Technological inclusiveness: A comparative study of Northern and Chinese induced technologies in the garment industry

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The Northern economies have been the main sources of technologies for the global garment manufacturing industry. Over the past decade, China has become an important alternative source of these technologies offering a range of technological choices for small scale and dispersed production of cheap consumer goods, particularly in the developing world. Preceding a national foresight exercise aimed at enhancing the capabilities of small-scale garment producers in Uganda, we examine the potential 'inclusiveness' of garment sewing machines imported from the Northern economies and China, and their individual potential to enhance the capabilities of poor garment producers, particularly, women and rural dwellers. Data for our study included a survey and semi-structured interviews with 147 garment firms and other key informants. Compared to the Chinese sewing machines, we found that the Northern machines have high acquisition cost, relies on scale and advanced infrastructure, and tend to exclude poor rural producers (often women). The transfer of Chinese technologies to Uganda, we also found is much easier, have larger spread effects, leading to smaller gaps in technological know-how between China and Uganda because of the context in which Chinese technological innovations are induced. We conclude with some implication of our study to theory and policy.

Keywords: Africa, China, garment industry, technology inclusiveness, Uganda

Introduction

Despite the significant achievement in poverty reduction in Uganda, inequality and unemployment keep rising in this transition country. The garment sector has been identified as one of the key sectors that can help create jobs in transition countries as it has the potential to move labour from the inefficient agricultural sector to the manufacturing sector (Gereffi and Memedovic, 2003; Moghadam, 2015). However, limited investment in garment making technologies and erratic supply of energy are among the major contributors to the sub-sector's current low capacity in garment production (GoU, 2009). Scholarly and policy makers in this regard have advocated for massive investment in garment

1

technologies to help improve Uganda's position in the industry to reduce poverty and inequality (Akoten and Otsuka, 2007). However, there are two main competing sources of garment making technologies in Uganda, and it is not too clear as to which of them the country should be investing in to help improve its position in the global garment making industry. Northern European countries, particularly Germany, United Kingdom, and Austria, remain the traditional sources of garment making technologies for the industry (Gereffi and Memedovic, 2003; Mytelka, 1991). Following substantial investment of Chinese firms in Africa, China in the past decade has become the alternative source of these technologies for the Ugandan garment industry. In this regard, the existing literature has identified various factors that shape and give form to the transfer, adopting and diffusion of these competing garment technologies in transition countries (Huang, 2003; James and Bhalla, 1993). The emerging consensus is that the Northern technologies compared to Chinese ones are much more durable, efficient, but expensive. The Chinese induced technologies on the other hand, are technological inferior, and cheap (Yamagata, 2007; Schrank, 2004).

Preceding a national foresight exercise aimed at enhancing the capabilities of small scale garment producers and reducing poverty, examine the potential appropriateness and 'inclusiveness' of these competing technologies, focussing on sewing machines in the Ugandan garment industry. By inclusiveness, we refer to the potential and appropriateness of these sewing machines' to enhancing the capabilities of poor producers, particularly women and rural dwellers, in ways that reduces inequalities which are known to offset the poverty reducing effect on economic growth (Hazarika, 2015; Ravalion, 2007). Inclusiveness in this context is also about improving the welfare of low income groups through the use of low cost technologies in a developing country (Paunov, 2013; Feder and Umali, 1993). We aim to provide empirical evidence to support policy makers in deciding which of the two technologies they could potentially put their bet on to help improve the competitive position of Uganda's garment industry while reducing poverty among women and rural dwellers.

Drawing on firm level secondary data, survey, and semi-structured interviews with 147 garment firms, and statistical data from organizations such as the International Cotton Advisory

Committee, World bank and Cotton Development Organisation, we compare the production characteristics of the two sewing machines, their repair and maintenance costs to assess their relative impact on poor producers in general, and women and rural producers in particular. We found that the Chinese induced sewing machines compared to their Northern counterparts have a discernible pro-poor, pro-women, and pro-rural impact on Uganda's garment industry. Contributing to the existing literature on technology inclusiveness, our study sheds light on the significant role of technology in poverty alleviation efforts in the third world.

The paper is structured as follows. First, with particular emphasis on the global garment industry, we provide a brief overview of the sources of inducement to the development of inclusive technologies and innovations. Second, we delineate the state of the Ugandan garment sector with emphasis on the sources of imports into the sector. Third, we present our sampling strategy, data sources and the operational framework guiding our inquiry. Fourth is our results and discussion. We then conclude with some implications of our findings for theory and policy.

Sources of inducement to the development of inclusive technologies and innovations

The appropriate technologies movement as espoused by the international organisations in the 1970s and 1980s were overwhelmingly driven by not-for-profit organisations (Schumacher, 1973). More recently, the rise of emerging economies such as China and India suggests that this dominant trajectory may be subject to change. The growth in capabilities in China, in particular, has coincided with a rapid growth in demand by poor consumers. These poor consumers may aspire to branded positional goods, but because of their low incomes will settle for simpler and lower quality products (Kaplinsky, 2010). This form of demand from poor consumers has reignited the appropriate technology concept with countries like China serving as the likely source. The re-emergence of the appropriate technology concept has led to the call for direct inclusive innovations for the poor and a better understanding of the Sources of inducement to the development of Inclusive technologies and innovations.

There are three broad sources of inducement for the development of technologies in China. The first is the increase in demand of low-cost technologies; due to rapid growth in markets in low income economies (Ruttan, 2001; Kaplinsky, 2010). This demand is driven mainly by low income earners' preference for function rather than position. As a result, consumers in developing countries are accepting China's strategy of producing low cost and inferior technologies into developing countries (Kaplinsky and Prahalad, 2005). Note that the low income level of consumers in most developing countries like Uganda is the main driving force for such low cost technologies. This may also serve as a conduit for poor consumers to be included in technology access and utilization. As observed by Chataway et al. (2013), the more inclusive a given innovation, the more likely consumption decisions will be made at the individual or household level.

Relative factor prices are the second inducing source of technical change; this is driven by process technologies. Wages in the AD economies are a fraction of those in the northern economies. Therefore, new technologies produced in these economies are likely to be highly labour intensive (Kaplinsky, 2010). In addition, because these technological innovations occur in the context of weak infrastructure, innovation in the developing economies such as China may be more robust and do not require high quality infrastructure (Hazarika, 2015; Kaplinsky, 2010). Moreover, because there is weak standardization in these developing economies, technological innovations in these economies may not take cognizance of international certification requirements. Furthermore, these technical changes arise from small-scale indigenous firms and focus on lower acquisition cost. The lowering of standard, coupled with their labour intensive nature and less reliance on infrastructure may point to the fact that unskilled labour and low income consumers may be included in the utilization of such technologies.

Trajectories of innovating firms are the third factor that induces the production of technologies that are appropriate for developing countries. In their efforts to improve upon their products and processes, firms are frequently confronted with the challenge of scanning through their known contacts and data-sources mainly due to the availability of imperfect information. In the

context of routines, they draw on their experiences past knowledge and networks to keep track of the changing environment and customer preferences (Kaplinsky, 2011). As such, these firms have their own path-dependencies and trajectories (Dosi, 1984). These large multinational firms in the northern economies mostly tend to focus on demands from their existing customers and disregard new technologies that will not satisfy the needs of their existing customers (Christenson, 1997). This is inconsistent with the growing belief that there is a huge market opportunity for transnational corporations (TNCs) in developing economies (Prahalad, 2006). On the other hand, southern-based trans-national corporations are in better position to develop technologies that are appropriate for low-income economies (Kaplinsky, 2011). Nevertheless, available studies have not sufficiently captured the inclusiveness of technologies from other emerging economies such as China relative those from the northern economies.

