African Technology Development Forum

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SCIENCE; INNOVATION; TECHNOLOGY; TRADE; DEVELOPMENT

Technology as a Tool of Empowerment

Men have become the tools of their tools
Henry David Thoreau

HIGHLIGHTS:

Innovation and Industrial Development in Africa

Empowering micro-entrepreneurs and small businesses through mobile phones in emerging markets and developing countries

Exploring the potential of new technologies to facilitate economic empowerment in developing countries: a focus on online networking

Rural housing: Skill transfer and the milestones for scaling-up: The case of Sustainable Rural Dwelling Units in Ethiopia

Connecting catch-up growth to sustainable development–a new theoretical perspective

Green entrepreneurship: the missing link towards a greener economy

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INSIDE THIS ISSUE

Innovation and Industrial Development in Africa
Hopestone Kayiska Chavula and Victor Konde 3

Empowering micro entrepreneurs and small businesses through mobile phones in emerging markets and developing countries 13
Erna Karrer-Rueedi and Dariu Trueb

Exploring the potential of new technologies to facilitate economic empowerment in developing countries a focus on online networking 19
Martin Labbé

Rural housing: Skill transfer and the milestones for scaling-up: The case of Sustainable Rural Dwelling Units (SRDU) in Ethiopia 24
Elias Yitbarek Alemayehu

Connecting catch-up growth to sustainable development – a new theoretical perspective 29
Philipp Aerni

Green entrepreneurship: the missing link towards a greener economy 42
Fulvia Farinelli, Marino Bottini, Sule Akkoyunlu and Philipp Aerni

Innovation and Industrial Development in Africa

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Abstract

The paper attempts to explore the role of innovation in industrial and economic development of a country and tries to offer an overview of some of the challenges and key elements that may be significant in building an innovative industrial base in Africa. This is triggered by the belief that poorer developing countries do not exactly depend on innovation to remain competitive on the global market. In other words, innovation is seen as key to advanced economies with sophisticated firms that invest significant resources in research and development (R&D), which is not the case with most developing countries. Hence the processes of technical change led by innovations are usually seen as a privilege of industrialized economies. In this paper, we attempt to show that African countries that seek to develop competitive and sustainable firms or economies have to develop, implement, promote and invest in innovation policies, plans and strategies.

1. Introduction

The relationship between innovation and industrial change dates back to Schumpeter's work in various ways and specifications in several countries. He placed innovation at the center of economic change, initiating simultaneously an evolutionary process of creative destruction or as a process of creative accumulation in industrial development (Malerba, 2004). The importance of industrial development as an engine of economic growth and development cannot be overstated. Virtually all of today's industrialized countries actively supported and protected their industries through specific policies and institutions. Africa will need to design and implement similar industrial development strategies to develop a sound industrial and technological base to enable the continent successfully integrate into the global knowledge economy. The continent's ability to modernize, meet its urgent development needs and priorities, and diversify its economic activities and exports will largely depend on the development of dynamic industries (Marti and Ssenkubuge, 2009).

Currently, many African countries depend on a few low value-added primary commodities that suffer from wide fluctuations in international prices. The current rapid growth in Africa's exports, for instance, has been driven by the high demand for primary commodities on the international market that has driven prices up resulting in favourable terms of trade for many African countries. A fall in demand of primary commodities will therefore have catastrophic socioeconomic impact on the African countries that highly depend on these commodities. Therefore, it is important that Africa makes use of the capital accumulation from the commodities-boom period by investing it in the build-up of ans industrial base that enables a diversification and production f goods and services that could lead to expansion of its export base. It would reduce its dependence on low value-added products, hence create new skills, jobs, work attitudes and institutions that could drive future productivity of African economies (Lall S. and Kraemer -Mbula, 2005).

Cognizant of the critical role that industrial development plays in economic development, various initiatives to spur industrial development on the continent have been undertaken. For instance, the Conference of African Ministers of Industry (CAMI), inaugurated in 1971 under the auspices of the United Nations Industrial Development Organization (UNIDO), created a high-level forum to address industrial development issues that affect Africa. In 1980, the Lagos Plan of Action (LPA) for Economic Development (1980-2000) focused on strategies to foster collective self-reliance and sustainable development on the continent, while in 1981, proposals for an Industrial Development Decade for Africa (IDDA) were adopted at the Sixth CAMI. Under the IDDA, industrialization was observed as a means of attaining self-reliance and self-sustainability as foreseen in the LPA. In 2001, the New Partnership for Africa's Development (NEPAD) adopted a common vision and strategy for the attainment of Africa's sustainable development, and in 2005, the African Union Commission (AUC) and the New Partnership for Africa's Development (NEPAD) adopted Africa's Consolidated Science and Technology Plan of Action (CPA) 2006-2010, which articulates Africa's common objectives and commitment to collective actions to develop and use science and technology for the socio-economic transformation of the continent and its integration into the world economy. It is based on three interrelated pillars of capacity building, knowledge production and technological innovation contributing significantly to the development of the knowledge society on the continent.

In 2008, the Summit of the Heads of State and Government of the African Union was devoted to the issue of industrial development in Africa. The dedication of an entire meeting of Heads of States and Government to industrialization attested to the political will and importance accorded to industrial development. During the Summit, a "Plan of Action for the Accelerated Industrial Development of Africa (AIDA)" was adopted. The Plan was complemented by a Strategy for Implementation, adopted during the 18th CAMI in October 2008.

