and Lorentzen (2009a).

To some extent this controversy is about semantics. LICs quite obviously do not massively invest in R&D in an attempt to come up with new-to-the-world innovations. But if one relaxes the constraint on newness somewhat, there is innovative activity in the sense that one firm or possibly an entire sector or a value chain adopt new ways of doing things, whereby "new" might merely mean new to themselves. This includes the adaptation and modification of innovations while they are being diffused. In fact, especially at lower levels of development, imitation productivity is key to reducing the technology gap (Tanaka 2006). And quite clearly innovative activities in poor countries will typically happen in sectors in which R&D is not the major driver of innovative outcomes. Of course, there is less of this activity than in more advanced circumstances, but that does not translate into a convincing

theoretical argument that widespread capacity constraints – in human capital, infrastructure, and the institutional framework – categorically rule out innovation (cf. Bell and Pavitt 1993).

But there are objective constraints. Increasingly extensive, restrictive, and enforceable international intellectual property regimes have made access to new and frontier technologies more difficult and more expensive (Krishna and Krishna 2005). Categorically disputing the appropriateness of frontier technologies for LICs would be off the mark: advances in modern biology are of course essential to achieving food security in poor countries. Globalisation does not just open up opportunities but is also a threat to the local research base in that global knowledge networks leave little space to punch in the junior leagues – either you spar with the best, or you do not really figure at all (Krishna, Waast, and Gaillard 1998). World-class science obviously requires world-class infrastructure and productive national scientific communities – consisting of interlinked complementarities of oriented basic research, well supported and highly motivated researchers, and functioning PhD programmes in universities – that are few and far between in LICs (Krishna and Krishna 2005, Lorentzen 2009b). It is furthermore not clear that IP regimes from advanced economies will raise welfare when adopted in developing countries (So et al. 2008). However, this also only underlines that innovation in LICs is an uphill battle, but not that it is an impossibility.

A further complication arises when top scientists in developing countries contribute to research projects whose objectives are determined by funders in developed economies. The outcomes of such projects may have very little utility for the developing country, with low resultant take-up by industry and other productive actors. Such subordinated integration (Kreimer and Zabala 2008) may lead to innovation that shows up in the developed country but not in the developing country, thus eluding the researcher looking for evidence of innovation in the "wrong" place (Hubert and Spivak L'Hoste 2008, Krauskopf, Krauskopf, and Méndez 2007). If it is true that developing regions have become markets for brains-for-hire where academically trained young people go into consultancies rather than joining university departments, selling their skills to the highest foreign bidder (Waast 2002), then research, although happening, is unlikely to show up in a way that innovation scholars would readily recognize or, for that matter, accept. This underlines – however unpopular such language may be in the feel-good discourse about the global knowledge economy – that science is at least in part hegemonic, is being controlled by hegemonic countries through the way they set research agendas and disburse resources accordingly, and is being pursued in a subordinated way in non-peripheral countries (Losego and Arvanitis 2008).

Table 1 – Articles published in selected journals by income groups, 1997-2008

	LIC	%	Lower MIC	%	Upper MIC	%	HIC	%	Total
Research Policy	1	.31	39	11.93	28	8.56	259	79.20	327
Industrial and Corporate Change	1	1.45	2	2.90	7	10.14	59	85.51	69
R&D Management	1	2.44	7	17.07	0	.00	33	80.49	41
Journal of Evolutionary Economics	2	4.76	2	4.76	0	.00	38	90.48	42
Technovation	32	8.65	62	16.76	34	9.19	242	65.41	370
Total	37	4.36	112	13.19	69	8.13	631	74.32	849

The second possibility is that there *is* innovation and that one can in principle see it, but that no one is looking. One reason for this could be that in relative and absolute terms, there are many more researchers in the BRICS and similar countries than in LICs. Since most researchers have a home bias in the sense that they tend to work primarily on their own country, this would explain why innovation stories from China far outnumber those from Mali. Similarly, since everybody – the financial press, key international organizations, and policymakers – agrees on the importance of BRICS-type countries for the global economy, this generates considerable demand for understanding them better. Hence, researchers have incentives to devote themselves to Brazilian biofuel, Indian IT, Chinese genetic engineering, or South African telescopes. The same is decidedly not the case for, say, irrigation systems in Eritrea or sheep husbandry in Tajikistan or health care service provision in Papua New Guinea. This does not mean that there are absolutely no funds available to study such things in similar countries. But it is certainly the case that the principal sources for funding on which innovation researchers draw do typically not include provisions for including Togo or Nepal. While this is an objective constraint, it is a poor reason for neglecting LICs in our research agenda.

The third possibility is that we *do* look at innovation in LICs but through the lens of our tried and tested concepts and using conventional methodologies which are somehow not appropriate. This is different from the above argument that there is no innovation, and more a case of researchers not knowing how to approach innovation in LICs and what to make of the evidence. Hobday (2005) made this point when he found that the various generations of firm-level innovation models do not appropriately deal with latecomer countries. They assume leadership status of firms, concentrate on large firms that pursue highly structured R&D, and focus on new-to-world or –market products and processes, to the detriment of smaller firms that more informally pursue innovation. Since Hobday based his critique on the shortcomings of these models for two rather advanced latecomer countries, Taiwan and Korea, it can only be inferred that the innovation field is even more at a loss when it comes to the much less advanced LICs.