However, these technologies have been perceived not to have inclusive attributes for the less privilege in society, particularly women and rural dwellers. The Northern technologies were produced to suit labour saving technological progress, assumes high-quality infrastructure and produces products for high-income consumers, and therefore, difficult for the poor to acquire (Stewart 1982, and Kaplinsky 2011). In addition, access to spare parts as well as the requisite information required for maintaining and repairing some of the northern technologies in the garment sector are limited (Bhalla, 1985). Some of the Northern made technologies produce on large scale and are skills intensive; therefore require skilled labour to operate them efficiently (Kaplinsky, 1990). In this regard, women are likely to be the worst affected. As indicated by Pearson (2000), women are relatively less skilled with higher levels of illiteracy compared to men. This creates more barriers for women when it comes to access and use of Northern technologies. Furthermore, women in developing countries bear a disproportionate burden undertaking time and labour intensive unpaid activities in their household. These include cooking, cleaning, fetching fuel or water, as well as child and elder care (Gill *et al.* 2010). For instance, women in rural areas spend from 1 to 5 hours a day gathering biomass for fuel and 1.6 hours a day collecting water in the dry season (Gill *et al.* 2010). This

5

makes it difficult for women to venture into skills and wealth creating activities that will enable them adopt skills intensive technologies (Gill *et al.* 2010). Men on the other hand have full control over technologies in the households and work places. Husbands at home are mostly responsible for regulating the family radio, television, and even controlling when and how other family members use them (Gill *et al.* 2010). At work, technologies meant for women are often co-opted by men once their utility and profitability are established (Gill *et al.* 2010). This means that women who do gain access to technologies do not see the economic benefits associated with it (Gill *et al.* 2010).

Technologies from the Northern economies are the most efficient. For example, Eckaus (1955) argued that there was a limited range of efficient technologies available in a given period of time; and these technologies are concentrated in Northern economies—Europe and North America. Building on this assumption, Emmanuel (1982) posit that research and development are mainly concentrated in developed economies where income levels are high; as such technological progress can only originate from these economies. He goes further to explain that the economically efficient techniques are always owned by transnational corporations in the Northern economies. He adds that all efficient technologies are capital intensive and that labour intensive techniques tend to use more of both capital and labour per unit of output and so they are economically inefficient. Thus, developing countries will incur economic costs (i.e. reduction in output and growth) if they use labour intensive technologies. Furthermore, there has been an intensive body of research in favour of the availability of alternative technologies. Studies such as Sen (1968); Jenkins (1975); Stewart (1982); and Kaplinsky (1990) have all laid credence with empirical evidence to the fact that there are efficient alternative technologies, although they do not make up the full spectrum assumed in the neo-classical framework. Over the past three decades, the global division of technological capabilities has been shifting from the Northern economies towards emerging economies particularly China (Kaplinsky 2009). The very large size of China, coupled with its middle income status (only until recently they were low income economies) and, its growing technological capabilities is making it the dominant source of technological innovation for poor consumers in developing countries like Uganda

(Kaplinsky 2009). Again, the structure of the Chinese economy is different from those of the West, hence by hypothesis, their technologies may be distinctive (Kaplinsky 2009). This is because the Chinese technologies are also assumed to be labour intensive, easier to access, less capital intensive, require minimum skills and are tolerant to poor infrastructure (Kaplinsky, 2009). Wade (1990) indicates that the Asians (led by China) rely heavily on small scale relatively un-mechanised technologies innovations and therefore are more inclusive compared those from Latin American economies. These attributes of the Chinese innovations mimics Ghandi's idea of the use of small labour intensive technologies. Ghandi argued that the reproduction of the Soviet growth path would reinforce massive processes of exclusion. This would seek to promote the choice and development which are more labour intensive and small scale (Chataway *et al.* 2013). Thus, these assumed characteristics of technological change from China are likely to be inclusive of the less privileged—women and rural dwellers in Uganda. However, these assumptions are yet to be validated, and the level of returns for Chinese technologies has not been explored enough in available studies.

The garment sector in Uganda

The sector's average contribution to employment in the manufacturing sector was 4.1 % in 2008. This increased to 4.9 % in 2009 and remained the same in 2010 but declined to 4.6 % in 2012. Over 56 % of the total labour forces across the value chain in the garment sector are women who are mostly employees rather than employers. (GoU, 2009). This makes it relatively difficult for women to become entrepreneurs in the garment sector. Among others, this is attributed to women's inability to access the requisite capital equipment for the production of garment. As shown in table 1, consumers on average spent 7 % of their income in 2009/10 on garments. This declined to 5 % in 2010/11. Rural households spent an average of 6 % of their income on garment in both 2009/10 and 2010/11. This was lower than the urban household expenditure in 2009/10 but higher in 2010/11. Households mostly spend on cheap garments from China or imported second hand clothes from the United Kingdom. The National Textile Policy of Uganda observes that Chinese made garment are available in every

part of the country relative to the locally produced ones (GoU, 2009). The huge presence of China was as a result of the expiration of the Agreement on Textiles and Clothing (ATC) on 1 January 2005.

Table 1: Share* of monthly household expenditure on garments by location (2005/06-2010/11) (%)

Location	2005/06	2009/10	2010/11
Urban	8	8	4
Rural	8	6	6
Uganda	8	7	5

Source: GoU, 2013
*This computation does not does not take into account food, drink and tobacco

Small scale production

The manufactures of garments in Uganda is mainly dominated by small to medium scale producers and constitute more than 90% of the garment producers in Uganda. These small scale producers support the livelihood of 2 million people across the garment and textiles value chain (GoU, 2009). Inputs such as fabric and capital equipment for garment production at the small scale level are almost all imported. They rely mostly on inputs from China for their operations. Small scale garment producers either sell their output through wholesalers and retailers or sell them directly in the open market (USAID, 2003). There are both Chinese and Northern garment making machines at this level. Small scale garment producers mainly employ electric treadle sewing machine for garment production in urban areas. On the other hand rural garment producers use manual treadle sewing machines. On average, small scale garment producers in Uganda employ between 1 and 10 workers majority of who are women.

Large scale production

Unlike the small scale producers, the large scale producers produce for both the local and international markets. There are also 35 large scale firms—these comprise of Asian, local and Northern garment production firms in Uganda. According to the Uganda Investment Authority,

China (and India) own more than 50% of the firms at this level of the value chain (UIA, 2013). These firms have some sense of how international markets are organized and how to go about finding contract opportunities. They mainly export garment to countries like Rwanda, Democratic Republic of Congo, and other countries in the Great Lake regions (UIA, 2013). However, garment and textiles exports into the international market have continuously been impeded by high cost of doing business in terms of high transportation, energy and finance which leads to low competitiveness of garment exports from Uganda. Similar to the small scale producers, 90% of the fabrics used for garment production are imported (UIA, 2013). The large scale firms import them on their own instead of procuring them from the local wholesalers or retailers. Furthermore, there are both Chinese and Northern sewing machines at this level of the value chain.

Sources of apparel imports into Uganda

Europe was the main source of imports of garment and its related products into Uganda e.g. second-hand clothes. However since 2002, the value of garment and its related products imports from China has far surpassed that of European Union. The value of garment imports from China increased from less than US$ 1 million in 1992 to US$ 31 million in 2014 (see figure 1). However, imports from the European Union declined from US$ 2 million in 1998 to US$ 1.1 million in 2012 (Figure 3). Import of already made garment has been recognised as the main challenge confronting garment production in the country. Local producers are finding it very challenging to compete with the cheap garment imports from China. However, there is an ever-increasing demand for cheap Chinese garments mainly because of the low income levels of consumers (GoU, 2009).

Figure 1: Imports of apparel/clothing/accessories into Uganda (000 US$)
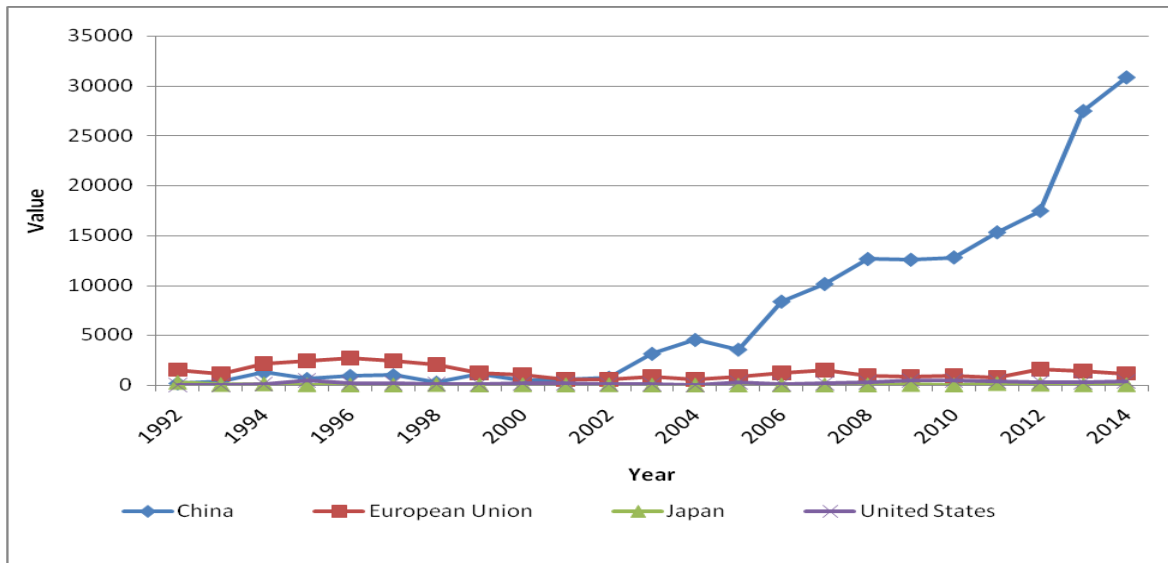
Source: WITS-COMTRADE database, Product Code 84, Accessed 15/03/2014

