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Inclusive Innovation and Innovation Policy

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FOR WHOM THE BELL TOLLS: Inclusive Innovation and Innovation Policy*

*Suma Athreye & Abhijit Sengupta***

***Abstract**: This paper argues that innovations for the poor (inclusive innovation) are in short supply because of poor "market access" due to underdeveloped or missing markets in rural areas where most of the poor are located, and because of poor "technology access" due to the absence of domestic innovative capability and high costs of adapting technology products for poor populations. Based on a review of 58 recent cases of inclusive innovation, which have been discussed in the media, in policy circles and in the academic literature, we identify the agency and areas where inclusive innovations have been successful and areas where significant gaps exist. Our findings reveal that domestic private firms, MNEs and other non-state actors have played a significant role in introducing pro-poor innovations but have mostly concentrated their effort in areas of low market access and/or high technology access. Inclusive innovation efforts are scarce in situations where technology access is low, although multilateral charities and agencies are targeting such areas. Policy support for inclusive innovation in India has taken the form of finance provision but this should be complemented by more R&D in public sector bodies and public investments in marketing infrastructure. In this sense, the constraints to inclusive innovation mirror the overall situation regarding innovation in India.*

1. Introduction

Inclusive innovations improve or enhance product and service characteristics to make their use relevant for poor populations, and thus harness scientific and technological advancement for the greater societal welfare. Celebrated recent examples include mobile phone money (M-Pesa) which brought banking solutions to rural populations in Kenya (see Jack and Suri 2011) and Chotukool, an ice-box that runs on battery to become a refrigerator produced by Godrej, a family firm in India, which is used to store medicines

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and milk in rural areas (Dhanraj et al 2011). In India, the more successful examples include Jaipur Foot,Narayana Health, Aravind Eye Care (See Krishna, 2017). As an idea, it has appealed to scholars in management (George et.al., 2012), development studies (see the special issues by Heeks et al, 2016 and Chataway et al 2014) and also to policy circles as a means of realising(UNESCO 2015; World Bank 2013).

As Chataway, Hanlin and Kaplinsky (2014) and Krishna (2017) note, the idea of inclusive innovation is not new in development studies and has a history that can be traced back to the early 1950s. Variously titled 'appropriate technology' (Stewart, 1978) or 'intermediate technology' (Schumacher 1981), the concern of many studies on innovation in developing economies was that technologies imported from more developed economies were not readily usable in developing nations. There were many costs of technology adaptation and the agency that would undertake those adaptations was not visible — both because indigenous firms lacked the required technological capabilities and because the ability to access technologies from abroad for any individual firm was quite high.

In India, the notion of inclusive development was a fundamental platform in the Freedom movement with pioneering contributions by thinkers such as Tagore (Shantiniketan experiment), Aurobindo Ghose (the Pondicherry Auroville) and Gandhi who frequently questioned the relevance of modern science and technology to the lives of the poor. Indeed the effect of these ideas, both in the development literature and in India specifically, lay behind the setting up of many public sector research organisations such as the Council of Scientific and Industrial Research in India and South Africa and the Chinese Academy of Sciences in China. But the period of concentrated public policy for innovation was in the 1970s and 1980s when particular sectors were identified as areas where India lagged behind in capabilities and firms were encouraged to build up their competences in these areas. Yet, in a sharp reversal of earlier polices where public R&D and innovation policy played the stellar role in reaching innovations to poor populations, academic and policy discussions on inclusive innovation since 2000, emphasise market extension activities through business model innovation and the entrepreneurial agency in the provision of better products and services for poor populations (Arora and Romijn, 2012). Indeed from 1991-2013, India did not have any particular innovation policy. Since 2013, innovation policy is back on the agenda but policy support has taken the form of supporting the private sector in providing innovations to the poor.

In this paper, we argue that innovations for the poor populations face two main kinds of barriers – poor "market access" due to underdeveloped or missing markets in rural areas where most of the poor are located, and because of poor "technology access" which depends upon domestic innovative capability and cost of technology adaptation for poor populations. Both barriers reflect market failure due to the presence of externalities in the provision of inclusive innovation, where social benefits of the innovation exceed the private benefits to a provider. In case of the former, enhanced market access through means of improved information dissemination and distribution networks acts as a public good, which reduces the incentive of any one provider to provide these services. In case of

the latter, enhanced technology access requires investments which are not forthcoming from private players given the low willingness to pay for the technology on part of the beneficiaries. By adopting such a framework, we rebalance the old and new ways of thinking about inclusive innovation and also provide theoretical support for scholars like Karnani (2017) who have argued for a greater role for the public sector in successfully penetrating bottom of pyramid markets.

A second contribution of our paper is to review a large number of recent cases of inclusive innovation, which have been discussed in the media, in policy circles and in the academic literature and classify them as overcoming market or technology access barriers. Based on this taxonomy, we identify the agency and areas where inclusive innovations have been successful and areas where significant gaps exist. In this way, we complement and extend existing reviews which have often been based on fewer case studies drawn from particular regions.

Our review of successful cases confirms that inclusive innovation, as evidenced by these successful cases, has indeed been market extending. We also find technology extending innovations are much scarcer even in crucial sectors like health and energy where we might expect technology to play a larger role. Second, although the bottom of pyramid literature developed in the context of MNEs who owned advanced technology that could be deployed to serve poor markets, we found domestic firms and social enterprises have led the inclusive innovation effort just as much. Public sector initiatives and public-private partnerships are much rarer. Lastly, we find that partnerships with NGOs have enabled many examples of inclusive innovation and they often occur to acquire complementary assets when intermediate markets in distribution, technology or finance are missing.

Some of the factors we identify such as weak public R&D and scarce public private partnerships are actually factors that have held back India's innovation more generally. But beyond this the framework of demand and supply side constraints pinpoint the areas of investment or remedial measures. Easing barriers on the demand and supply side will raise not just inclusive innovation but innovation in the wider economy as whole.

The remainder of the paper is organised in the following way: Section 2 reviews the existing literature and introduces the reader to the conceptual framework we develop. Section 3 describes the collation and selection of cases while Section 4 discusses the findings of our analysis when we apply by our conceptual framework to our database of inclusive innovation cases. We conclude with a discussion of the implications of our study and potential directions that research on the inclusive innovation may focus upon in the future.

2. Literature Review and Background

Developed economies have long been a beneficiary of the virtuous cycle of industrial growth, technological prosperity and enhanced quality of living. On the other hand,

developing countries have lagged behind in technological progress and the virtuous cycle has never completely taken off. In a prescient paper, Rosenberg (1963) drew attention to the double-bind that many developing countries face that makes indigenous technological development very hard and a virtuous cycle well-nigh impossible. Not only did developing countries lack a technology goods producing sector (like machinery) thus creating supply-side constraints, but even if state policy established such a sector, Rosenberg pointed out that most developing economies of that time did not possess a diversified industrial base that could provide a local demand for improvements in machine technology. The demand for technology was a derived demand from the demand for products but poverty meant that such a broad based demand was small to start with. This double bind of supply and demand constraints existing simultaneously made Rosenberg pessimistic about the potential for polices focussed on building machinery sectors alone ever succeeding.

The last two decades have seen the emergence of new economic powerhouses, such as China and India, and witnessed fast paced growth in Sub-Saharan Africa. These countries have acquired a broad based industrial sector and even boast of several firms that produce world class technological products. Despite this impressive growth, their economies exhibit a disturbing duality between the industrially developed regions and the agriculture dependent poor regions (Seven and Coskun, 2015; Daniels, 1999). Indeed most of the world's poor, as defined by the UN Millennium Development Goals, continue to exist in these same countries (UN, 2014). While urban and rich populations have access to the latest technological products and health services, rural areas and low income households live without several of the advances that are taken for granted among urban dwellers (Karnani, 2007). In a sort of inversion of the old problem identified by Rosenberg, a well-spring of demand for technological products exists and governments and multilateral agencies are willing to subsidise this demand to increase uptake, but a corresponding supply of technology products for the poor is not forthcoming.