> [M]any of the models tend to imply there is one "best practice" model to follow. This is a highly dubious implication. The evidence shows that there can be no standard textbook for innovation. Innovation not only depends on firm culture and context, but also leadership, ingenuity and vision. While the search for underlying structures is useful as a benchmark to understand progress, problems and patterns, the essential feature of innovation is rule-breaking rather than identifying and pursuing rules or patterns. […] The appropriate model will not only depend on the sector and the particular innovation challenge, but also on the history, experience and capability of the firm in question (Hobday 2005, 140).

The fourth and final possibility – which is a more extreme version of the third – is that there is innovation in LICs which we simply do not recognize: what you (don't) see is what you (don't) get. There may be several reasons for this. Perhaps the most important is that innovation researchers are most comfortable with studying technical change, and regarding firms as the major engines driving this process. But although technology consists of the social pool of the *industrial* arts (Schmockler 1966; see also Nelson's (2008) differentiation of "physical" and "social" technologies), "social" is not confined to the formal sector of the

economy. In fact, since technology is not just things one can touch, but is also reflected in how people more or less intelligently go about doing things within the social structures in which they live, the utilization of technology may lead to innovations that have utility even though it would be difficult to attach a market value to them, if only because they are not being commercialized in the traditional sense of the term.[2]

Apart from our inexperience in the informal economy, we are also constrained by the notion that innovation is a change in products and productive or organizational processes. In contexts where products are agricultural commodities that undergo very little processing and are pursued by individuals and households, the most important dimension of innovation might be social. This is a phenomenon that innovation researchers are ill equipped to tackle.

In sum, there are four possible reasons why LICs figure so poorly in innovation research:

1. There is no innovation in LICs.
2. There is innovation in LICs but everybody is too busy studying innovation in "sexier" countries.
3. There is innovation but understanding it requires an analytical apparatus we do not have.
4. There is innovation but, like the fellows in Plato's parable of the cave, we do not recognize it.

The discussion has hopefully shown that things are much more complex than what is suggested in (1) and that the state of affairs described in (2) is something for which one ought to hang one's head in shame. The merit of (3) and (4) is the subject of the next section which presents work on innovative activities in LICs produced for the most part outside the innovation research community (for a discussion of just what is meant by that, see Fagerberg and Verspagen 2009).

Innovation in LICs: A brief macro overview of the literature

The review that follows represents an overview of articles indexed in the Social Sciences Citation Index, ISI Web of Knowledge, for a twelve-year period starting in January 1997.[3] The second half of the 1990s coincides with a rapid relative and absolute growth in the innovation literature in general (Fagerberg 2005, Figure 1.1). In light of the evidence presented in Table 1, an earlier start date would unlikely have made much difference with respect to the coverage of LICs. Search terms combined both groups of countries ("developing countries", "low-income countries", "least developed countries") and each individual LIC with "innovation" and "development", respectively.[4] The inclusion of "developing countries" and "least developed countries" which overlap with LICs was meant

[2] The flip side of this is that interventions in support of rural development must be multi-sectoral, involving not just agricultural experts but also specialists in human and social development, social protection, and gender among others (Binswanger 2007).

[3] This section draws heavily on Mugadza et al. (2009) which develops the methodology in more detail.

[4] The inclusion of "development" was meant to ensure that phenomena that innovation scholars would identify as innovation whereas researchers from other disciplines might use different language to describe them, are included in the review. This merely acknowledges that innovation is a means to an end and not an end in itself.

to guard against the possibility of losing relevant publications that although dealing with low-income countries did not denote them as such.[5] The search results are reported in Table 2.

Table 2 – Results from the literature search

Search terms	Developing countries AND innovation	LICs AND innovation	LICs AND development	LDCs AND innovation	LDCs AND development	"Country" AND innovation	Total
Hits	474	33	648	14	278	351	1798
1st filter: abstract	50	5	38	1	13	164	271
2nd filter: full text	25	3	24	1	4	96	153

For practical reasons we concentrated on the single-country studies of innovation (351) and the multi-country studies of both innovation and development (1,447 articles). Criteria for inclusion were that the article had to address a product, process or organizational innovation – regardless of whether it identified the phenomenon in such language – and explicitly cover LICs.[6] A two-stage filtering process, based on the abstracts and finally on the full text, identified 153 relevant articles.

45 per cent covered East and West Africa which roughly corresponds with the weight of these two regions in the LIC group. Nigeria, Tanzania, and Kenya accounted for half of them. All of Southern Africa was covered just as much as Tanzania by itself. Central Africa did not figure at all. 14 per cent of the articles addressed South Asia, five per cent South-East Asia, and one per cent Central Asia. In Asia, Pakistan (7%) was the most analysed country. All remaining papers covered more than one region.[7]

Not surprisingly, most papers were concerned with bread on the table and disease at the door. Agriculture accounted for more than one in three papers (37%) and health for one in four (26%). Manufacturing appeared in 14 per cent of the analyses, and another four per cent dealt with a mixture of these. Hence 80 per cent of the literature addressed one of three key issues for development in poor countries. The rest mostly looked at basic services (water and sanitation, education, energy). The only potentially high-tech issue was IT (5%).