Until 1997, the EU remained the most important source of these machines into Uganda. However, the gradual rise in value of small scale sewing machines imported from China has made them the leading sources of small scale sewing machines for Uganda. The value of imports of Chinese small scale sewing machines rose from US$ 35,000 in 1992 to US$ 95,000 in 2014. On the other hand, the value of small scale sewing machine imports from EU declined from almost US$ 128,000 in 1992 to US$ 45,000 in 2014. This may be attributed to the growing decline in demand of the small scale sewing machines from the Northern economies. Though Japan continue to serve as a source of small scale sewing machines for Uganda, import value of the capital equipment from Japan has consistently remained relatively lower than the that of China and the EU.

**Figure 2: Trends in the import of small scale garment making machines into Uganda ('000 US$)**
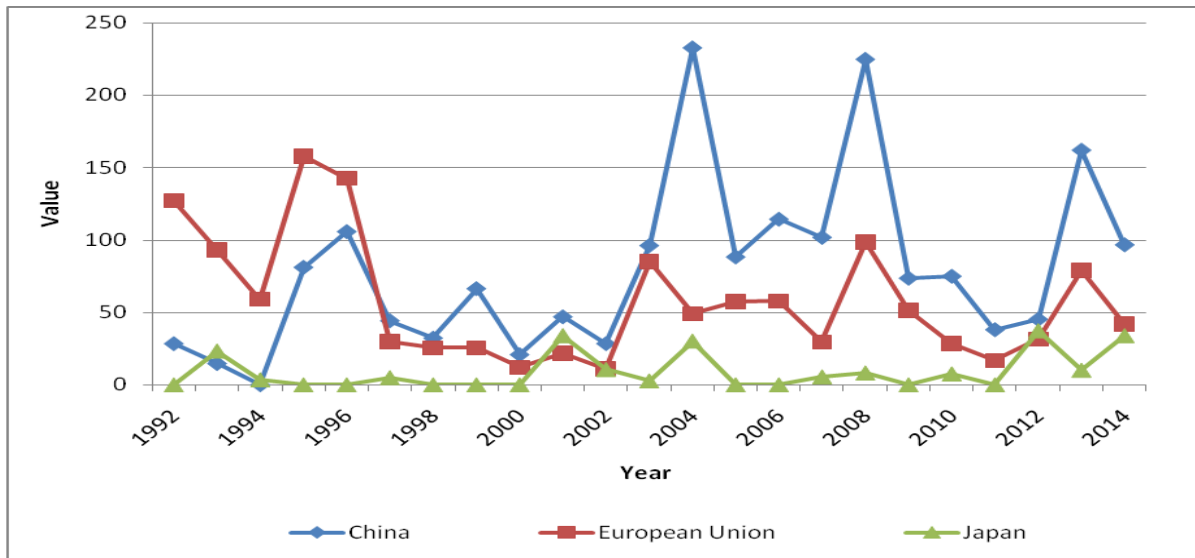
Source: WITS-COMTRADE, SITC 3, Product Code 72433, Accessed 17/03/2014

Sources of imports of sewing machine parts into Uganda

The total value of imports of sewing machines needles and other parts of the sewing machine from China has surpassed those from the EU. The value of imports of Chinese sewing machine parts increased from US$ 1,200 in 1992 to US$ 34,000 in 2014 (Figure 3). The EU continues to play an important role as a source sewing machine parts despite the fact that its import values are lower than those of China. Import values of sewing machines from China may be higher because of the frequent replacement of Chinese sewing machine parts (Figure 5). Later in this study, we will show that the frequent breakdown of Chinese sewing machines and low cost nature of the China made machine spare parts is the main inducing factor for their higher imports.

Figure 3: Trends in the import of sewing machine needles/parts ('000 US$)

11
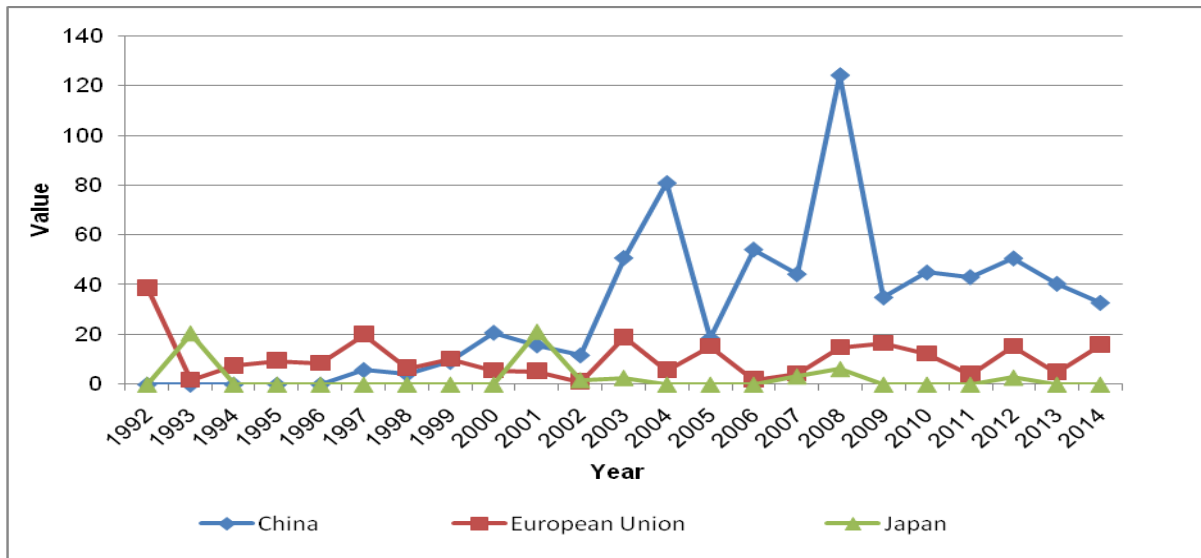
Source: WITS-COMTRADE, SITC 3, Product Code 72439, Accessed 17/03/2014

How does China fit into the garment sector in Uganda?

The role of China in the garment and textiles sector in Uganda cannot be ignored. First, China is increasingly becoming the sources of garment and textiles to Uganda. As indicated above, the value of garment and textiles imports from China increased from US$ 1 million in 1998 to US$ 38 million in 2012. This surpassed that of the country's traditional sources of imports. However, the influx of relatively cheap textiles and garment from China is crowding out local garment producers in developing countries like Uganda (Amankwah-Amoah, 2015). Garment producers in Uganda have found it extremely difficult to compete with the low cost alternatives from China considering the fact that they are appealing to many low-income earners. Second, similar to any other African country that took advantage of the AGOA and EPA, Uganda has been outcompeted by the growing presence of Chinese garment and textiles on the international market. This was as a result of the closure of the MFA and ATC. It is, however, unmerited to blame the garment and textile crisis entirely on China. The Chinese have strategically capitalised on their comparative advantage of cheap labour and technological advancement. Over-dependence on preferential treatment afforded by AGOA made the country neglect other untapped markets such as South America (Thoburn, 2009).