Prahalad and Hart (2002) first proposed the idea that there is a fortune at the bottom of the pyramid, in the 4,000 million poor consumers that earned less than $1,500 per annum and saw a key role for technology in enabling such growth. In their words:

> *"The emergence of the 4 billion people who make up the Tier 4 market is a great opportunity for MNCs. It also represents a chance for business, government, and civil society to join together in a common cause. Indeed, we believe that pursuing strategies for the bottom of the pyramid dissolves the conflict between proponents of free trade and global capitalism on one hand, and environmental and social sustainability on the other…. The bottom of the pyramid is waiting for high-tech businesses such as financial services, cellular telecommunications, and low-end computers. In fact, for many emerging disruptive technologies (e.g., fuel cells, photovoltaics, satellite-based telecommunications, biotechnology, thin-film microelectronics, and nanotechnology), the bottom of the pyramid may prove to be the most attractive early market".* [1]

[1] Prahalad and Hart (2002) : page 67.

This well-intentioned call to arms, addressed mainly to MNEs operating in emerging markets who owned some of the most advanced technologies, argued that it is market access, entrepreneurship and limited managerial visions which have held back the poor from being able to benefit from innovation that had already enriched the lives of the higher income populations (Prahalad et.al., 2012). An unintended consequence of the persuasiveness of their argument was that many governments withdrew investment from the very public sector research centres that had been set up in the 1950s to innovate for the poor.[2] Policy focus shifted completely towards entrepreneurial private actors in taking up the mantle of delivering the benefits of technology to the marginalized sections of the society, UNESCO (2015) estimates that similar effort from the public sector research now accounts for only about 4-6% of the overall expenditure on R&D in middle income technology leaders such as China and India.

Despite this widespread shift in locating the agency of inclusive innovation activities, very little attention focussed on the barriers that successful commercialisation of innovations targeted at poor markets may face, nor was attention focussed on the question of why it is that in inclusive innovation happens so infrequently even though such innovations potentially have a huge market? In this paper, following Rosenberg (1963), we identify the (supply side) technology access and (demand side) market access constraints to inclusive innovation, and propose a framework that incorporates both.[3] In the following Section we will use this framework to analyse known cases of inclusive innovation to understand which constraints are dominant and how managerial practices have responded to alleviate those constraints.

2.1 Innovations for the poor

Innovation studies have primarily focussed on the role played by the private sector in enhancement and adoption of technology, and its overall economic impact in the form of increasing productivity and profitability. However, innovation examined from the point of view of "major breakthroughs" (MRI, antibiotics, cancer drugs, nano-technology, microelectronics, the Internet etc.) reveals the complex inter-relationships between various stakeholders involved in the innovation process, and unexpected social welfare implications on those sections of the society, on whom the impact of such innovations are often not directly relevant (Hall et.al., 2012; ; Rivera-Santos and Rufin, 2010; Sinha, 2006). The gradual realisation of the skewed view of innovation, based solely on the point of view of producers, has resulted in the examination of innovation with a bottom-up view (Smith et.al., 2013; von Hippel, 2007), often studying it with a "systems" lens, incorporating the

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[2] This has only been exacerbated by intervening economic and financial crises and corresponding policy response of withdrawal of public funds from research (Becker, 2015).

[3] Although technology access is often associated with technology push policies and market access is associated with demand pull polices, we do not delve deeper into the policy implications of our study as to do so would go beyond the scope of this paper.

whole ecosystem within which the innovation is financed, produced, marketed and consumed (Sonne, 2012).

It is also being recognised that pro-poor innovations may not require large capital intensive and expensive platforms to have a positive impact on the poor, but such outcomes are also possible in low resource basic environments, using cheap raw materials easily obtainable and drawing on traditional knowledge (Gulati, 2010; Rao, 2013; Radjou and Prabhu, 2014). Termed as "frugal innovation" or "grassroots innovation", the phenomenon is often seen to be extremely relevant for the developing economy context (Rao, 2011; Zeschky et.al., 2014), given the scarcity of resources, underdeveloped infrastructure and low access to high end technology. As Kapinsky (2011) points out these trends and arguments echo earlier debates on appropriate technology and intermediate technology. However, the ability of frugal innovation alone to tackle poverty has been questioned, and evidence points towards both positive and negative impact of the former on the latter (Knorringa et.al., 2016).

Inclusive innovation is a broader idea, which includes frugal innovation, as well as the private, public and third sector initiatives, and conceptually links more explicitly to welfare of the poor. Dutz (2007) promotes the idea of inclusive innovation as "knowledge creation and absorption efforts that are most relevant to the needs of the poor". This is consistent with a discussion about the role of entrepreneurship, private capital and the not-for-profit sector in its creation and delivery – a discourse that has largely been driven by the new opportunities in the "Bottom of the Pyramid" (BoP) market for private firms, and how these opportunities can lead to "win-win" innovations benefitting both the poor (to whom they are targeted) and the firm which develops it (Prahalad, 2010; Prahalad et.al., 2012).

While there is no doubt that in many cases, involvement of private capital has indeed resulted in benefits for the poor, the shift in policy focus which saw a withdrawal of public sector effort and the exclusive reliance on market forces, has also garnered some severe criticism (Ansari et.al., 2012; Karamchandani, et.al., 2011; Karnani, 2007). Many have questioned the very assumptions of the private sector led BoP model, such as whether the model is sustainable beyond the short term, or whether such activities create adverse incentives instead of solving genuine problems of the poor (Banerjee and Duflo, 2007; Ansari et.al., 2012; Hall et.al., 2012). Another area of criticism is that an overt dependence on corporate entities for poverty reduction ignores the complex interactions that form the basis of poor societies, the power relations between various stakeholders and the local vulnerabilities faced by poor populations (Arora and Romijn, 2012; Chatterjee, 2014; Sama and Casselman, 2013). Finally, it skews focus of state policy away from strengthening of regulatory and social mechanisms, infrastructure development and employment generation, resulting in long term adverse welfare implications for the poor (Karnani, 2011).

In parallel, there was a shift in the discourse, from the private capital led poverty alleviation, to a more collaborative bottom-up approach involving co-creation and opportunity exploitation by the poor rather than being passive consumers (Simanis and Hart, 2009; Simanis et.al., 2008). This view of inclusivity and poverty alleviation is based on the communities directly involved with learning and capacity building, with the help of locally embedded intermediaries such as NGOs, civil society organizations, universities and government agencies, who may also act as intermediaries between corporate entities and the poor (Hart and Sharma, 2004; Sen, 1999; Arora and Romijn, 2012; Grobbelaar et.al., 2017).

Consequently, researchers and policy makers are increasingly examining bottom up approaches to innovation involving local actors (businesses and consumers), the state and corporates, coming together to deliver welfare enhancing opportunities to the marginal sections of the society (George et.al., 2012). In the process, the term "innovation" is now used to refer to products, processes, business models, supply chains – encompassing all aspects of entrepreneurial and policy initiatives. It is also being realised that there is no single over-arching model of innovation which can address the needs of the poor, but one needs to examine a whole range of feasible models – including but not limited to, grassroots and frugal innovation (Knorrina et.al., 2014), user led innovation (von Hippel, 2007), innovation platforms (Swaans et.al., 2014) and many more, each serving a different purpose and suitable for a different contexts.

It is clear is that a holistic approach to research on inclusive innovation is required, which takes stock of both the complementarities and trade-offs between roles of state and private actors in harnessing technology for poverty alleviation (Chataway et.al., 2014) but is also designed to avert failures of four types viz. Development of innovations for BoP, designof innovations for BoP, diffusion of innovations for BoP and use of innovations by BoP (Foster and Heeks 2015). We broadly agree with these suggestions but also believe that in order to formulate sensible policy, one should first examine the extent to which these innovations face barriers to commercialisation from both demand (market) and supply (technology) sides of the market. The nature of the barrier and the stringency of the barrier will have a profound effect on the agency of innovation.