[5] "Developing countries" is not always a precisely defined term. For the purposes of this discussion, it excludes high-income countries and includes all others. Least developed countries (LDCs) are not just (and sometimes not even) poor. The term is based on a composite indicator of national per capita income, human development, and economic vulnerability (UNCTAD 2008). 37 LDCs are also LICs which in turn make up about a third of all developing countries.

[6] Hence articles about LDCs or developing countries that do not distinguish between those that are LICs and those that are not, are excluded.

[7] Countries that are not even mentioned in passing include Kyrgyzstan, Laos, Papua New Guinea, North Korea, Burma, Yemen, Central African Republic, São Tome and Principe, Comoros, Liberia, Guinea-Bissau, Somalia and Eritrea. But even less exotic places such as Mozambique, Benin, and Chad are only mentioned in conjunction with other countries. Finally, there is one article each about Cambodia, Sierra Leone, Mauritania, Guinea, Gambia, Madagascar, and Rwanda.

The most important type of innovation addressed was organizational (36%), followed by process (20%), product (19%), and a mixture of the two (7%). The preeminence of organizational innovation reflects the concern with participatory processes involving communities in strategies aiming at a solution of their problems. Insofar technology was specifically addressed, it was in many cases homemade; sources included local firms (10%), communities (9%), government (8.5%), organizations (7%), universities (5%), and local-only networks (7%). Together with various forms of local-foreign partnerships (9%), local actors were involved as sources of technology in more than half of all cases. Among external actors, foreign organizations (24%; e.g. World Bank, WHO) occupied the top spot, followed somewhat unexpectedly by foreign universities (5%). Foreign firms by themselves accounted for only two per cent. Of course, this finding may not just confirm that MNCs play at best a small role in LICs but also reveal a bias – it is implausible that technology accumulation in LICs throws everything upside down that is known about external technology transfer and technological learning in developing countries, but there may rather be a selective focus on "local topics" among researchers addressing LICs issues.

In terms of scope, one out of three articles limits itself to a narrow understanding of innovation systems, consisting only of S&T institutions proper. Given that such institutions do not play a large role in those countries, this is unexpected. Likewise, *fewer* papers are concerned with informal as opposed to formal networks. This does obviously not reflect the relative significance of such networks in poor countries, and perhaps rather reveals that researchers analyse what they are methodologically more comfortable with, and hence formal and documented over the informal and less tangible forms of interaction. In terms of substance, the issues these papers raise largely concern appropriateness (34%; e.g. of a certain technology to a specific local environment) and building local capabilities (42%), plus governance problems. A final observation is that the knowledge production reflected in these papers is mostly generated outside the LICs. 57 per cent of single-authored papers and more than 70 per cent of multiple authored papers originated in middle- or high-income countries. Only one in four multiple authored papers are based on collaborations between foreign and local researchers.

In sum, based on this brief overview, there is no overwhelming evidence that the relevant issues lie somehow outside of the expertise of the innovation research community. Building capabilities in rural production systems or enhancing health service delivery is hardly something from outer space. Nor does it seem that the issues most frequently addressed are for some reason only visible to experts from other disciplines. Having said this, however, innovation research has traditionally more focused on manufacturing which is a more marginal issue here. It has been less concerned with agricultural innovation systems, although there are important exceptions. Services have featured more as high-end professional services than as primary healthcare. Also, innovation research has acknowledged the importance of informal networks, including among non-firm actors. But this is to date a statement of faith and has not yet spawned much conceptual thinking or empirical analyses. Given the importance of actors other than firms who operate in contexts that cannot always and readily be described as markets, which emerges from the literature review, this may point to some problems researchers interested in innovation in LICs face.

A more detailed look
Issues in manufacturing

Just over two dozen papers were authored by innovation researchers, namely people who use concepts, methodologies, and publication outlets characteristic of the field. They focused on capabilities mostly at the firm level, the role of linkages, and the significance of these phenomena for economic performance. The majority of papers was published within the last few years, confirming that LICs are indeed at best an emerging field of enquiry in innovation studies. Bar very few exceptions, the focus is on the manufacturing industry.

Although framework conditions do influence upgrading, it is important to focus on firm capabilities first (Murphy 2007). At the most micro level, capabilities require appropriately skilled personnel. Small and medium-sized firms in Nigeria were more likely to innovate if their owners or managers had academic qualifications, were specialized in science and engineering, or had experience of working in MNCs. Investment in employee training also affected innovative performance positively, as did R&D expenditure (Abereijo et al. 2007). Chipika and Milson (2006) found similar results for light engineering SMEs in Zimbabwe. Management capabilities are especially important because they determine the development of coherent systems without which technological capabilities cannot be built (Marcelle 2005).