Thirdly, prices of garments and textiles produced in Uganda are uncompetitive. This is mainly because of the high cost of production in the country (GoU, 2008). Chinese traders in the garment and textile sector in Uganda have only exacerbated the situation by providing fierce competition to local retailers. As a result, the demand for Chinese products has soared at the expense of locally produced goods. Even Africa's traditional export markets have now also succumbed to China's domination in the garment and textile industry. While the economic activities of Chinese companies may stimulate local development to an extent, their dominant presence has stirred up some resentment amongst the locals. For example, Chinese clothing manufacturers in Kampala have been under fire for failing to meet legal minimum wage and working conditions (The Ugandan Monitor, 2012). There also exists a strong presence and influence of labour unions in Uganda, which often exacerbate existing tensions in their bid to protect the workers' welfare. The recent emergence and escalation of Chinese produced Ugandan prints has also contributed to the strained relations between the two parties. This was a profitable niche market segment that Ugandan producers enjoyed and dominated as Ugandan prints were in demand not only in East African region but also in Northern countries. Now China has also entered the market and is actively competing in the same market. The manufacturing of Ugandan prints in China is seen as an insult to the Ugandan people and manufacturers who feel rights to commercial enterprise based on Ugandan cultural heritage should remain in the country. Finally, lack of capital and technological investment and creation of a domestic value chain have also contributed to the current predicament. However relative to their Northern counterparts, China is increasingly becoming the dominant source of sewing machines in the country. As indicated above, the assumed nature of the Chinese technology is likely to make it inclusive but we lack empirical evidence to support this assertion. In this regard, our study compares Chinese and Northern garment machines in Uganda; with emphasis on women and rural dwellers to ascertain the inclusiveness of these technologies and potential for poverty alleviation.

Operational framework

Conceptual framework

Women and rural dwellers as the less privilege group in society in Uganda. Poverty is largely as a result of consumption power (Chataway *et al.* 2013). The power of the poor to consume products is loosely linked to the participation of the poor in processes of production (Chataway *et al.* 2013). In this regard, we expected inclusive innovations to create jobs, increase productivity and profitability for women and rural dwellers. We therefore followed Chataway *et al.* (2013) in assessing the inclusive nature of Northern and Chinese sewing machines in the garment sector in Uganda. This enabled us to consider the following indicators:

(a) Whether women and rural dwellers are involved in the ownership of the Chinese innovations compared to the Northern ones.

(b) How the Chinese sewing machines, relative to the Northern ones are affecting the capacity of rural dwellers and women to be owners. For instance, capital and skills intensive equipment may preclude the poor from ownership.

(c) How the character of the Chinese sewing machine enable rural dwellers and women go into production; and whether it requires large or small scale production units.

Figure 4: Inclusiveness of Northern and Chinese technological innovations in Uganda
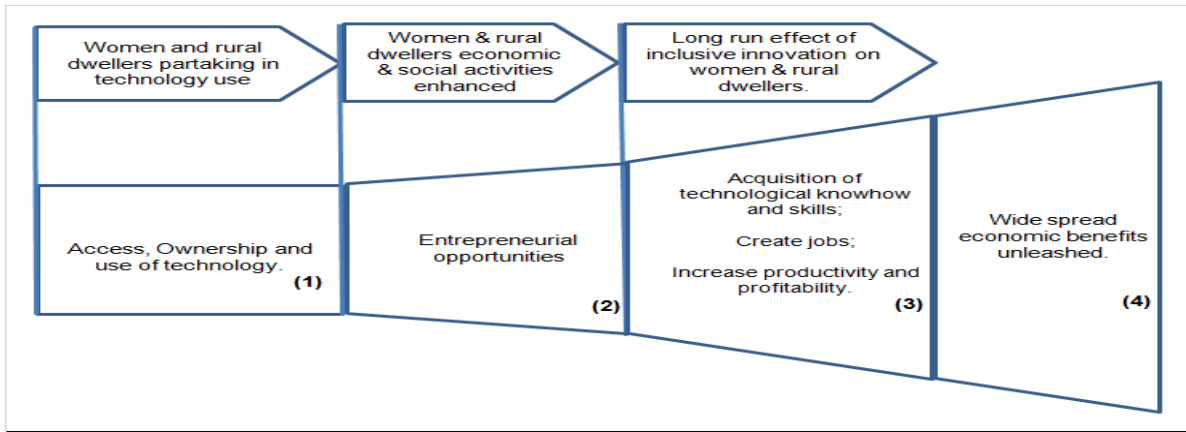
Our conceptual framework shows the major pathways that will enable women and rural dwellers to participate in the use of technologies to improve upon their livelihood. We argue that when women and rural dwellers are able to access, own and use a technology, a positive chain reaction is initiated that leads to; (2) enhancement of their social and economic activities which enable them to leverage to create new entrepreneurial opportunities for themselves; (3) These developments then trigger inclusion of rural dwellers and women in the innovation cycle – acquisition of technological knowhow and skills, create jobs, increase productivity and return; (4) This in turn leads to wide spread of economic and social benefits in society One issue is that the technology in use must be sustainable and must yield high returns.

Sampling strategy and data sources

The first stage of the data collection started with archival research to understand the trends in garment making technologies trade between Uganda and its trading partners—China and the Northern economies. The archival research was based on international databases such as World Development Indicators, World Integrated Trade Solutions of the World Bank, official government document reports and other academic publications. Some of the official government reports that were used include the Uganda 2012 Statistical Abstract (GoU, 2013), projections of demographic trends in Uganda 2007-2017 (GoU, 2010), the Uganda National Textiles Policy (GoU, 2009) and the Uganda

Industrial Policy (GoU, 2008). These archival documents provided detailed time series data on trends in the import of garment making machines in Uganda.

For primary data collection purposes, we obtained the list of registered garment producers from the Ugandan Ministry of Trade, Industry and Cooperatives (MTIC). The list contained 594 registered small scale garment producers across the four regions or provinces of the country. All the firms on the list were also part of the MITC's cooperative union and met the ILO's (2002) definition small scale firms which are normally non-agricultural firm with an average of 1 to 10 employees. We had no specific sampling procedure to follow so we started by selecting the 4th registered member whose enterprise was some few metres away from our research base in Kampala. We then selected every fourth person on the list until we moved through the list. A total of 147 garment producers were finally sampled. These garment producers made up of 43% males and 57% females were single entrepreneurs—sole proprietors and/or owners of the garment making machine they use for their work.

The main data for our empirical inquiry was collected using semi-structured interviews. Interviews took place at the work shed of respondents and covered their perspectives on the garment technologies they employ in their everyday work. Each interview lasted for an hour and was transcribed within 24 hours of collection. In addition, the survey was conducted in Entebbe, Jinja and Kampala (52 respondents). I also conducted the survey in the Eastern (36 respondents), Northern (33 respondents) and Northern (26 respondents) regions of Uganda.

The full data analysis followed four stages. First the short survey data was analysed using excel spreadsheet to develop demographic profiles of our respondents and the relative technology ownership patterns. Next, we meticulously sifted through the interview data collated and cross-checked what we thought were salient narratives with other vital objective information we gleaned from the databases, official government documents, and archival information to overcome possible biases in what we heard in the field (Ritchie and Spencer, 1994). Following this, the disparate data were triangulated (Jick, 1979) into a whole, and analysed drawing on theoretical insight from the

technology inclusiveness literature. Identified segments and categories were then analysed and interpreted iteratively until common themes emerged and became saturated (Strauss, 1978; Suddaby, 2006). We present the fine details of our findings in the next section.

COMPARING THE INCLUSIVENESS OF THE ALTERNATIVE SEWING MACHINES

Access to garment making technologies by location

As shown in table 2, majority of our female respondents in both urban (54%) and rural (68%) areas were mainly housewives, and the demanding nature of the housewife job tends to deprive women the opportunity to earn their own income for the acquisition of sewing machines. The men in rural households are mainly farmers (61 %) and the main breadwinners and 46% of the men in urban areas were unemployed. In addition, 18% and 21% of the men in urban areas are petty traders and farmers respectively.

Table 2: Occupation of respondent before acquiring a sewing machine (%)

Type of occupation	Rural					Urban Communities				
	Male	%	Female	%	Total	Male	%	Female	%	Total
Housewife	1	3	23	54	24	0	0	28	68	28
Petty Trading	4	11	5	12	9	5	18	9	22	14
Farming	22	61	13	30	35	6	21	0	0	6
Unemployed	5	14	1	2	6	13	46	4	10	17
Other	4	11	1	2	5	4	14	0	0	4
Total	**36**	**100**	**43**	**100**	**79**	**28**	**100**	**41**	**100**	**69**

We estimated access to garment making machines by the location of the garment producer. As shown in Table 3, In both the urban and rural communities, Chinese sewing technologies are easier to access than the Northern ones. For instance, manually operated Chinese sewing machines are easier to access in rural communities (73 %) than those from the West (27%). Lack of capital and energy infrastructure in the rural communities is the main factor that is limiting garment producers from acquiring Northern sewing machines. One of our respondents from the Eastern region explains:

> There is no electricity in this village.......so I buy a machine that can work without electricity.....otherwise it will be useless......if the government brings electricity I will buy a machine that can use power.

Later in this study, we will show that relative to the Chinese sewing machines, the Northern machines are not able to operate efficiently in locations where there are no energy infrastructure—particularly the rural communities.