2.2 Market access for inclusive innovation

Ramani et.al. (2012) emphasize that the market for pro-poor innovations has several demand side characteristics that are distinctive: first, consumers have a limited ability to pay and a limited access to finance with which to overcome their inability to pay (Banerjee and Duflo, 2007; Khavul and Bruton, 2012); second, consumers may not be aware of available technological solutions which help alleviate a particular problem they face (Jamie, 2007); third, the market has missing or under developed delivery mechanisms such as lack of dedicated suppliers and networks, sometimes also physical infrastructure like roads and railways for vehicular traffic and telecommunications networks (Ramani et.al.,

2012); and fourth, such markets may be very heterogeneous and finding efficient scales of production could pose a challenge (Seelos and Mair, 2007). Singly and together, these characteristics can lead to a breakdown of the market mechanism which connects the demand and supply sides of the market.

Many issues to do with perceived value versus price paid can be addressed through business model innovations that change the value proposition for the consumer to appeal to poorer market segments. Local retailers and (for health, education and energy products) locally based civil society organisations, could also be incentivised through appropriate commissions to take the product into the rural hinterland and educate the end consumer about the product benefits and use. Shampoo sachets (from CavinKare and Unilever), the Shakti initiative (Unilever), and P&G's Pur water endeavours attempt to do exactly this (Karnani, 2007).

An underdeveloped distribution mechanism can also be addressed through carefully chosen partnerships with organisations operating in rural areas such as non-governmental organisations. In many emerging economies mobile phone networks have become the new distribution channels for a variety of products. For long term advantage, some deeper commitment to the establishment of distribution channels is necessary but such investment is infrequent from private firms. Apart from adding to the costs of reaching final consumers, underinvestment in distribution channels can mean the absence of two-way communication between user needs and product design which has led to product or service offerings which really do not address the primary motive of being useful to poor populations. Thus, scholars have found a profound mismatch between what is offered as innovation for the poor and what the poor actually need (Karnani, 2007; Landrum, 2007). Manibog (1984) found that low cost efficient cook stoves failed to be adopted widely in Asia because it could not attain the high temperatures required for Asian cooking. Ramani et al (2012) found that for toilets to be perceived as valuable in rural areas there needed to be behavioural change in the population that made villages look down upon traditional practices of open defaecation.

Even when the product introduced was suitable, the management literature has also pointed to many cases where market led introduction of the pro-poor innovations led to losses and eventual withdrawal by the provider – for example, Phillips health care and stove projects, Nike World Shoe project and P&G's Pur water sachets. The reasons for the lack of success ranged from lack of profitability, to lack of basic marketing infrastructure in these markets which hinders an increase in the rate of market penetration (Simanis, 2012).

Successful innovations like Chotukool show us the way. Rejecting standard models of distribution, Godrej & Boyce worked with India Post to deploy the Chotukool to target communities. *"The India Post network is very well spread in India and is about three or four times larger than the best logistic suppliers. We used the logic of people communicating with each other, a kind of word-of-mouth diffusion which is very slow but the best way to reach out because each*

region and each community in India is different and you need to tailor communications to people's needs." [4]

Although partnerships offer a way out for many firms, the first best response to such market failures is probably intervention by the state to build the infrastructure of roads and railways that integrates these fragmented markets with big towns and cities. While the current literature largely focusses on the intermediaries and their co-creating role in the development of innovations benefitting the poor (Hargreaves et.al., 2013), there is very little attention on how the government and allied organizations can catalyse and facilitate the co-creation process (Goyal et.al., 2015). This can be done through the provision of key public goods that are necessary catalysts in the inclusive innovation process – such as, ICT facilities, connectivity and transportation from urban to rural areas, dedicated information dissemination services to the rural poor, or in other words invest in the underlying marketing infrastructure.

The issue of market access is even more acute for goods and services which are consumed collectively. Examples of such goods of *collective consumption* would include sanitation, clean energy, education, and health. In these sectors, consumption requires other individuals to participate to be effective but at the same time also depends on complementary investments. For example, investing in clean energy without also addressing overall energy consumption requirements, defeats the purpose of such investments. What can a poor farmer do with one solar lamp that runs for a couple of hours? A meaningful difference to his livelihood lies in a power supply of at least twelve hours that extend the working day and help her commercialise her artisanal skills to diversify sources of income. However, the constraint to solar lamps running for longer number of hours may lie in the shortcomings of battery storage technology or electricity grid networks, which probably needs R&D support from universities and public sector research organisations and investments in the electricity infrastructure network. Similarly, to take another example, the sale of toilets will not change health outcomes for the poor without access to doctors, hospitals and clearly defined protocols for patient care. It is difficult to see a private sector firm or NGO taking charge of organising the whole system of care and it is questionable whether they should undertake these activities with an eye on profitability alone.

In both the case of solar lamps and healthcare, the presence of externalities, where the private benefits of developing and marketing the innovation fall short of social benefits, lead to underinvestment (in battery technology) or adverse incentives (treating only the already healthy) for private players. These examples of collective consumption point towards a classic case of market failure, with the needs of the poor being met only by innovations too expensive to afford, or not at all. Thus, there exist significant barriers to

[4] Gopalan Sunderraman, Executive Vice President of Godrej & Boyce Manufacturing, India as quoted in WIPO (2013).

market introduction of radical inclusive innovations, which neither the private sector nor the not-for-profit sector can tackle by themselves.

In the case of goods for collective consumption, success stories come from the Gates Foundation and the Global Alliance for Vaccination and Immunisation (GAVI) who have provided the basic support in provision of vaccines. In order to provide a ready supply of vaccines to poor countries, GAVI asked producers to bid for Advanced Market Commitments, for a contract period of ten years. This was an incentive designed to stimulate development of pro-poor vaccines when there was a situation of market risk. (Kremer and Grennerster, 2004). Distribution of the vaccines was undertaken by GAVI through public sector delivery systems in each country. Apart from the use of procurement mechanism, some social enterprises and NGOs (micro credit organisation) have used interlinked markets - particular credit markets to finance the collective investments in innovations that benefit the community. For example, the social enterprise FINISH Society aims to create awareness of sanitation as an innovation by working with NGOs on behaviour change and partners with insurance companies to offer collective insurance premiums at a discount when the village invests in sanitation. A Dutch NGO, WASTE provides the technologically adapted toilets.

These examples provide models of what catalysing interventions could look like when consumption externalities may deter the adoption of inclusive innovations. While still small in number, the above examples illustrate possible ways forward, particularly through collaborative models, of bridging the market access gap for inclusive innovations. As we shall see below, the challenge posed by the technology access gap is far more serious.

2.3 Inclusive innovations and the access to technology

Access to technology may also may hinder the supply of inclusive innovations. To assume that the presence of technologically able firms will ensure there are no problems of technology access is far too facile. Technology development and upgradation with use have underpinned most forms of innovation, irrespective of the target market. This is true for the innovations aimed at poorer sections of the society as well, although the nature of the base technology and the upgrade process might be substantially different. In considering technology access we need to examine a number of scenarios – (a) where technologies that can help the poor exist and needs adaptation to the local context (high adaptation costs) (b) where such technologies need to be developed anew due to low maturity levels of the base technology (high cost of technology access); (c) the support infrastructure for technology access and adaptation is weak (such as weak IP) and (d) the technology needs to be supplied by specialists not available locally. We now discuss these scenarios in detail.