There is much interest in the modes and mechanisms of learning. Learning is a complex activity and does not just depend on curiosity or willingness. Based on an analysis of the acquisition of tacit and explicit marketing knowledge by local firms in Vietnam from their foreign counterparts in international joint ventures, Hau and Evangelista (2007) conclude that learning *intent* plays an important role not just for the acquisition of external knowledge but also because it indirectly affects learning capabilities. Therefore learning itself must be done skillfully which requires a minimum level of capability as well as the presence of intent at both the organizational and individual level (cf. Chipika and Milson 2006). In other words, the mere existence of a R&D department headed by a senior manager is not good enough, as evidenced by the poor record of new product development in Nigeria's food industry (Ilor et al. 2000). In order to be successful, organizational learning occasionally demands radical change in terms of taking on one's shared norms, beliefs and practices such as the lack of technological capability. Huange et al (2003) describe how a Nigerian bank thus first introduced internet banking, and subsequently generated further learning by developing mobile banking.

Somewhat in conflict with Hau's and Evangelista's (2007) results, Oyelaran-Oyeyinka and Lal (2006) contend, based on an analysis of SMEs in Nigeria, Uganda, and India, that non-formal learning can be the dominant form of mastering technologies. However they concur that *explicit* learning of new technologies is essential for technological upgrading. There clearly needs to be some convergence of terminology before such results can be meaningfully compared. Goedhuys (2007) reports that in Tanzania firm size, skill level, training and R&D activities are positively related to learning. Hence large firms learn better, and small firms compensate for the lack of resources that would allow them to afford more systematic learning through linkages with other firms. Her important finding is that learning and linkages do not necessarily go hand in hand and may indeed be substitutes, for example when shallow financial markets prevent SMEs from accessing credit to invest in learning.

In line with the emphasis innovation studies places on interactions in the system, most articles focus on linkages. At the level of the national system of innovation, Lanteri and Quagliotti (1997) held effective feedback mechanisms from farmers to breeders responsible for the limited effect the seed industry in Africa has been having on agricultural output of the continent. Uddin (2006) studied the relationship between innovations and their diffusion for technology promotion in rural micro-industries in Bangladesh. Insofar local artisans respond to the needs of local users, innovation is demand-driven. Users also provide feedback on innovations which may lead to modifications and further developments. Thus, innovation and diffusion are co-evolving processes of technological development for which user-producer interactions are key.

Yet it is important not to glorify interactions as something that is intrinsically good. The relationship between networking and technological learning is not straightforward. In their study of light engineering firms in Zimbabwe, Chipika and Milson (2006) found that while the association between the two is generally positive, some networks actually maintain and reinforce ignorance. This puts paid to the romantic notion that clustering firms will *per se* advance economic development (e.g. Phambuka-Nsimbi 2008). They also found that different networks might be good for different aspects of technological learning. One of the problems with interactions is that there are so few of them. In the presence of inadequate research infrastructure, lack of funding, and lack of interest by firms, linkages between universities and the private sector in Nigeria are pretty much non-existent which constrains the potential impact of biotechnology research on industrial innovation in Nigeria (Adeoti and Adeoti 2005). However, in Zambia a partnership between various stakeholders led to the establishment of the country's first internet service provider through the commercialization of a university-based e-mail system (Konde 2004).

In Tanzania, linkages are not always directly linked to upgrading. A study of social interactions between manufacturers in the Mwanza district revealed that they are driven by multiple rationalities that are difficult to isolate from one another (Murphy 2003). Key among them is a desire to access credit and a desire to build reputation and to gather information all of which may of course advance industrial development. Social capabilities of the agents managing change processes in firms are important for the capability to undertake innovation, and this social dimension of innovation should thus be studied more (Murphy 2002).

Caniëls and Romijn (2008) mapped the nodes of the network surrounding the jatropha biofuel value chain in Tanzania, from seed cultivation through pressing to distribution. They found that although networking, learning, and the convergence of expectations are present to differing degrees along the value chain, the network on the whole is weak, lacks cohesion, and – insofar it is dominated by two large actors – might actually disintegrate. This again underlines that linkages are a means to an end and not a good thing by themselves. Linkages in their spatial context were discussed only marginally (Caniëls and Romijn 2003a, b), rather in contrast to the popularity of this topic among innovation researchers focusing on middle-income countries.

International linkages feature in some of the work. In Tanzania, foreign firms play a limited role in stimulating innovation in local firms but are important for human resource development (Goedhuys 2007). In line with work on the importance of dynamically

upgraded human capital for the catch-up success of a few Asian economies, especially Korea, the author therefore concludes that public policy should promote interactions between local and foreign firms in order to stimulate technological learning. Nadvi and Halder (2005) report for the surgical instrument industry that the relationship between the Tuttlingen cluster in Germany and the Sialkot cluster in Pakistan is cooperative more than competitive, possibly at the cost of limiting some Sialkot firms in their potential technological trajectories. In general, the nature of linkages between clusters is an important consideration for industrial policy.

Rather few articles confront the *so-what?* question of how much difference capabilities and networks make to economic performance. Prajogo et al (2007) dispute the significance of R&D intensity in its impact on innovation performance in Vietnam. In a purely technical article, Amonov, Pulatov, and Colvin (2006) describe a new cotton cultivator which would have environmental advantages, increase efficiency and raise profits for Uzbekistan's cotton farmers. Kaplinsky (2007) argues that competition from China and India implies that LICs can advance their industrialization only to the extent that they manage to differentiate themselves from these juggernauts, and thus through innovation, in their attempt to muscle into global value chains.