Table 3:   Access to garment making technologies in Uganda

Category of Technology	Type of Machine	Rural	Urban	Total
Sewing machines				
Hand Operated Machine	Chinese	4	1	5
	%	(57)	(100)	(63)
	Northern	3	0	3
	%	(43)	(0)	(38)
	Total	**7**	**1**	**8**
	Total %	**(100)**	**(100)**	**(100)**
Manual Treadle Machine	Chinese	52	5	57
	%	(73)	(7)	(80)
	Northern	19	7	26
	%	(27)	(58)	(31)
	Total	71	12	83
	Total %	(100)	(100)	(100)
Electric Treadle Machine	Chinese	0	31	31
	%	(0)	(55)	(55)
	Northern	0	25	25
	%	(0)	(45)	(45)
	Total	0	56	56
	Total %	(0)	(100)	(100)
	Overall total	**78**	**69**	**147**

Women are able to own Chinese sewing machine relative to the Northern ones. Key factors such as the less capital intensive and easy accessibility of the Chinese machines make it easier for women and rural dwellers to acquire them. Taking ownership of the garment making machine aid women to be able to plan and make decisions particularly on allocation of resources for the production of garment. Our field data also shows that more women became entrepreneurs as a result of acquiring the Chinese made sewing machine. Table 4 below shows that 86 percent of the women in rural areas were able to venture into garment production as a result of getting a Chinese sewing machine. A female garment producer in Kiyonga in the Eastern region of Uganda explained that:

> Before I bought this sewing machine [Chinese sewing machine] I was a housewife.....you see it was very cheap so I was able to save to buy it.......I actually started in my house.....two years

later I was able to buy two and so I decided to open [establish] my own shop [garment making firm]....it is better than housewife job.

In addition, majority of the garment producers earn their income from their job as garment producers. In rural areas 46 out of the 50 female garment producers who use Chinese sewing machine earn 100% of their income from garment production. The number of garment producers who earn all their income as a result of using Chinese sewing machines is far lower in urban areas relative to those in rural areas.

Table 4: Percentage of respondent's income earned from garment production

Machine Type	Male	Female	% of income
	0	1	10
	0	1	40
Chinese	1	2	70
	1	0	80
	18	46	100
Total	**20**	**50**	
	0	1	50
Northern	1	0	95
	37	22	100
Total	**38**	**23**	

Production coefficients of the Chinese and Northern sewing machine

In comparing the level of productivity of the two alternative machines, we focused on two factors—capital and labour—for the measurement of the level of productivity of the alternative technologies. At the urban and rural level, we will also later discuss how we measured capital and labour. In urban communities the study shows a well-behaved production function. Table 5 shows an expected higher O/K and a lower O/L for the Chinese machines compared to the Northern sewing machines in urban communities. However in the rural communities, the Northern sewing machines are "economically inefficient" considering that it has a lower coefficient of capital and labour. Thus assuming that product quality is constant, the choice of technique in the urban communities will reflect the factor prices. Conversely, in rural areas there is no set of factor prices that will lead to the choice of the Northern sewing machines if the products are homogeneous.

Table 5: Summary of the production coefficients of the two types of sewing machines

	Urban		Rural	
	Chinese	**Northern**	**Chinese**	**Northern**
Annual quantities of garment produced	1,728	2,160	864	648
Output/Capital Ratio (O/K) (garment/US$/pa)	11.21	8.82	9.10	4.20
Output/Labour Ratio (O/L) (garment/worker/pa)	9.00	10.00	4.00	3.00
Capital/Labour Ratio (K/L) (US$/pa)	0.80	1.14	0.44	0.70

Capital Costs involved in using a Chinese or Northern made machine

We computed the cost differences between the Chinese and Northern sewing machines in garment production at the small scale level. In doing this, we divided the cost components into fixed and variable cost. The fixed cost is the cost item that does not vary in total even when the output changes—Cost of Machine. The variable cost is a cost that varies with the level of output. This means any increase in output requires an increase in input. Transport, labour, repair and maintenance, as well as energy cost, are the main variable costs involved at the small scale level. Table 5 provides broad aggregation of the cost profile assuming that the variable costs are unchanged from year to year. However, this does not take into account the uneven yearly incidence of repair and maintenance of the Chinese and Northern sewing machines. We will unpack the uneven nature of these two cost items (i.e. maintenance and repair cost) later. The discussion will be made over the life span of the two sewing machines. Though they constitute a relatively smaller component of the cost structure, repair and maintenance are critical over the entire life span of the machine. I am assuming full capacity utilisation. Small scale garment production is undertaken in both rural and urban communities in Uganda. Table 5 below presents the average cost of using the two sewing machines in both urban and rural areas.

Table 6: Average annual cost of using the Chinese and Northern sewing machines (US $/year) (%) (Unless otherwise specified)

	Electric Treadle (Urban)		Manual (Rural)	
	Chinese	**Northern**	**Chinese**	**Northern**
A. Acquisition Cost (US$)	363	524	202	321

B. Fixed Cost

Cost of Machine	61	88	34	54
	(13)	(14)	(8)	(14)

C. Variable Cost

Transport Cost	8	13	32	45
	(2)	(2)	(7)	(12)
labour Cost	355	472	316	236
	(76)	(74)	(72)	(61)
Repair Cost	21	30	45	36
	(5)	(5)	(10)	(9)
Maintenance Cost	6	11	12	17
	(1)	(2)	(3)	(4)
Energy Cost	16	28	0	0
	(3)	(4)	0	0
C. Total Annual Cost	**468**	**642**	**438**	**388**
	(100)	**(100)**	**(100)**	**(100)**

Fixed Cost

Cost of the sewing machine

The average acquisition cost of a Chinese and Northern electric sewing machine in Uganda is respectively US$ 323 and US$ 524. The average acquisition cost for a Chinese manual sewing machine in Uganda is US$ 202 and that of the Northern economies is US$ 321. The acquisition cost of a machine has become the standard for measuring capital. However, this is not satisfactory since it does not capture the value of capital used within a given period and also does not make allowance for inflationary cost. Thus, the study focuses the analysis on the discounted annual value charged for using the sewing machine. Base on the prevailing real market rates at the time of the data collection, the study employs a discount rate of 9.8 %. The study assumes a 10 years life span[1] and a zero scrap value for both Chinese and Northern sewing machines. In all the study sampled 10 brand new Chinese and Northern sewing machines each which the machine operators started using in 2010. Table 8 shows that the average annualised capital cost of the electric treadle Chinese sewing machine

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[1] After a 10 year period, both sewing machines can be used for a longer period of time. However, for the purposes of easier comparison we considered a 10 year period of operation for both alternative machines.

is US$ 61.00 in urban communities. This constitutes 13 % of total annual cost of production. That of the Northern sewing machines is US$ 88, which is US$ 20 higher than the annual cost of the Chinese sewing machines. In the rural areas, the cost of a manual Chinese sewing machine is US$ 34.00 whereas that of the manual Northern sewing machine is US$ 54.00. The cost of the manual Chinese sewing machines and Northern sewing machines represents 8 % and 14 % of the total cost of production respectively in the rural areas. Therefore the Northern sewing machines are more capital intensive than the Chinese sewing machines. This annualised cost for the two sewing machines also captures the cost of transporting the machine after it has been acquired.

Variable cost

Transport Cost

Transport cost does not directly affect the smooth operation of the sewing machine, but plays a crucial role in determining the final selling price of the garment produced. It is the cost incurred by the machine operator for moving the machine and its parts to a repairer for repair works. Relative to the Chinese sewing machines, a garment producer will have to travel further distance to access the parts of a Northern made machine in both urban and rural communities. The study estimates the average cost of transport per kilometre in Uganda to be US$ 0.78. We measured the average cost of transporting the machine by taking the product of average transport cost per kilometre and the total distance travelled to access the machine. This is done at both the rural and urban levels. Sewing machine repairers are mostly located in urban areas. This makes the cost of transporting sewing machine within urban areas for repairs relatively cheaper than transporting the machine from rural areas to the repairer in urban centres. The average cost of transporting a Chinese sewing machine and its parts for repair works in urban communities is US$ 8. That of a Northern sewing machine is US$ 13. Similarly, the cost of transporting the Northern sewing machine for rural works is higher than that of those of the Chinese sewing machine.