Where a technology that can be adapted for inclusive innovations exists, a gap may still exist between the technology that is available and the adaptation that is required in the

local context of the poorer population being considered (Schuster and Holtbrügge, 2014). The story of how Chotukool was developed as a refrigeration product provides important insights about this issue. Navroze Godrej, director of special projects, has been cited as saying,

> *"We imagined we would be making a shrunken down version of a refrigerator. Make it smaller, make it cheaper. And we had preconceived notions of how to build a brand that resonated with these users through big promotions and fancy ad campaigns… we realized our original hypothesis was quite wrong. We knew we couldn't just repackage and reconfigure an existing refrigerator and just pass that off".* [5]

As they talked to customers they realized that women managing households in rural India faced diverse challenges: as they could not store food, they were used to buying and preparing food every day; most potential customers had intermittent power (which ruled out a standard refrigerator) and lastly if the refrigerator broke down, the cost of repair would likely be prohibitive, because there were few local repair shops or servicers in rural areas. Thus, Chotukool ended up utilising battery technology rather than compression technology to power a cooling ice-box rather than a large cupboard of food. Future versions of Chotukool hope to improve battery power by relying on in-licensed battery technology.

The concerns encountered by Godrej Boyce are likely to apply to a number of consumer durable products. Design capabilities and in-house R&D for product development in domestic firms are necessary for such initiatives to succeed. Equally important is a deep understanding of local use, which is often synonymous with local capacity building and interactions with local actors (Schuster and Holtbrügge, 2014). Thus, although inclusive innovation and BoP markets were strategy concepts that emerged in the global strategy literature, it is likely that larger domestic firms would also start to operate within this domain.

An interesting aspect of inclusive innovation noted by many scholars is that the gap between the existing technology and the product adaptations required to commercialise them by sale to rural households may be navigated either by specialists within the original product domain or by intermediaries with local knowledge who have the capacity to develop it further (Foster and Heeks, 2013; Hughes and Lonie, 2007). Thus, the overall innovation process involving technology development and diffusion is different in the context of the poor than that of the counterpart in the wealthier markets and a large part of this difference lies in the nature of user-led innovation. Users can be extremely important in driving technology adaptation to local needs and circumstances, as they are equal participants in the technology adaptation and diffusion process. These user innovators may range from informal sector workers (Nichter and Golmark, 2009) to lead users participating in the innovation process (Heeks et.al., 2014). Another aspect of technology based inclusive innovation are the localised intermediaries who are also

[5] Navroze Godrej as cited in Forbes (2015).

innovators themselves, who help to adapt external innovations to the local context (Foster and Heeks, 2013), and this is quite different from the traditional brokerage role played by innovation intermediaries (Howells, 2006).

Additionally, the technology gap—between what is available and what needs to be modified—may be relatively large or small, depending on the degree of mismatch between demand and supply. Small gaps represent low hanging fruit. As the degree of adaptation grows and requires more R&D effort, market failures due to inadequate protection of the innovation or due to free-riding on early innovation efforts can make R&D investments in technology adaptation for inclusive innovation a far more difficult proposition, than innovation for general markets with wealthier users of the innovation. Firms like Godrej which have undertaken such innovation, also seek to secure their market share by active investment in complementary assets such as after sales service provision and by using their IP rights.[6] The importance of IP protection may seem counterintuitive as so much of the discussion on affordable health seems to argue for weaker IP rights. Yet, adaptive R&D required to make innovations suitable for poor markets can only be protected from imitative competition by providing stronger IP rights to firms. Any policy initiative that subsidises the cost of R&D for inclusive innovation will also encourage the supply of technology products more adapted to the needs of poor markets (Sinha, 2006).

For more radical innovations, which require bespoke R&D targeted to poor markets, both funding commitments and market risk are very high. Utz and Dahlman (2007) argue that India's "green revolution" initiative in the 1960s offers some lessons on the nature of effort that maybe be involved for truly radical inclusive innovations especially where the technological good involved is relatively standardised. This public sector driven initiative introduced hybrid seed technology together with access to fertilisers and pesticides to farmers in order to increase agricultural productivity in a major initiative to boost agricultural productivity and output (Parayil, 1992). Across India, agricultural research stations were set up to closely monitor the adaptations need to the hybrid strains of seeds and make them thrive in local farming conditions. Many seed scientists were employed to conduct thousands of trials of hybrid seeds in different climatic conditions to find the strain that would work for any particular soil-climatic condition. At the same time, agricultural education programs were rolled out to change farming methods. As fertiliser and pesticide effectiveness were very sensitive to irrigation – farmers had to be taught to irrigate e and invest in irrigation rather than wait for rainfall. In modern parlance, thousands of dollars were spent on education to affect behaviour change. Lastly, the government introduced procurement programs to create a ready market for the new grain and to stabilise prices.

No modern technology in health or renewable energy has seen a similar effort from national governments although several multilateral initiatives have filled this space by promoting the pooling of technology by producers to stimulate supply of innovations to poor markets through licensing. The GAVI alliance (Kremer and Grennerster, 2004), the

[6] See WIPO (2013) where Mr. Sunderraman stresses the importance of IP.

UN-backed Medicines Patent Pool have used patent pooling to effectively transfer technology for inclusive innovation for payment of licensing fee. Clean and green energy technologies have been inspired by the open source movement to make basic technology available on license but to have a right to know about subsequent applications--initiatives of this type include the EcoPatent Commons, GreenXchange and the Canada's Oil Sands Alliance (COSIA). Tesla announced that it too would open up its patent portfolio and join the open source movement in 2014. Awad (2015) analyses the legal implications of these types of patent pledges, all of which involve complex licensing and ownership models, but they constitute an important avenue for access to radical technology to stimulate innovation for poor markets.

Lastly, social enterprises have been able to harness traditional knowledge in the search for inclusive innovation. Fressoli et al (2016) cite the Honey Bee Network (HBN) in India and the Social Technologies network in Brazil as examples of such attempts. The HBN emerged in 1989 among a group of scientists, farmers, academics and others interested in documenting and disseminating traditional knowledge and local innovation in local languages. The network's main activity is the scouting and documentation of innovations and traditional knowledge based on different actions such as visiting communities, interviews, awards and competitions. Sonne (2012) notes that the second step is related to the exploration of the commercial potential of products and processes identified during scouting. This involves supporting local grassroots innovators in the process of patenting, but also offering further assistance in terms of prototyping, incubation and seed funding in order to assure commercial viability. In contrast the STN emerged in Brazil in the early 2000s and involved a range of participants, from academics to activists, unions, government representatives, funding agencies, and, especially, NGOs and community groups. It was a mixture of grassroots and mainstream Science and Technology Institutions. Individual innovations were scaled up using loans and supporting resources from public sector player with empowerment and social justice as their important aims.

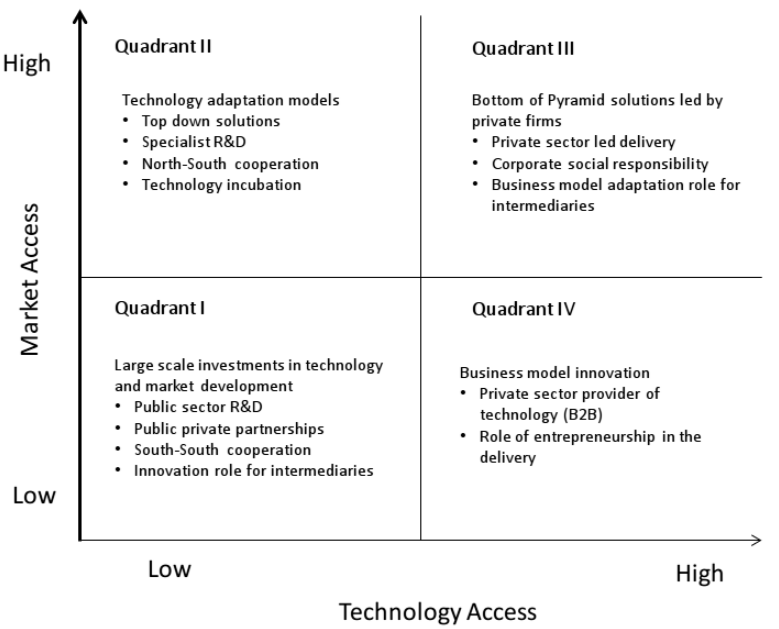
Although in principle, grassroots innovation are the best suited to tackle global problems because they use pre-existing knowledge, they face the twin problems of accessing scattered knowledge and lack of good IP mechanisms that can encourage the sharing of it. Utz and Dahlman (2007) argue that innovative forms of IP to protect traditional knowledge should be considered based on compensation and licensing fee for the use of traditional knowledge, rather than enforce IP by establishing individual ownership. This would draw out traditional knowledge (for example in medicine and farming methods). Thus moving from the private firm to the social enterprise, access to technological knowledge is difficult and using it to solve local problems needs special institutional arrangements that can incentivise the supply of appropriate technological products.[7]

[7] This is not a problem that is limited to developing nations – developed economies also encounter similar problems in serving their relatively poorer markets (Mazzucato, 2016).