A few papers address framework conditions. Ilori et al. (2002) blame the absence of a comprehensive science and technology strategy for the weak performance of Nigeria's manufacturing sector. Adegbite (2001) makes a similar argument for Nigeria's largely failed business incubators. Murphy (2006) shows that market liberalization has had a differential impact on Tanzania's industrial capabilities; on the one hand it created conditions conducive to entrepreneurship, on the other it discouraged the more creative manufacture of higher-quality merchandise. Storm (2008) suggests that Washington Consensus-type policies are inimical to the promotion of much needed structural change and that only powerful developmental states, in conjunction with key actors in the economy, can unleash the growth potential of LICs. Meager (2007) attributes the decline of three traditionally innovative textile and shoemaking clusters in Nigeria to the impact of globalization and liberalization. This was not the direct effect of heightened competition, especially from Asia, but the combined result of a dysfunctional institutional environment, deficient infrastructure, and the informal nature of the three clusters, leading eventually to involution, clandestinisation, and social fragmentation. A different take comes from Howcroft and Ataullah (2006) who show that the introduction of financial liberalization, while slow to exert an impact, increased productivity in Pakistan's commercial bank sector.

In sum, these analyses raise similar issues and make similar arguments to those one is familiar with from the literature on MICs. They concentrate almost exclusively on innovation in the manufacturing sector which – as the introduction has shown – is not where most of the action in LICs is. The next section deals with issues that really matter.

Issues in rural livelihoods

Researchers who publish on innovations affecting rural livelihoods by and large do not hail from innovation studies. They publish in journals with exotic titles such as *Mountain Research and Development* and the *World's Poultry Science Journal.* And they focus on rather different

things. The majority of papers, as indicated in the overview of the literature, cluster around issues related to health and agriculture.

In health, authors analyse the entire value chain from drug development to disbursement as well as new medical equipment. In light of market failures for R&D in tropical diseases, Berndt and Hurvitz (2005) make the theoretical case for advance-purchase agreements to provide incentives for pharmaceutical companies to research active ingredients for disease profiles that are prevalent in LICs (see also Ito and Yamagata 2007). Social venture capital and R&D public-private partnerships will only work if pharmaceutical majors are convinced that that the high risks and costs associated with R&D for low-margin products are outweighed by greater access to knowledge, technology, or markets, and if IPR protection can be reconciled with affordable prices (Wheeler and Berkley 2001). Breman, Alilio, and Mills (2004) stress the importance of public-private partnerships in malaria research and control. Others focus on innovative medical equipment that can make, for example, screening for cervical cancer (Franco, Duarte-Franco, and Ferenczy 2003), catheters for congenital heart disease (Kumar and Tynan 2005), microchips for CD4 lymphocyte counts (Rodriguez et al 2005), or a new technique for Cesarean section (Ansaloni et al. 2001) more affordable in countries with severely constrained resources (see also Siddiqi, Lambert, and Walley 2003).

Other papers address institutional arrangements in the health sector (e.g. Bloom, Standing, and Lloyd 2008, Peters and Chao 1998). Messen et al. (2006) describe an experiment with performance incentives to improve public health system delivery in Rwanda. Phillips, Bava, and Binka (2006) assess how the deployment of nurses and volunteers to villages in Ghana reduced childhood mortality rates (see also Nyonator et al 2005). Kincaid (2000) explains how the social network approach helped increase the use of modern contraceptives in Bangladesh. Gulzar and Henry (2005) address the determinants of inter-organizational collaboration to increase the availability of resources, improve service effectiveness and access to health care in Pakistan.

A few papers are concerned with the modes of transmission of external knowledge (where "external" need not necessarily imply "foreign"). Asbroek et al. (2005) underline the complexity of culture-specific and health-system specific barriers that impeded a smooth implementation of a lung health strategy, conceptualized abroad, in Nepal. Awoonor-Williams et al. (2004) describe how operational innovations in family planning and safe-motherhood care were successfully transferred from a well resourced experimental to a resource-constrained district in Ghana thanks to their adaptation to account for contextual factors.

Drug disbursement is addressed in several contexts. Goodman et al. (2006) show how training shopkeepers – who in many parts of Africa dispense over-the-counter malaria drugs – in correct treatment regimes can significantly improve shop-treated childhood fevers. Similarly, Fraser-Hurt and Lyimo (1998) underline that facilitating the import of high-quality anti-malarial nets and their distribution through existing and new outlets (such as "net committees") can have multiplier effects, provided a large amount of guidance is made available to the committees (see also Rowland and Nosten 2001). Rubardt et al. (1999) report similar findings from Malawi where the distribution of permethrin-impregnated curtains depended very much on the trust enjoyed by the community workers and the leadership

provided by the village headmen. Cultural acceptance is key for HIV/AIDS interventions (Burke 2004). Training issues are addressed by Gouws et al (2004) who show that health workers at first-level facilities in Tanzania and Uganda often do not have the skills to administer antimicrobial drugs properly to children.