Cost of energy of the sewing machine

Energy infrastructure is one of the key factors influencing garment producers to use an electric treadle sewing machine in the urban communities. Rogale *et al.,* (2005) indicates that using electricity for sewing speeds up the sewing machine and thus increase productivity. This leads to an increase the value and productivity yields in garment production (Rogale *et al.,* 2005). However, this also means that the garment producer will incur energy cost. Measuring the cost of energy consumed by a sewing machine is difficult. The first issue is that garment producers do not have any system for measuring energy cost per sewing machine. The monthly electricity bills include all the other equipment such as pressing irons and electric cutters that are available at the tailoring shop. This issue is compounded by the fact that both the Chinese and Northern sewing machine use a 5hp electric motor for sewing. In situations where there are two or more small scale garment producers sharing the same electric meter, the producers share the electric bills using a system I describe as a *points system.* I use the *point system* to distinguish between the energy consumption rates of the two types of sewing machines in consideration.

The *point system* is a crude method of rating the amount of power an electrical appliance consumes. The higher the amount of electricity consumed by the electrical appliance, the more points it gets. The challenge with the *point system* is that it does not capture obsolescence of the equipment as cautioned by Stewart, (1982); given that obsolete capital equipment is more likely to consume more energy than relatively new ones. Thus, the study assumes that the Chinese and Northern sewing machine have a rate of 2.0 and 1.2 respectively. This assumption is based on the fact that the Northern sewing machine weighs[2] more than the Chinese made ones. In comparing the energy cost, the study adopts the point system with the assumption that the alternative machines are in the same condition.

Using the Electricity Regulatory Authority of Uganda's end user tariff rate for 2012, energy consumption at the small scale garment production level is in the category of low voltage supply for small general services. This category involves electricity supplied to residential houses, small shops

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[2] Note that energy requirement is directly proportional to the mass of an object (Perrett and Jeffery, 1922).

and kiosks, etc—metered at low voltage single phase and supplied at 240 volts (see UMEM, 2012). In this category, the consumer pays US$ 0.036 for the first 15 kilowatts hour (Kwh) of energy consumed (UMEM, 2012). Since the two technologies use 5 hp electric motors for garment production, it was difficult to use only the motors in isolation to make any meaningful comparison. However, factoring the points system into the equation and converting the horsepower of the electric motor into kilowatts makes it possible for comparison. It is necessary to note that 1 horsepower hour is equivalent to 0.746 kWh (FAO, 1997). In addition, all things being equal an electric motor cannot operate to its full capacity. On average, electric motors operate with a maximum load factor of 75 % (FAO, 1997). According to the United States Congress (1993) a load factor is the average percentage of full operating power that the electric motor uses. Hence, the study assumes a load factor of 75 % for the electric motor and an average 8 hour machine working period per day. Therefore taking into account the load factor of the electric motor, a 5 horsepower motor will consume a maximum of 2.80 kilowatts hours of power a day.

The results show that garment producers who use electric treadle Chinese made machines spend an average of US$ 16.00 per annum on energy (Table 8). On the other hand, users of electric treadle Northern machines spend approximately US$ 28.00 per year on energy (Table 8). Garment producers in the rural communities do not incur cost mainly because there is no electricity infrastructure. The study takes note of the fact that garment producers in rural communities use their man-power for the production process; however, this has already been captured as compensation for labour as such the study only focuses on energy consumption in urban communities.

Repair cost

Another important component of the cost structure garments production is the repair cost of the sewing machine. The study estimated cost of repair using two key indicators—the average cost of spare parts and the rate charged by the sewing machine repairers per repair session. As indicated earlier, the cost of repairs is uneven. The cost may depend on different factors. It may depend on the extent of damage as well as the level of complication associated with the damage (Interviews, 2012).

The repairer will charge a higher rate if he (there were no female repairers) encounters more challenges during repairs and vice versa. Again, the machine owner will have to incur higher repair cost if part of the machine to be replaced is relatively expensive (Interviews, 2012). As the machine ages, repair works becomes frequent because of an increased rate of wear and tear on the machine. This leads to an increase in the cost of repairs of the machine. All these factors makes the repairs cost of the machine uneven over the lifespan of the machine. Table 6 shows how the cost of repairs varies from year to year.

Table 7: Breakdown of annual repair cost of the Chinese and Northern (US$/year)   (N= 20)

| Location | | Year | | | | | | | | | | Average |
		1	2	3	4	5	6	7	8	9	10	
Urban	Chinese	14	15	16	18	20	21	24	26	28	31	21
	Northern	19	21	23	25	28	30	34	37	40	44	30
Rural	Chinese	29	31	34	38	41	45	50	55	60	66	45
	Northern	23	25	28	30	33	36	40	44	48	53	36

Field data from the 147 firm interviews shows that the Chinese sewing machine breakdown twice a year whereas the Northern sewing machines break down once every 2 years. Nevertheless, average annual cost of repairs for the Chinese sewing machine in urban communities is lower than that of the Northern sewing machines. This is because the Chinese sewing machine spare parts are cheaper and easier to access compared to the Northern sewing machines. In addition, the Northern sewing machines are more sophisticated and difficult to repair. In view of that repairers charge higher rates to repair them (i.e. Northern sewing machines). Thus despite the greater durability of the Northern sewing machine, its annual cost of spare parts and repair fees exceed those of the Chinese sewing machine. In the urban communities, users of Northern sewing machines spend an average of US$ 30 a year on spare parts and repair works. On the other hand, users of Chinese sewing machine spend an average of US$ 21 annually on parts and repair workers. Unlike the urban communities, the cost of

repairs on the Chinese sewing machine is higher than the Northern sewing machines in the rural communities.

Wright (2001) indicates that the many problems associated with sewing machines are caused by dust, lint or thread ends. The robust nature of the Northern sewing machines enables it to withstand the dusty environment in the rural communities to a greater extent than the Chinese sewing machine. In rural communities the Chinese sewing machine break down 3 times a year whereas that of the Northern sewing machines is once per year (Tables 8 and 9). On average, a Chinese sewing machine user spends almost US$ 45 per year on repair works and users of the Northern sewing machines spend US$ 36 per year (Tables 8 and 9). One of our female respondents' puts it succinctly:

> I have two of this machines [Chinese machine] and three of the British ones.......but I don't use these ones [British made ones] because they are broken down and the spare parts are expensive and not common on the local market.....I have told a friend of mine who travelled to Kenya last week to buy me some when he is coming back to Uganda.

In a related development, another had this to say:

> I really like the British machines...they are very strong and can last long, the only reason why we all use the Chinese machines here is because they are cheaper and as you can see.....there is no electricity here and so we use the China ones....they are very simple and easy to use.

Relative to the Chinese sewing machine, the energy requirement and difficulty in accessing the parts of the Northern sewing machine serves as a barrier for the less privileged to sustain its operation. Women and rural dwellers find it difficult in sustaining the operation of the Northern sewing machine. This is due to the capital and energy intensive nature and the difficulties associated with access to parts of the Northern sewing machines, women and rural dwellers find it challenging in sustaining its use.

Skills demand for repair works

There is generally high demand for repairers due to their limited number on the local market. Interviews with the 5 sewing machine repairers show that out of an average weekly receipt of 25

Chinese sewing machines, they are only able to repair 15 of them. This means that repairers will not be able to repair 40 % of the total Chinese sewing machine they receive. A sewing machine repairer spends an average of 3 hours to repair a Chinese sewing machine. They are also able to repair 5 out of an average weekly receipt of 15 Northern sewing machines. This means that a repairer will spend an average of 8 hours per day to repair only 1 Northern sewing machine. The resultant effect is that the repairers are able to repair only 33 % of the Northern sewing machines they receive a day. A sewing machine repairer in Kampala explains that

> This week alone I have more than 20 Chinese machines to repair my customers are all on me.....we [repairers] are very few here so there is a lot of pressure on us. This is the main place where people repair their machines.

In some cases, the machine users end up abandoning the sewing machines (particularly the Northern sewing machines) when the repairers are unable to repair the sewing machines. This is as a result of the complex nature of the machine damage or in some cases challenges in getting sewing machine parts. Another garment producer at Kiyembe-Kampala indicates that

> I bought a Singer sewing machine from the United Kingdom in 2006.....I really enjoyed using that machine.......but it got damaged last year [2011] when my shop got burnt.....I sent it to different repairers but none of them were able to repair it.....I had to abandon it because the damage was too complicated......