2.4 A conceptual framework for thinking about inclusive innovation

The discussions above identified two key issues which relevant pro-poor innovations need to address – namely, bridging the market access and the technology access gaps. Depending on the local contextual problems facing the target population and the level of technological development necessary to address these, one has to design a suitable adaptation of the available technology, the right delivery mechanisms to enable the innovation to reach the poor, and the correct incentive mechanisms for both supply and demand side stakeholders for adoption to happen in a sustainable manner. Not all pro-poor innovations have addressed or needed to address all these issues related to bridging the market and technology access gaps. In this paper, we develop a conceptual framework which helps to position a pro-poor innovation based on the extent to which these twin gaps have been bridged. Thinking along these two dimensions naturally provides four alternative scenarios under which a potential inclusive innovation may be classified, which have been represented as the Quadrants I – IV in Figure 1.

Figure 1: Conceptual Framework



The first of these is represented in Quadrant I, which is representative of a situation where both market access as well as technology access is low, as a consequence of which, the relevant pro-poor innovation have to be able to bridge both these gaps. This represents situations where large investments are needed in both developing the technology for the needs of the poor as well as for building the market through which it can be delivered. We believe that the role of public sector R&D are key in such situations, or at the very least, or at the very least, private sector can develop the base technology, which can then be adapted

and delivered via local government backed intermediaries and partners, who are innovators themselves. Typical examples lie in the health sector, particularly in the development of drugs, vaccines etc. for the developing world.

Quadrant II is representative of the situation where significant investment in technology adaptation is still required for the inclusive innovation to flourish, but the level of market access is high thus providing easier access for the provider to ultimate consumers. In such cases, the new technology may be incubated in private or public laboratories, universities etc., and the delivery may be led by provider itself. North-South cooperative ventures may also be appropriate in such situations, as it is primarily a technology push that is necessary.

Innovations which require a small to moderate improvement in the technology to suit the target market, but for which a market is already relatively well developed and accessible through partnerships may be categorised in Quadrant III. This is representative of situations which could be addressed by the many Corporate Social Responsibility (CSR) driven initiatives in the private sector targeted to the BoP market segments. The projects addressed in Prahalad (2005; 2007) are typical under this scenario.

Finally, Quadrant IV is representative of the situation where technology access is high but market access is low – which is typically seen very often in developing economy contexts. These are situations where the roles of the business model and the delivery mechanism become very important. The delivery may be through existing or newly developed channels and intermediaries, but can also be carried out by entrepreneurial ventures with knowledge of the local context and need.

In the absence of significant public R&D targeting low technology access (Quadrant I and II), domestic firms and social enterprises may resort to partnerships to obtain the complementary resources in the form of agreements for product designs, new technology, key intermediate inputs or finance to undertake the required technology adaptations. These partnerships could be with other firms, international charities and multilateral agencies. Similarly, firms in Quadrant 1 and Quadrant IV, where low market access dominates may also invest in partnerships with rural organisations that increase their market reach. Two common forms of such partnerships rely on NGO networks of distribution within rural areas and mobile phone operators.

3. Mapping known cases of inclusive innovation

Armed with the conceptual framework developed in the previous section, we aim to map known cases of inclusive innovation in order to understand the agency and also the systematic effect of market access and technology access barriers. Potential cases of inclusive innovation were first identified, each case critically examined, and then classified into Quadrants I, II, III or IV or as a pure business innovation, based on our understanding of the source of the underlying market/technology access barriers encountered by the innovation and its context. For each case, the authors independently studied the history

and context of the innovation and came up with a classification. These were then compared for mismatched classifications, and for those cases where mismatches arose, the authors attempted to gather additional data on the context and reclassify them. The process was repeated till a mutually satisfactory fully classified sample was obtained. A full comprehensive list of cases of inclusive innovation, their descriptions, and associated classification schemes are attached in the Appendix.

3.1 Assembling the inventory of inclusive innovation cases

The inclusive innovation cases were obtained primarily from reviewing the following four major sources:

a) A comprehensive study was carried out by the Monitor Group (now Monitor Deloitte) on "market based solutions" in emerging economies, which were then reported in *Emerging Markets, Emerging Models* (Karamchandani, Kubzansky and Frandano, 2009).[8] A comprehensive study of various pro-poor innovation models were carried out as part of this study, which provided us with a number of cases to examine as part of our study. Additional secondary sources were then utilized to explore these cases further.

b) The Innovation and Inclusive Development Discussion Report (OECD, 2013)[9] is a study of various factors which lead to or hinder innovations from impacting economic development positively. This report discusses a number of policy relevant themes, including productivity gaps and role of technology, which may impact development of low and middle-income groups around the world through grass roots innovation. Once again, a number of cases were discussed, which formed the basis of our investigation as well.

c) A study focussing on sub-Saharan Africa, under the aegis of UNDP's African Facility for Inclusive Markets (UNDP, 2013)[10], presents 43 in-depth cases of enterprise development in the region. The study focussed on inclusive business models and the challenges and constraints they face in achieving their full potential. This report also provided a very good basis for exploring individual cases for the taxonomy presented here.

d) The website of Acumen, a not-for-profit organization (http://acumen.org/investments/) investing in entrepreneurial ventures across the globe which aim to alleviate poverty. According to their website, Acumen aims to "invest in companies whose products and services enable the poor to transform their lives". They work across sectors in agriculture, education, energy, health, housing and water and sanitation. Once again, a number of cases were identified

[8] The full report can be found at: https://s3.amazonaws.com/PfP/Monitor_Emerging+Markets_Full+Report.pdf

[9] The full report can be found at: https://www.oecd.org/sti/inno/oecd-inclusive-innovation.pdf

[10] The full report can be found at: http://www.enterprise-development.org/wp-content/uploads/UNDP_AFIM_Realizing_Africas_Wealth.pdf

from the promotional material available at the website, which were then followed up from other secondary sources.

In addition to the above sources, some inclusive innovation cases were obtained from using various search phases such as "inclusive innovation", "frugal innovation", and "innovation for poor" in web based search engines.

Like all studies that rely on published cases, our sample has a bias towards successful cases which have survived. Thus, we can provide no information about failed cases or cases that represented better inclusive innovation solutions but failed nevertheless.

3.2 Criteria for the selection of cases

In all we found 123 cases of potential inclusive innovation, based on the sources detailed above. Of these, we found that 58 cases could be classified as a truly inclusive innovation as they involved some degree of technology adaptation for the local context, while the remaining 65 were primarily business model innovations without a technology adaptation and research aspect. If the case involved development of new technology (however incremental) or adaptation of existing technology suited to a particular context, while going through distinct phases of research and development (however informal), they were classified as inclusive innovation.

On the other hand, if the case only involved creation, re-definition or re-calibration of existing stakeholder relationships to facilitate technology diffusion or market access or solving informational asymmetries in a market, they were classified as business innovation and not included in our anlaysis. As an example, if mobile phone technology was used to provide a new service to rural farmers which involved either access to new information or finance, the classification was based on what the value addition was on the underlying technology.