In sum, most health papers address an innovative "solution" to a "problem" and only a few discuss how the implementation of such a solution depends on proper contextualization. Much of this research resembles the neoclassical view of technology as a freely available public good whose assimilation is essentially costless. The implicit assumption seems to be that if there is an effective drug that costs little and needs to be administered only twice a year to kill intestinal parasites, terrible diseases such as schistosomiasis should not really exist. Issues of health system capability which would explain why so many children needlessly die from a highly preventable disease, do not appear to be addressed in the literature.

By comparison, the appropriateness of technology, its contextualization, and the involvement of user groups in the design and implementation of solutions are more prevalent in agricultural research on LICs. For example, in tick control, the need for technical and administrative dip management skills and high set-up costs and maintenance costs have resulted in the collapse of many communal dipping facilities. A novel pesticide resistance management strategy trialed in Kenya reduced the incidence of tick-borne diseases and was also cheaper and therefore more appropriate (Kamidi and Kamidi 2005, see also Westerman et al. 2006).

Without a greater understanding of contextual factors, certain actions by communities may simply seem irrational. For example, during the war in Sierra Leone, farmers in the rebel enclave planted lower-yield African rice because they lacked the necessary inputs for higher-yield Asian rice for which seeds were also available. Hence innovations differ between food-secure and –insecure contexts (Richards 2006).

Social organizations accepted by the community were key to the introduction of small-scale agroforestry, which improved the ecological conditions of degraded land in Bangladesh (Nath, Inoue, and Myant 2005). Participation of communities was also behind the success of forage innovations in Ethiopia (Ayele 2003), and behind the introduction of GIS in forestry management in Ghana (Kyem 2000). In Cambodia, farmers contributed to an innovative farming practice that addressed poor seed germination, alleviated a seasonal food shortage, and provided a rice surplus for the market (Mak 2001). Similarly, in Madagascar community institutions played an important role in using innovative crop management in mitigating risk from draught, plant health, or lack of credit (Ducrot and Papillon 2004). Where farmers are not involved, for example in setting research agendas, the result may be inappropriate and costly solutions, as happened in Malawi with specific agroforestry technology (Thangata and Alavalapati 2003; see also Qi et al. 1999, Gathumbi et al. 2003).

Of course, communities do not have one common utility function, and household characteristics affect how individuals adopt innovation, as illustrated with fallow management in Zimbabwe (Mudhara, Hilderbrand, and Nair 2003; see also Gathumbi et al 2002). Even within households there are differences; results from Malawi and Uganda show that innovations in the ways poor farmers are linked to markets may change the power and

influence women have over household decision making (Kaaria et al. 2008). Likewise, experience from Ethiopia shows that unless innovations in support of biodiversity acknowledge the role women play in barley seed selection, they are likely to be less successful (Romani 2003).

The role of education and training in using innovation to improve rural livelihood is also discussed. For example, in Nepal a mother's education is positively associated with the likelihood that her child is not malnourished. This is not because education is also correlated with income, but because it allows her to make sense of external nutrition knowledge. This is therefore important when designing information platforms (Eklund, Imai, and Felloni 2007; see also Sonaiya 2007). Evidence from Ethiopia shows that education also plays an indirect role in the adoption and diffusion of agricultural innovations, because uneducated farmers copy early adopters provided social networks facilitate such learning (Weir and Knight 2004).

In sum, issues of concern in LICs for which innovative activities might provide solutions are considerably different from those typically analysed in innovation studies. The next section discusses the respective epistemologies.

Innovation in development: In and out of the silos

With the important exception of Schumpeter, some of the very early work on innovation was not done by economists, but by sociologists. In 1962 Everett Rogers published *Diffusion of Innovations*, a volume that four decades later was published in its fifth edition and whose ideas clearly benefited from a rather extended shelf life (Rogers 2003). The book was essentially a review of diffusion research known until then. Although the majority of the work focused on developed economies, it did pay attention to developing countries as well; in fact, it started out with an anecdote recounting a largely failed experiment to introduce boiling water for sanitary purposes in a Peruvian village. The example captured what rural sociologists were mostly interested in, namely agricultural and medical technologies.

Martin (2008) points out that when the rather few economists and sociologists working on innovation fifty years ago did consider each others' research, sparks flew, albeit for all the wrong reasons. The debate in the late 1950s between leading lights such as Rogers on the one hand and Griliches on the other in *Rural Sociology* was primarily confrontational and made for hardly any cross-fertilisation in the decades hence (see also Cottrill, Rogers and Mills 1989). Without wanting to judge that particular period of intellectual history in innovation research, it is doubtful that a similar form of benign neglect is justified at present.

It is instructive to assess whether conceptual domains and understandings about key cause-effect relationships overlap among the various disciplines or knowledge fields that are concerned with innovation in the context of development. If they do not, there is very little hope for cross-fertilisation or even just sharing insights.

The first big difference lies in the unit of analysis. Whereas in innovation studies firms are the principal agents of technical change and thus the focus, the more informal constitution of the economy in many LICs means that firms are a relatively less representative actor. This does not mean that they do not exist or that they do not make an important contribution to national income, rather that most people do not wake up in the morning to take a bus to a

factory or an office block. And because everything is smaller scale, the advanced-country *firm* is also not simply the poor-country *farm*. Instead, individuals and the communities of which they are part are the key actor in planning and implementing agricultural and rural development (Binswanger 2007). This has entered the vocabulary as the "livelihoods approach" in which people's needs and priorities (are supposed to) inform higher level policy development and planning (Allison and Ellis 2001).