The repairers are mainly located in these communities because they are able to access energy for the equipment they use for the repair works. Thus, the few repairers available are overburdened with lots of repair works. Contrary to standard literature that AD technologies are less skills intensive (Clark et al 2009; Kaplinsky 2009), the frequent breakdown of the Chinese sewing machine has demand implications for repair skills. Therefore both sewing machines require skills for repair works. Thus, users of the Chinese sewing machine can easily lose valuable clients compared to those who use Northern sewing machines since they may not be able to get their machines back from the repairers on time for production. A Chinese sewing machine user in Keyembe in Kampala had this to say:

> My machine [Chinese sewing machine] was not working [broken down] during the Christmas holidays….but I had a lot of work to do for my customers…..So I disappointed

them……they don't bring their material for me to sew again…..I lost them as my customers…..all my friend who use the British machines did a lot of work [sewing].

Maintenance cost

Most problems associated with sewing machines can be traced to high concentration of dust, lint or thread ends that have collected on the working parts of the sewing machine. A proper maintenance culture of the sewing machine to some extent can avert these problems. Depending on the extent to which the sewing machine is used, garment producers will have to maintain it accordingly. I observe that the garment producers use soft nylon brushes to dust away lint under the needle plate and around the feed dog of the sewing machine. The bobbin of the sewing machine is also another place where lint and fuzz accumulate. Regular replacement of the throat plate, blunt and broken needles, bobbin case and bobbin housing (hook mechanism) of the sewing machine is also vital to keep the sewing machine efficient (Wright, 2001). After that the sewing machine should be oiled for proper lubrication and then covered immediately after use (Wright, 2001).

Items that are used by the garment producer for maintenance activities vary between the two sewing machine technologies. On the Ugandan local market, the cost of 125ml oil is US$ 1.07. In the urban communities, users of Chinese sewing machine require an average of 125 ml of oil to lubricate the machine every quarter of the year. In addition, they require 3 packets of needles every year for proper maintenance of the machine. Each packet of Chinese sewing machine needle costs US$ 0.71. Therefore, the Chinese sewing machine user will have to spend an average of US$ 2.14 annually on needles. The Northern sewing machine users also require 250 ml of oil to lubricate the machine every quarter of the year in rural communities. However, the Northern sewing machine requires only one packet of needles annually. Each Northern made needle costs an average of US$ 2.86.

The difference is due to the frequent breakdown of Chinese sewing machine needles relative to that of the Northern sewing machine. Similar to the repair cost, the annual cumulative cost of maintenance of the Northern sewing machines is higher than that of the Chinese sewing machine. In urban communities, the average maintenance cost of Northern sewing machines is US$ 11.00 whereas

that of the Chinese sewing machine is US$ 6.00 (Table 8). Maintenance cost is higher for both

technologies in rural communities relative to those in urban communities. Cost of maintenance for the

Northern sewing machines is US$ 17.00. The cost of maintenance for the Chinese sewing machine in

rural communities is twice (US$ 12) the cost of its maintenance in urban areas (Table 8). This is due to

the higher level of wear and tear of the technology as a result of high level of concentration of dust in

the rural communities. For instance, the Chinese sewing machine requires a lot of maintenance in

terms of lubrication and frequent replacement of needles. A garment producer in Kiyonga, a rural

community in Jinja explains that *"the dust is our serious problem.....it causes a lot of damage to our*

machine....we always oil it". Aging machines also tend to breakdown more frequently because of wear

and tear. As such; the operator will end up spending more resources for maintenance work on the

machine. This makes the level of expenditure on maintenance of the two sewing machines vary year

by year.

Table 8: Breakdown of annual maintenance cost for the two sewing machines (US$/year) (N=20)

Location		Machine Life Span (Years)										
		1	2	3	4	5	6	7	8	9	10	Average
Urban	Chinese	4	5	5	5	6	6	7	8	9	10	6
	Northern	7	8	9	10	11	11	13	14	15	17	11
Rural	Chinese	8	8	9	10	11	12	13	14	16	18	12
	Northern	11	12	13	14	15	17	19	21	23	25	17

Labour cost

The study uses remuneration of employees for the measurement of the cost of labour. Labour

compensation is based on the number of garments that are produced per day—that is on a piece of

work basis at the small scale level. The field data shows that operators of both Chinese sewing

machine and Northern sewing machines work for an average of 8 hours per day and each employee

earns US$ 0.36 per garment produced. Again, a sewing machine operator produces more garments

with Northern sewing machines than the Chinese sewing machine when the machine is powered

with electricity. The Chinese sewing machine experience frequent breaks during production mainly

because of frequent rethreading, needle breaks, as well as oiling. Therefore, Northern sewing machine

operators in the urban communities earn more income than those who use Chinese sewing machine.

On average, a Chinese sewing machine operator earns US$ 355 per annum (Table 8). This is lower than a Northern sewing machine operator who earns an average of US$ 472 per annum (Table 8).

The situation is different for those in rural communities. The bulky nature of the manual Northern sewing machine makes its operation more laborious than that of the Chinese sewing machine. The manual Chinese sewing machines on the other hand are less bulky; as such it is easier for the operator to operate compared to the Northern sewing machines ones. As such, operators using Chinese sewing machine are able to produce more garments in the rural communities than those using Northern sewing machines. On average, an operator of manual Chinese sewing machine earns US$ 316 whereas those who use manual Northern sewing machines earn US$ 236 annually (Table 8).

Output of Chinese sewing machine and Northern sewing machines

The amount of value addition and quantity of garment produced is captured in this Section by using a medium sized "*kitenge*" as a standard for measuring the output of both technologies. The location of the garment firm affects the quantity of garments that can be produced within a given period. A garment producer in an urban area is able to access energy to speed up garment production. Producers in rural communities on the other hand have no access to energy infrastructure as such rate of production is slower. Again, the amount of value added to a garment is determined by the appearance and performance of the garment. A good appearance of a garment shows on the seams—this is normally smooth fabric joins with uniform stitches (Aldrich 1994; and Carr and Latham, 1994). Conversely a good appearance of garments occurs when the seam has achieved strength, durability, security and comfort (Aldrich 1994; and Carr and Latham, 1994).

Though both the Chinese sewing machine and Northern sewing machines in urban areas use a 5 hp electric motor, we observe that the Northern sewing machines work faster than that of the Chinese sewing machine. The 5 hp electric motor enables both sewing machines to work at 1800 revolutions per minute (rpm) (Brother Sewing Machine Manual, 2009); however, the speed partly leads to skipping of stitches as well as occasional breakdown of some parts of the Chinese sewing machine. This leads to delays; and reduction in quality and quantity of output of the Chinese sewing machine relative to the Northern sewing machines. A sewing machine repairer indicates that

> I always advise the tailors not to fix the motor [5 hp electric motor] on the China machines......they are too light [less bulky] for the speed [1800 rpm]......that is why they break needles frequently.

Therefore, when using the Chinese sewing machine for the production of garments, a lot of skills are required in handling the machine to avoid fabric damage. A respondent indicated that:

> You need to be very skilful and experienced enough to be able to able to use the Chinese sewing machine.....before you can sew with no errors.

As indicated above, the difference in output is due to the continuous interruption as a result of frequent replacement of broken needles, rethreading and frequent oiling of the Chinese sewing machine. This causes delays when using the Chinese sewing machine for production. Just as indicated by Grills and Brown (1975) that an operator will have to spend time to make good a fault incurred in the sewing operations. This affects the quantity of garment and reduces the value of the garment produced with the Chinese sewing machine. Interviews with the 147 firms show that both technologies use a daily average of 30 yards of fabric in the urban communities. However due to their frequent mechanical issues, the Chinese sewing machine add relatively lower value to the garment. Furthermore relative to the Northern sewing machines, this issue also makes the Chinese sewing machine produce fewer quantities of garment. The Chinese sewing machine produce an average of 8 medium sized *Kitenges* a day (1728 *Kitenges* per annum) and that of a Northern sewing machine is capable of producing 10 medium size *kitenges* a day (2160 *Kitenges* per annum). A *"Kitenge"* produced with an Chinese sewing machine will add an average value of US$ 0.77 and that of the Northern sewing machine is US$ 0.88.

Unlike the urban communities, the two technologies—Chinese sewing machine and Northern sewing machines—are manually operated in rural communities. Ideally, the Northern sewing machines are mainly meant to operate with electricity but it can easily be used manually by detaching the 5 hp electric motor from the machine. However this comes with some challenges which affect the

output of the garment. Without the required pressure on the fabric from the presser foot[3], the feed dog[4] of the sewing machine cannot do its job efficiently. This prevents the fabric from feeding through; causing jams and damages to the fabric and hence reducing the quantity of the garment to be produced per day. Garment producers in rural communities use paper makers for the production of garments. Correcting errors on paper markers are difficult, time consuming and compromise the value that is added to the garment. A garment producer in Kiyonga, a village close to Iganga in the Eastern region of Uganda indicates that:

> We only use paper and markers for the designing…..it wastes a lot of time and you can make a lot of mistakes".