The case of the well-known M-Pesa in Kenya (Hughes and Lonie, 2007), which is used to provide low cost banking and financial services to the rural poor, was classified as an inclusive innovation, as it involved the development of a mobile technology platform using basic SMS and SIM-card technology, with which money could be transferred between users securely. On the other hand, the development of the mCent Browser[11] is classified as a business model innovation, as it involved using existing freely available browser technology to connect to advertisers, which in turn financed and enabled the provision of free mobile internet access to customers with low ability to pay. This service did and continues to involve development on existing browser technology, but the technology itself did not undergo an upgradation from its existing state, and hence it was classified as a business model innovation.

It is important to note that we did not explore cases of innovation and new technology, which *ultimately* led to benefits for the poor and marginalised populations, without being

[11] http://www.jana.com/home

directly invented with the aim of helping these sections. All major inventions have had some positive impact on the poor, whether it is the Internet, Bio fuels, the MRI and other diagnostic instruments, or key medicinal breakthroughs or any other. Inclusive innovation in our view, is the successful commercialisation of inventions *directly* aimed at alleviating poverty and raising standards of living of the poor populations.

In Table 1 we provide a summary of the 58 cases we analysed while Table 2 provides the same for excluded cases which were categorised as business model innovation. Tables A1(or included cases) and A2 (for excluded cases) in the Appendix provide the full list of cases, brief descriptions, and the associated websites we used for gathering more information. The inclusive innovation cases we analyzed were located across the globe, with majority of them geographically originating in South Asia (54%) and/or Africa (44%). This is not surprising given that more than 40% of the world's poor is concentrated in these two regions and requires the largest volume of intervention by state and non-state actors for poverty alleviation.[12]

Table 1: Cases categorized as inclusive innovation by sector

Sectors	*Some examples*	*Numbers*	*Percent*
Energy and energy solutions	Grameen Shakti (Bangladesh), M-Kopa solar, Nuru energy, Sunny people, Nest, Aishwarya solar lantern, Bio gas milk chiller, Chhotukool	27	46.5
Health (medicine)	BASF SAFO (Vitamin A fortification), Aravinda eye care, Jaipur foot	7	12.1
Health (clean water)	Tata swatch water purifier, Byrraju community water, Bio sand water filter	6	10.3
Health (sanitation)	Banapads, Ecotat, Sulabh Sauchalaya	3	5.1
Agriculture (Farming)	Treadle water pump, Farmer hopes, Money maker pump	3	5.1
Finance and Insurance	M-PESA, INOVA, Allianz and care international, Finger print enabled ATM	4	6.9
Information and Communication Technology (ICT)	Akash, Nokia easy sharing, Motophone, Inova, Essoko, Freeplay lifeline radio	6	10.3
Automobile	Tata Nano	1	1.8
Housing	Moladi	1	1.8
Total	-	58	

[12] See the World Bank report "Poverty and Shared Prosperity 2016: Taking on Inequality" (http://www.worldbank.org/en/publication/poverty-and-shared-prosperity).

Table 2: Cases not categorized as inclusive innovation by sector

Reasons for exclusion	*Examples*	*Numbers*	*Percent*
Purely business model (Health sector)	Narayan health, Life spring hospital,	11	16.9
Information providers to farmers	E-Choupal, Fisher friend,	24	36.9
Education or awareness services providers	Gyansala, TIME	11	16.9
Internet or telephone service providers	Bharati air tel, Jana, Comat	5	7.7
Purely financial service providers	Grameen bank, SKS finance	5	7.7
Socio-economic development projects	Ambuja cement foundation, Spandana foundation	4	6.2
Employment agencies or promoters	Team lease, Guangsha construction	3	4.6
Others	Manila water company, BSF grameen	2	3.1
Total		65	

3.3 Classification into quadrants of Figure 1

Once a case was identified as one of inclusive innovation, we used a collection of secondary data sources (such as websites, blogs, news articles) on and by the organizations that had introduced the particular innovation, in order to assess the degree of market access and technology access gaps bridged by the innovation.

Market access was evaluated from the perspective of the target customer, who were likely to be poor and belonging to the deprived sections of the society. Availability, affordability, scalability and awareness were the main criteria used for assessing market access. In particular, we considered the following questions in order to evaluate market access constraints faced by an innovation.

a. Was the target customers' ability to pay for the base technology too low (if the innovation had not been introduced)?
b. Was the target customer unaware about the need for the particular innovation which could help them solve a particular problem they were facing?
c. Was the market for the innovation otherwise characterized by missing infrastructure used for distribution and supply of the technology?
d. d. Did there exist barriers to scaling up in the production and distribution of the technology, making it cost ineffective to supply it to the target population (prior to the innovation being introduced)?

If the answer was a "Yes" in two or more of the above questions, we considered the market access of the innovation to be LOW (Quadrants I and IV), or in other

words, the market gap that was bridged by the innovation to be high. In all other cases, the market access was considered to be HIGH.

Technology access was evaluated from the perspective of the producer or the innovator. Adaptation costs, access costs, support infrastructure and need for external sources were the main criteria we considered to evaluate technology access. In particular, the following questions were considered in evaluating the technology access barrier faced by an innovation:

e. Did the technology require a high degree of adaptation, as reflected in high adaptation costs, in order to be useful for the target customer?
f. Was the underlying technology not matured, making it difficult for adoption outside controlled conditions?
g. Was the innovation developed in an environment where key technology infrastructure weak or missing?
h. Was the innovation developed with the help of an external specialist organization, such as a foreign technology specialist or university?

Once again, if the answer was a "Yes" in two or more of the above questions, we considered the technology access of the innovation to be LOW (Quadrants I and II), or in other words, the technology gap that was bridged by the innovation to be high. In all other cases, the technology access was considered to be HIGH.

We present the findings of the above classification exercise in the Appendix, along with the relevant answers to the above questions, for every one of the 58 cases of inclusive innovation. Note that given the nature of the secondary data sources used, there was a subjective element in the answers obtained to the above questions, but which were validated by the authors by their mutual independent responses, as discussed above.

4. Findings

The results of the classification exercise are presented in Tables 3, 4, 5 and 6. Table 3 shows the breakup of the cases in the four quadrants, and we see that majority of the cases (37 out of 58 or 64%) of inclusive innovation included in our sample belong in Quadrant IV, characterized by low market access and high technology access. The cluster with the next highest number of cases is Quadrant 1, characterized by low market access and low technology access (17 out of 58, 29%). Thus 54 out of 58 cases in the sample (93%) are innovations low market access, and surprisingly, only 4 out of the 58 cases fall in Quadrant 3 and none in Quadrant 2, both of which are characterized by high market access. When we look only at the cases originating in India (20 of 58 or 34%), we find a broadly similar picture. The majority of cases are characterized by high technology access (13 of 20 cases). Although there are proportionately more cases in quadrant 1 (7 of 20), when compared to Table 3a, this difference is unlikely to be statistically significant because of the very small numbers.

Table 3a: Break up of cases (N=58) within our taxonomy based on type of organization

	Low Technology Access	*High Technology Access*	*Total*
Low Market Access	Quadrant I: 17 (29%)	Quadrant IV: 37 (64%)	54
High Market Access	Quadrant II: 0	Quadrant III: 4 (7%)	4
Total	17	41	58

Table 3b: Break up of cases originating in India (N=20) within our taxonomy based on type of organization

	Low Technology Access	*High Technology Access*	*Total*
Low Market Access	Quadrant I: 7 (35%)	Quadrant IV: 12 (60)	19
High Market Access	Quadrant II: 0	Quadrant III: 1 (5%)	1
Total	7	13	20

4.1 Agency: who innovates for the poor?

Table 4a provides the break-up of the 58 cases of inclusive innovation not only based on the taxonomy proposed, but also on the type of the organization(s) involved in delivering it to the target population, and the nature of *major* partnerships they form in delivering the innovation to the target population.[13] The typology of organizations being considered were: (a) private domestic firms (b) MNEs (c) NGOs (domestic and international) (d) organizations *labelling themselves* as social enterprises (either for profit or not for profit) and (e) charities. The typology of possible partnerships being considered were: (a) joint ventures (where two or more partners come together to form the primary organization delivering the innovation, while retaining their individual identities) (b) public-private partnerships (c) partnerships with NGOs and social organizations reaching out to the local target populations (d) partnerships where at least one partner is an university (e) partnerships formed for other reasons and (f) no major partnerships formed.