Communities may be heterogeneous even when they are culturally and linguistically similar and not characterized by enormous socioeconomic status differences. This is because local priorities differ – for example, due to a different exposure to risk – and because poorer people can generally afford less experimentation with innovation compared to those that are a little less poor. In South-Eastern Nigeria, three villages adapted differentially to environmental change depending on the severity with which it affected communally owned forests (Dunn 1998). All of this is mediated through social hierarchies (McKay et al. 2007). Communities can be further disaggregated into households and gender. For example, homework is both a source of exploitation of workers and an opportunity for marginal households to earn some income and thus promote local development. Which outcome eventually prevails will depend not just on social protection and joint action but prominently on educational achievements in the households. This has a gender dimension: if community-based childcare allows older girls to attend school and, if necessary, work part-time, positive developmental outcomes are more likely than in the absence of such institutions (Mehrotra and Biggeri 2005).

The focus on individuals as actors in the innovation system has implications for what one means by "capabilities" or "absorptive capacities". Although human capital is obviously an important dimension in innovation studies, it features mostly in the aggregate as more or less skilled workers that have a mediated impact – for example, through the way in which management employs these skills – on innovative outcomes. But in rural livelihoods, the link is much more direct. Thus, a study in Kenya showed that education had a significant effect on farmers' willingness to take risks and, by implication, adopt new technologies. Since less educated farmers can and will imitate the early innovators, innovation has externalities that can be encouraged even in the absence of a broad, and thus potentially unaffordable education campaign (Knight, Weir, and Woldehanna 2003; see also Chitere 1998). That there can be innovators or early adopters and late adopters in the same farming community, is confirmed by research on the adoption of plantain and banana based technologies in three Niger Delta states in Nigeria as well (Faturoti et al. 2006).

In poverty research, Sen's (1984, 1999) definition of capability concerns the freedoms (e.g. from hunger or disease) that people enjoy allowing them to lead the kind of life they value. Improving capabilities has an impact on earning power and not just the other way round (cf. Kanbur and Squire 2001). This logic resembles the work on technological change and learning where absorptive capacities are central to technological upgrading and catch-up.

Of course, capabilities are not just lodged at the individual level. Community coordination can strengthen its ability to adapt to change. When local institutional arrangements and social capital facilitate more extensive indigenous communication and innovation, adaptation is likely to take place faster (Dixon 2005). For farmers to identify and evaluate market opportunities, develop profitable agro enterprises and intensify production while sustaining

the underlying resource base, they rely on what innovation researchers would call complementary assets: effective partnerships with business support services, NGOs, and the private sector to facilitate market visits and mitigate risk. Such micro-level community processes must be linked to higher macro-level processes to ramp up scale and afford better institutional conditions (Sanginga et al. 2004). When capabilities are exaggerated, innovations may have unintended negative consequences or may simply not be adopted which is why policy interventions must always be properly contextualized (Reed 2007, Yazbeck 2004).

There is on the whole not a lot of work on innovation "systems", a point acknowledged by Travis et al. (2004) who argue that piecemeal disease- or service-specific strategies are unlikely to bring about the kinds of improvements in health care needed to achieve the Millennium Development Goals; instead they must be conceived of in the context of human resources, finance, drugs and supply systems, and the generation and use of information. Faturoti et al. (2007) discuss the decline in yields of banana and plantains in Nigeria as a malfunctioning of the innovation system, especially with respect to a lack of coordination and generally weak linkages among actors (see also Agwu, Dimelu, and Madukwe 2008).

"Linkages" is quite a popular topic. Often they become relevant not just at the level of operation, but at the inception of an idea. In Malawi, researchers and extension officers failed to consult farmers about the suitability of their asset conditions for a new bean variety which consequently was not much adopted (Masangano and Miles 2004). By contrast, in Tanzania an HIV/AIDS clinical trial was very successful partly because researchers built relationships with important stakeholders and formed strategic alliances with policymakers (Philpott, Maher, and Grosskurth 2002). Disconnects between the scientific community and government can be addressed by knowledge brokers (van Kamen, de Savigny, and Sewankambo 2006; see also Hyder et al. 2007).

Social networks and the exchange of knowledge to which they give rise are not just influenced by formal group membership and proximity, but also by ethnicity. In Cote d'Ivoire, non-indigenous groups of farmers were less likely to join extension groups but had higher crop yields because they exchanged more knowledge among themselves (Romani 2003). When linkages do not materialize due to coordination failures, potentially very beneficial innovations may never be effectively diffused (Odame 1997). Research on linkages sometimes provides an empirical counterpoint to the somewhat ideological mantra of community involvement and client buy-in. For example, an analysis of a soil fertility project in Togo found that the project planners talked the talk of participatory development but did not walk the walk of actually involving farmers and other relevant community members in the major decisions. This left farmers with counterproductive outcomes such as increased maize yields without a market to sell the maize on, and generally benefited the wealthier farmers. Not surprisingly, resource-poor farmers declined to adopt the practices the project managers recommended (Nedelof and Dangbegnon 2007). Unfortunately, there is more evidence of poor (research) design leading to useless outcomes (Adjei et al. 2008).