Though the two sewing machines are generally slow when operating manually the Chinese sewing machine are relatively more efficient. The manual treadle Chinese sewing machine and Northern sewing machines respectively produce 4 and 3 *Kitenges* a day in rural communities. However, in terms of value addition there is no difference between the two technologies at the rural level. The study further estimates the percentage of waste that is produced as a result of using either a Chinese sewing machine or a Northern sewing machine. This is not the waste caused as a result of labour errors but due to mechanical issues related to the sewing machine. We compute this by taking the difference between the fabric lengths after cutting has been made and the actual length that goes into the production of the garment expressed as a percentage. This is on the assumption that both technologies use homogeneous fabric to produce homogeneous output. The total annual value of garment produced by the Northern sewing machines is the higher than the Chinese sewing machine. However, the total value of garments produced by the in rural communities Northern sewing machine is lower than that of the Chinese sewing machine (Table 9).

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[3] The bulky nature of the Northern sewing machines makes it difficult for the operators to exert pressure on the presser foot and this causes a malfunctioning of the feed dog.

[4] The feed dog of the sewing machine is responsible for pulling the fabric through the machine in discrete steps, in-between stitches.

Table 9: Annual level of output of the two sewing machines

	Urban		Rural	
	Chinese	**Northern**	**Chinese**	**Northern**
Length of Fabric used (Yards/year)	6,480	6,480	2,592	2,592
Length of Fabric after cutting (Yards/year)	5,848	5,910	2,315	2,315
Percentage of Fabric Waste (%)	5.00	4.00	6.00	6.00
Annual Quantity of Garment produced	1,728	2,160	864	648
Value added/Garment (US$)	0.77	0.88	0.69	0.69
Total Annual Value (US$)	1,331	1901	596	447

Rate of returns of the two technologies

We used two key discounting measures to compare the returns of the two technologies—Benefit cost ratio and Net Present Value (NPV). These discounting measures enable the study to take into account changing costs and revenue over time. It also facilitates easy ranking of the two technologies in terms of their levels of returns (Gittinger, 1982, pg 52). The study uses prevailing real market interest rate of 9.8 % (at the time of research) for the computation of the present values of the sewing machine technologies.

Net present value of the Chinese and Northern sewing machines

Net present value considers the revenue and cost flows to examine whether technologies may be able to pay for it-self. A positive NPV indicates that the project may be able to pay for itself and vice versa if the NPV is negative (Gittinger, 1982). Therefore, the formal criteria for selecting a technology using the NPV is to identify the one with a positive Net Present Value when discounting it at the opportunity cost on capital. We used the various cost components above to estimate and compare the present values of all the cash inflows and outflows of the two technologies. This was discounted at a rate consistent with the prevailing risk associated with the technologies. It is essential to note that this discounting measure is not suitable for ranking the technology in terms of returns—it is an absolute and not a relative measure (Gittinger, 1982, pg 71). Table 10 shows that using both technologies in the urban and rural communities can pay for their investments. However, the NPV for the Northern sewing machines is higher than those of the Chinese sewing machine in urban areas. The reverse

holds when it comes to the rural communities—the NPV for the Chinese sewing machine is superior to that of the Northern sewing machines.

Table 10: Annual rates of return for the two alternative sewing machines

Location	Northern	Chinese
Urban		
NPV (US $)	111	79
BCR	1.12	1.02
Rural		
NPV (US $)	20	41
BCR	0.49	1.03

Benefit cost ratio

By definition, a Benefit Cost Ratio (BCR) is a ratio between the present value of the benefits and costs of a project (Gittinger, 1982). This shows how well the technology can pay for itself. I do this by taking a ratio of the NPV and the cost of investing in the technology. Since the NPV discounts to the year of investment, both the NPV and investment costs are comparable. Thus if the BCR is equal to or greater than 1 then it implies returns on the technology are positive. However, if the technology is less than 1 then it means the cost incurred in using the technology is greater than the net benefits; thus the technology cannot pay for itself. (Gittinger,1982). Clearly, Northern sewing machines are more profitable than the Chinese sewing machine in the urban communities. However in the rural communities, the Chinese sewing machines are superior to the Northern sewing machine. Therefore though they are capital intensive, the Northern sewing machine is able to pay for itself better than the Chinese sewing machine in the urban communities and vice versa in rural communities. Thus, though the Chinese sewing machines appear to be more inclusive than the Northern a machine, their level of profitability is mixed. This notwithstanding, Chinese sewing machines may benefit rural

dwellers but may not serve well for women in urban areas. That is if one considers the fact that the Chinese machines add less value and also yield lower returns relative to the Northern ones in the presence of energy infrastructure. This also means that the Chinese sewing machine may not be entirely inclusive in urban areas.

Summary and conclusion

Endemic poverty and the dwindling fortunes of Uganda in the global garment industry have partly been attributed to the inability of rural dwellers and women to access and utilise technologies for garment production in the country (GoU, 2014). Historically, the Northern economies, particularly Britain and USA have been the main sources of technologies for small-scale garment producers in Uganda. Over the past decade, China has become an important alternative source of these technologies, particularly, sewing machines in Uganda. Preceding a national foresight exercise aimed at enhancing the capabilities of small scale garment producers, we examined the potential inclusiveness nature of Chinese and Northern sewing machines in Uganda. Drawing on inclusive innovation, as a meta-theoretical lens, we compared the inclusiveness, profitability, productivity, job and wealth creation attributes of Chinese and Northern garment making technologies in Uganda. These comparisons are important because poverty is endemic in Uganda (both absolute and relative poverty), despite the fact that Uganda achieved the MDG1 target of halving the proportion of people living below $1 a day more than five years ahead of the 2015 deadline. This is against the backdrop that high inequality rate and unemployment can offset the poverty reducing effect on the country's economic growth.

Our study shows that technology plays a very significant role in poverty reduction; and that women and rural dwellers are the less privileged to technological innovations in the garment sector. This is partly but largely because women in developing countries bear a disproportionate burden undertaking time and labour intensive unpaid activities such as cooking, cleaning, fetching fuel or water. This creates a barrier for women to venture into skills and wealth creating activities that will

enable them adopt skills intensive technologies (Gill *et al.* 2010). Rural dwellers also have no access to energy in Uganda. As such they are unable to use technologies that require power to operate. They are only able to use manual machines, which only produces lower quantities of garment. These attributes excludes these two groups—women and rural dwellers—of technology consumers from using technologies to improve upon their livelihood. Our study found that women and rural dwellers that use Chinese sewing technologies are able to access, own and utilise them to improve their livelihoods relative to the Northern ones. The Chinese garment making technologies contributes positively towards the socioeconomic welfare by creating new entrepreneurial opportunities for women and rural dwellers that use Chinese sewing machines. Thus, this paper further concludes that the use of Chinese sewing machines spur the inclusion of rural dwellers and women in the use of technologies—acquisition of technological knowhow, develop their skills and create jobs.

This is coupled with the fact that China has become the dominant source of garment making technologies in Uganda. Furthermore, relative to the Northern machines, the Chinese sewing machines are less capital intensive and are economically efficient in both rural and urban areas. However, there is no set of factor prices that will result in the choice of Northern sewing machines if the products are homogeneous. However, contrary to the assumptions in literature that the Chinese sewing machines technologies are less skills intensive (Clark et al 2009; Kaplinsky 2009), the frequent breakdown of the Chinese sewing machine will require skills for repairing them. I also conclude that though the Chinese sewing machines may be inclusive, they may not be profitable relative to the Northern ones.

We conclude that the Chinese machines add less value to garments relative to the Northern ones. This is because it skips and produces weaker stitches. Furthermore, we conclude that the level of profitability of the Chinese sewing machines is relatively lower than those from Northern economies in urban areas. From this perspective, the Chinese sewing machines are more profitable than the Northern machines in rural areas. It is therefore important for policy makers to note that preference for function rather than position among low income consumers in most developing

countries like Uganda is the main driving force for such low cost technologies. As a result, garment producers in Uganda are accepting China's strategy of producing low cost and inferior quality technologies into developing countries (Kaplinsky and Prahalad, 2005). This may also be the conduit for poor consumers such as rural dwellers and women in particular to be included in technology access and utilisation.

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