From Table 4a, we can see that about 30% of the innovations in our sample originated in domestic private firms, 24% in MNEs, 21% in NGOs, 24% in Social Enterprises and the rest in charities. This confirms that inclusive innovations have indeed been a story of improving market access for the poor undertaken by private firms and social enterprises, as noted in Heeks et. Al. (2016), but our analysis adds that in most cases these innovations have relied on *easily accessible* technologies. The push for the development of inclusive innovation products that incur high technological costs is significantly weaker, although

[13] All organizations are expected form partnerships of some kind or the other. The kind or partnerships we consider are only those which are central to the development and delivery of the pro-poor innovation being considered. We exclude donors, funders and other financing bodies from this.

this effort too is mainly from MNEs and NGOs. Social enterprises and private domestic firms play a much smaller role in this area. Inclusive innovation with high market access, which may involve displacing an existing product or developing new technologies, are the least popular.

Looking at the Indian cases separately (reported in the Table 4b), some interesting differences can be seen. MNEs and social enterprises have a lower involvement in inclusive innovation and the bulk of introductions come from NGOs (40%) and domestic private firms (40%). 60% of these innovations are in Quadrant 4, suggesting domestic firms and NGOs have relied on readily accessible technologies and to a lesser extent focused on alleviating constraints to market access.

Table 4a: Break up of all cases within our taxonomy based on typology of primary organization involved and nature of partnerships they embark on

		Quadrant I	*Quadrant II*	*Quadrant III*	*Quadrant IV*	*Total*
Type of organization	Private domestic firms	3		1	13	17 (30%)
	MNEs	7		2	5	14 (24%)
	NGO	5			7	12 (21%)
	Social Enterprise	2		1	11	14 (24%)
	Charity				1	1
Nature of partnership	Joint Ventures	3			3	6
	Public Private Partnerships	4			3	7
	Partnerships with NGOs and Social Enterprises for local delivery	2		1	17	20
	Partnerships involving universities	1			3	4
	Partnership others				1	1
	No major partners	7		3	10	20

Table 4b: Break up of Indian cases within our taxonomy based on typology of primary organization involved and nature of partnerships they embark on

		Quadrant I	*Quadrant II*	*Quadrant III*	*Quadrant IV*	*Total*
Type of organization	Private domestic firms	2		1	5	8 (40%)
	MNEs	2		0	0	2 (10%)
	NGO	3		0	5	8 (40%)
	Social Enterprise	0		0	1	1 (5%)
	Charity	0		0	1	1(5%)
Nature of partnership	Joint Ventures	1		0	0	1
	Public Private Partnerships	1		0	2	3
	Partnerships with NGOs and Social Enterprises for local delivery	0		0	7	7
	Partnerships involving universities	0		0	1	1
	Partnership others				1	
	No major partners	5		1	3	9

The large role of domestic firms and social enterprises in introducing innovations has received less attention in the literature when compared to the inclusive innovations introduced by foreign/multinational firms. The BoP literature developed as a specialized strategy for MNEs operating in emerging markets and so some may have expected to see a larger role for them. Yet, our analysis suggests that domestic firms and social enterprises (who have better knowledge and more experience of operating in local markets) have been active initiators of inclusive innovation projects.

4.2: The role of partnerships

Exploring the nature of partnerships that organizations form in order to develop and deliver the innovation also threw up some surprising results. As can be seen in Table 4 again, in about a third of cases (34%) partnerships with NGOs and social enterprises helped innovating firms to overcome the market access barriers (such as identification of the target population, creating awareness about the innovation, designing effective delivery channels etc.). Again remarkably, in the majority of cases no major partnerships were formed, and the innovation was carried through from concept to delivery by a single organization (in many cases MNEs). The public sector, either in the form of public research centers, public-private partnerships or universities, featured very little. In India, a larger proportion of cases (9 of 20) cases involved no partnerships— many of these cases were in Quadrant 1.

Table 5 below outlines the purpose of partnerships with NGOs and Social Enterprises in the 20 cases that involved them, as obtained from the secondary data available to us. These are small numbers but the majority of cases (40%) the partnership was aimed to extend distribution of products in rural areas. The second most important reasons were access to technology and access to finance for the target population.

Table 5: Reasons for private firm partnerships with NGOs in the full sample

Reason for partnership	*Energy*	*ICT*	*Health*	*Others*	*Total*
Distribution of products/services	2		6		8
Finance to households	5				5
Intermediate manufacturing/adaptations			1	1	2
Technology usage in local market		4		1	5

4.3: Inclusive innovation by broad sector of use and product group

Table 6 presents the break-up of the cases based upon the sector where the innovation was introduced. For the analysis, we define the following sectors based on the sample: (a) energy (b) health care (c) agriculture (d) finance (e) information and communication technology (ICT) and (e) others, such as transportation and housing.

In general, we do see some emerging patterns when innovations are considered sector by sector. As mentioned above, Quadrant IV was the most populated in all cases, implying that the majority of the pro-poor innovations in our sample adapted available technologies rather than develop new ones. It is only in the health sector that we see that a significant proportion (9 out of 16) of the innovations could be considered addressing low technology access situations (Quadrant I). In energy, the proportion was far smaller (5 out of 27), and none in the other sectors. Thus overall, when it comes to inclusive innovations, the reliance is on available technologies rather than development of technologies to serve poor markets is in evidence – apart from the health sector.

Table 6: Break up of cases within our taxonomy based on sector targeted by the innovation

	Low MA, Low TA Quadrant I	*High MA, Low TA Quadrant II*	*High MA, High TA Quadrant III*	*Low MA, High TA Quadrant IV*	*Total*
Energy	6			21	27
Health*	9			7	16
ICT			4	5	9
Agriculture				3	3
Others	2			1	3
Total	17		4	37	58

* The sub-sectors under health (from Table 1) have been combined under one heading

If we examine the nature of the primary organization which introduced the innovation in terms of the sectoral break-up, we find that private domestic firms and MNEs have indeed played an important role as indicated within the BoP literature. However, social enterprises and NGOs have played an equally important role across the sectors, especially in the energy and health sectors.

Table 7: Break up of cases by sector and type of organization

	Private Domestic	*MNE*	*Social Enterprise*	*NGO*	*Others*
Energy	10	4	9	3	1
Health	2	4	3	7	
ICT	3	4	1	1	
Agriculture		1	1	1	
Others	2	1			

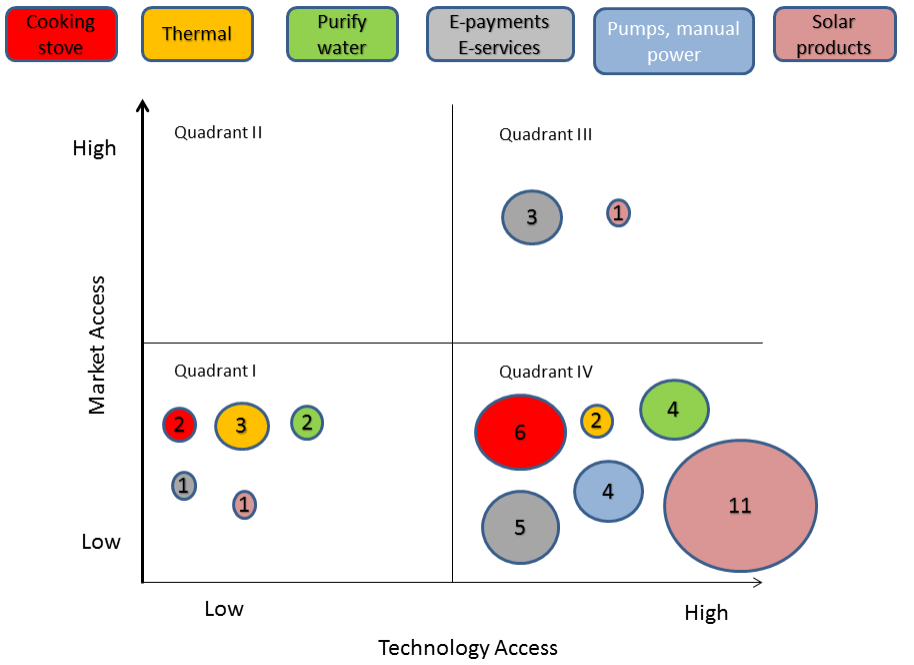
Using a sectoral classification maybe misleading because most of the cases of inclusive innovation reported in the earlier tables encompass only six product groups as shown in Table 8 below. These product groups are cooking stoves, cooling/heating thermal devices, water filtration and purification methods, e-payments and eservices, pumps and manual power and solar products including lighting products and these cover 45 out of the 58 innovations categorized in our study.