Some papers address the economic impact of universities. In Nigeria, frequent personal contact between researchers and farmers had an impact on the adoption rate of an innovation aimed at the improvement of yam yields (Ijoyah, Aba, and Ugannyan 2006). In Ghana and Benin, the relevance of doctoral research to small-scale farmers was secured through informing diagnostic studies through pre-analytic choices, drawing on the research

needs and circumstances of the farmers (Roling et al. 2004). Similarly, the Marine Studies Programme of the University of the South Pacific is designed to be a conduit between sustainable management of marine resources and the needs of local communities (Veitayaki and South 2001).

Conclusion: From each according to his (or her) ability

It would be a crass oversimplification to say that innovation researchers look at the wrong things with the right tools, while everybody else who is interested in innovation in LICs focuses on the stuff that really matters to poor people's livelihoods but moves conceptually on somewhat shaky ground. Yet there is a little bit of truth to this. Innovation studies is good at explaining technological learning and upgrading of firms who are linked to other important actors in dynamic evolutionary settings supported by institutions conducive to change. Due to its systemic perspective and its relatively coherent roots in (if not the same then) cognate literatures that address technical change, capability building, and innovation systems (Fagerberg and Verspagen 2009), it produces convincing stories of why catch-up at times works, and why other times it fails. Yet due to a conceptual and methodological apparatus that was developed for advanced countries and has only lately been enriched somewhat to accommodate middle-income countries, both of which are characterized by socioeconomic conditions very different from those prevailing in poor countries, it has so far only been able to address marginal phenomena in LICs, namely upgrading in industrial sectors that may be dynamically important but that at present sustain much fewer livelihoods than agriculture. It has also stayed completely clear of health (innovation) systems, despite the enormous importance they have for development in Africa and South Asia.

The other literatures reviewed here focus on all the pressing issues – how to earn a livelihood off the land despite the many obstacles to small-scale agriculture, and how to protect one's family from the terrible diseases that afflict too many people in poor countries. But these analyses often juxtapose a problem with a solution, and it is only when that solution does not work that they introduce systemic aspects. This is rarely based on common and agreed conceptual frameworks, but introduced ad hoc. The rich literature on technology transfer or the role of institutions in economic development is largely ignored even though it is very relevant. As a result, innovation comes across as many piecemeal solutions to many different problems, and not as a coherent narrative. In a sense, therefore, the research is just as messy as the real world which is why it is difficult to extract patterns and learn from it. Innovation is of course also a collective endeavour by people to better their lot, so in principle there must be lessons from one set of experiences to another. In other words, the many tales must combine to a compelling story that spells out how catch-up in low-income countries can work. So far, that does not seem to have happened.[8]

[8] This is by no means a new phenomenon. Although "technology transfer" and "innovation diffusion" are evidently related concepts, Cottrill, Rogers, and Mills (1989) showed that researchers in the one tradition rarely referenced work of those in the other. The claim that innovation scholars ignore those working on rural livelihoods in LICs, and vice versa, would also need to be put to the test through a co-citation analysis. This will be the next step in this paper. It may also be the case that such cross-fertilisation takes place in journals of relatively recent vintage that are not yet indexed in ISI-Web of Science which is why we are currently expanding our database.

Yet apart from the respective terminology, innovation system researchers have perhaps more in common with sociologists interested in the diffusion of innovation than they realize, and vice versa. Before evolutionary economics became influential for the study of technological change (and long before the notion of national innovation systems emerged), sociologists had pointed out the discrepancy between the desire and the need for change, and the poor implementation record of innovation in developing countries (Rogers and Shoemaker 1971). They underlined that the spread of new ideas requires a series of sequential transmissions (i.e. in contrast to the notion of the costless assimilation of technology in neoclassical economics) and is complicated by the degree of heterophily (i.e. dissimilarity in key attributes) between source and receiver. They stressed that the absorption of an innovation is not a discrete event but a process, starting with knowledge (the innovation becomes known and is understood), persuasion (its relative benefits are assessed), decision (adoption or rejection), and confirmation (reinforcement or reversal depending on outcomes of further assessment). Actors are heterogenous: some are innovators, others early adopters, and some are laggards. Adoption behaviour, in turn, is influenced by the systemic position of the actor and the norms of the system (ibid). In modern poverty research terminology, this points to issues of vulnerability and powerlessness.

These arguments can be used in innovation studies without getting lost in translation. In fact, this review also identified points of contact between innovation studies and other researchers interested in innovation in LICs. It is important to exploit such overlaps in order to make innovation studies more meaningful to the poor. Obviously, life in the LICs is not neatly divided into manufacturing and agricultural and health issues. They are connected: healthier people have a better chance of earning an income, educated people are more likely to make informed health choices, higher incomes (or the provision of safety nets) – all issues discussed in the literature reviewed here – can help people avoid getting locked into low-risk, low-reward situations and open up opportunities for investing into more dynamic activities (cf. Kanbur and Squire 2001).

There is no doubt that the respective fields would benefit from comparing notes and informing each other. More adequate models would emerge, and research on how innovation affects the poor would certainly benefit. In the end, maybe even the poor would.

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