Table 8: Break up of cases by product group

Products	*Cases*	*Countries introduced*	*Quadrants*
Cooking stoves	8	India, Kenya, Ghana, Indonesia, Burkina Faso, Mozambique	1, 4,
Cooling and heating	5	1 East African product, India, Nigeria, Nepal	1, 4
Purifier and Filtration	6	India, Bangladesh, Kenya, Ecuador, Mali, Guatemala, 1 global product	1, 4
E-payments and e-services	9	Kenya, Tanzania, Ghana, India, Bangladesh, Burkina Faso, Nigeria, Mongolia	1, 3, 4
Pumps and manual power	4	India, Rwanda, Africa, US based development	4
Solar products including lighting	13	Kenya, Tanzania, Uganda, India, Pakistan, Laos, Hong Kong based HQ in one product, Africa,	1, 4, 3

The first thing to note is that in terms of our discussion in Section 2.2, none of these really constitute 'collective consumption' goods and so we would expect many of these innovations to behave like other technology products and have a market extending nature. So not surprisingly, Table 8 shows a preponderance of occurrences in quadrants 1 and 4. Going further, as shown in Figure 2, a majority of these occurrences are concentrated in Quadrant 4 (32), a significantly lower number in Quadrant 1 (9), and only 4 in Quadrant 3.

Figure 2: Distribution of the six major product groups among the 4 quadrants.



It is interesting that similar goods appear to be provided using different technologies in different countries. For example, cooking stoves used a variety of fuel (bio-fuel, ethanol, purified kerosene) which while less polluting than wood fire were not perhaps the best technology that could be offered for cooking stoves. Similarly, there were at three different technologies used in the cooler and heating products. The failure to sell better vintage technology and the inability of the more efficient product (e.g. Chotukool) to globalize despite in many cases the involvement of global firms suggest a high order of market fragmentation which in turn is both an economic opportunity and in the long run a constraint on scale economies. It is very hard to say more because of the unavailability of more detailed market share data.

5. Discussion and conclusions

The innovation literature has for long addressed the need for technology led solutions aimed at solving problems faced by the poor one hand, and more bottom up solutions inspired by innovations at the grassroots, often using very basic raw materials combined at low cost (Radjou and Prabhu, 2014; Zeschky et.al., 2014). In recent years global strategists have also paid attention to BoP markets as a new site of value creation and appropriation (Prahalad and Hart, 2002; Prahalad, 2010, George et al 2012). This has led to a spurt in research and in practice focused on these markets, and the mutual benefits to

private firms and low income poorer populations from products and services designed specifically for the latter.

In this paper, we reviewed the barriers faced in commercialization of inclusive innovations, along the twin dimensions of market and technology access and proposed a simple taxonomy based upon such barriers. We then analyzed a sample of 58 pro-poor inclusive innovation cases, to anlayse where the locus of inclusive innovation efforts has been located.

We have seen that both domestic private firms and MNEs did play important roles in bringing pro-poor innovations to the market, they have focused heavily in certain contexts where levels of technology adaptation was low, but missing markets meant that the target consumer did not have access to the relevant technology to solve certain problems (access to low cost energy, safe water, health infrastructure etc.). In a sense, these cases of pro-poor innovations characterized low hanging fruits for firms – and many private firms did step in to supply innovations that filled these gaps.

Our analysis also revealed social enterprises and NGOs have a made a significant contribution in this regard, both as initiators of such pro-poor innovations, as well as by acting as partners and intermediaries through which domestic and foreign firms accessed the target populations, created effective delivery channels and enabled target households to access finance and information. Specialist organizations such as universities have been the source of idea generation or specialized technology in very few cases. For these actors too, the target has mostly been those innovations which enhance market access but where technology access was already high.

Two key points emerge from our analysis. First, the role of large technological developments, where a significant improvement to existing technologies was made through sustained research and development, has rarely been seen in the context of inclusive innovation. Second, large gaps exist within the innovation landscape, across sectors, where private sector R&D may be confronted with huge market and technological risks. Here the mood of retreat in public sector investment may have contributed to the lower supply of innovations.

Second, as we have seen from our analysis, instances of inclusive innovation are rare when innovations face barriers to technology access. Private response in the face of technology access barriers is likely to be muted primarily as a result of market failure due to presence of externalities (Swaans et.al., 2014; Vorley et.al., 2012; Kale et.al., 2013), which are known to affect the incentive structure of both innovators and potential customers of such innovations (Karnani, 2011).

Thus our analysis supports the case for a renewed look at the role of public sector R&D, which can complement the ongoing effort of the private sector, social enterprises and NGOs. Research initiatives in universities and public funded laboratories can help to bridge the significant gaps between available technologies and the required breakthroughs

directly relevant for the poorer sections of the society. Beyond inclusive innovation, these measures will also benefit all innovation. India has one of the lowest rates of R&D spending in the world. Public R&D can directly lift this ratio. What the policy mix to do this should look like, is a question that needs careful empirical investigation beyond the scope of the data analyzed in this paper.

Although, strides have been made in the clear enunciation of a nation-wide innovation policy since 2013, policy measures have mostly focused on the provision of cheap finance and compelling the private sector to contribute to socially responsible activity. This has of course elicited a strong response from the private and social sector in the form of several entrepreneurial efforts to serve the bottom of pyramid markets. However, the impact of these activities remains largely unknown. Anecdotal evidence suggests that some of the celebrated cases of inclusive innovation in India, such as the Tata Nano (the poor man's car) and Chotukool (the rural refrigerator), were not in fact successful in penetrating BoP markets. Both have been repositioned to meet the needs of semi-urban areas. Again assessing such impact was beyond the scope of this paper.

This paper has other limitations. First, while we covered a variety of successful inclusive businesses in the wider sample (some of which had a technology component and some which were purely business model innovations), we were restricted to those cases of inclusive innovation, which were discussed in various websites, blogs, media and technical reports. We presume that many such innovations also failed to make an impact, and/or were not discussed widely and eventually withdrawn. While such failures could be for many reasons unrelated to the central point being made here, the unobserved nature of these excluded cases need to be acknowledged. Second, we are unable to judge or measure the actual impact of inclusive innovations ourselves, and must rely on reports from the external sources, which in many cases could be subjective. This also means that the role of institutions, such as regulatory frameworks, governance factors or even the IP related issues are not considered within our analysis. One might ask for example, if partnerships with NGOs represent a new institutional arrangement or a transient solution to a infrastructural gap? Should IP in use be rewarded more to encourage technology access?

However, the above limitations also open new avenues of research. The question of actual impact of individual projects on its intended beneficiaries, and its mapping to our typology is one area which would be of interest to BoP and innovation scholars. This requires project level data and more detailed analysis of who benefitted from the innovation and how. The relevance of the institutional framework and its role in facilitating the introduction of pro-poor innovations by various actors, and its eventual impact on society is yet another area which begs more study. Finally, as mentioned previously, the policy-mix which yields the best impact in terms of the welfare of poorer populations needs further theoretical and empirical investigation.

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