Notwithstanding all these initiatives and experiments with diverse trade and industrial policies, the contribution of the industrial sector to Africa's growth is well below its envisaged maximum productivity levels. Currently, the continent remains the least industrialized region of the world. For instance, the share of sub-Saharan Africa (SSA) in value-added global manufacturing actually declined in most sectors between 1990 and 2000 (Lall S. and Kraemer-Mbula, 2005) and industrial production and exports in most African economies have declined in relative importance, diversity and sophistication. Africa's share of global manufacturing production (excluding South Africa) fell from 0.4 percent in 1980 to 0.3 percent in 2005 and its share of world manufactured exports fell from 0.3 to 0.2 percent over the same period. Africa's share of manufacturing in GDP is about one third of the average for developing countries. Per capita manufactured output is less than 20 percent while exports are less than 10 percent of the average for developing countries. Currently, Bangladesh alone produces as much manufacturing value added as the whole of sub-Saharan Africa, excluding South Africa (Page, 2010).

Almost two-thirds of Africa's merchandise exports are accounted for by agricultural, fuel and mining products. The continent's post-independence leaders looked to State-led, import substitution industrialization as the key to rapid economic growth (UNECA, 2010). The industries they created, however, were frequently uncompetitive and unsustainable and efforts to spur industrial development largely vanished with the economic crises of the 1980's and 1990's. This to a greater extent is envisaged to have been due to the minimal emphasis placed on science, technology and innovation (STI) in the industries on the continent during the time.

The period between 1980 and 2000 is characterized by the implementation of very unpopular policies to liberalize African economies. In particular, the privatization and liberalization policies promoted by the World Bank and IMF under the Structural Adjustment Programmes (SAPs) which led to the collapse of many uncompetitive state-owned enterprises, relocation of foreign firms and loss of jobs and revenues in many countries. Although there are valid arguments that it could have been implemented with a 'human face', one cannot deny that it's the investments that followed these draconian policies that are now bearing fruits. For example, African exports continued to grow despite a large contraction in 2009 due to the global crisis, as they rebounded by 25 percent in dollar terms in 2010, outstripping world export growth of 21 percent (UNECA, 2012).

As stipulated earlier, one of the elements that was neglected immensely in the 1990s was the promotion of innovation. The budget for education, R&D, subsidies for innovation and technology acquisition, among others, were either eliminated or greatly reduced during the period. A host of institutions and other research centres were required to raise their own funds and expected to expand their private operations to raise funds, with minimal government support.

However, the notion of national industrial policies has made its way back to many African countries, with new and reviewed industrial strategies over recent years. This is an indication that, after swinging between two extreme positions (i.e. the import substitution and structural adjustment policy prescriptions), governments are reflecting on the policy mixes that best suit their current needs (Page, 2010). It has been suggested that the most effective policies in spurring growth seem to be the ones directed at supporting investments in education, training and innovation. This is deemed to be achieved through some selected and targeted policies encouraging experimentation and innovation as the essential ingredients of growth-oriented industrial development (Di Maio, 2008).

The main objective of this paper is to show that African countries which seek to develop competitive and sustainable firms and economies, as well as products and services have to develop, implement, promote and invest in innovation policies, plans and strategies. The paper is structured as follows: Section 2 describes the history behind innovation policy and strategies, Section 3 highlights the current status and the challenges that hinder innovation and the development of a sound industrial base in Africa. It then proceeds to provide framework elements that could be considered by policy makers seeking to promote innovation for industrial development in their countries in Section 4. Each of the elements described includes a number of examples drawn from the experiences of countries inside and outside Africa. Section 5 summarizes the main findings and conclusions.

2. Historical perspectives to innovation and industrial development

Already in the 1970s, it has been widely argued that the dismal performance of the industrial sector has, to a great extent been due to the fact that many of the African firms have been largely passive technology learners that merely focus on adoption and routine operation of externally supplied technologies, especially where technological effort developed is essentially aimed at the absorption of production capabilities. As opposed to active technology learners such as Singapore, South Korea etc., African countries have not built any significant innovation capabilities i.e. the technological effort aimed at mastering the production capability together with the improvement capability (Viotti E.B., 2002; Bell and Albu, 1999). Any domestically generated industrial technological change has been essentially minor, adaptive and routine maintenance involving little or no technological creativity and upgrading. The main technological tasks have been to acquire and learn how to operate

and use the available technologies and undertake investment and production activities. As a consequence, the improvements have been marginal hence they could not compete or keep abreast with dynamic and innovative firms that have been emerging globally.

Recognizing the significance of knowledge and technological innovations, several science and technology (S&T) initiatives have been launched in African countries that sought to use S&T as a vehicle for achieving rapid economic development. During the 1970s, many African countries established national research councils and R&D centres. This development was partly driven by the Conference of Cabinet Ministers responsible for the Application of Science and Technology (CASTAFRICA I) held in Dakar, Senegal in January 1974. Consequently, by the time the second conference was held in 1987, the number of African countries with S&T promotion bodies increased from 4 to 28. Several R&D institutions specializing in natural sciences, agricultural, medical, nuclear, industrial and environmental research also increased rapidly on the continent. Almost all of these institutions were government-funded and were predominantly geared towards agricultural and primary products research (Adeboye, 2000).

Several international organizations have played significant roles in the development of S&T policies among African countries. They have supported S&T development efforts through science, technology and innovation policy reviews, the establishment of networks of centres of excellence, promotion of transfer of technology and development of higher education and R&D institutions etc. These organizations include UNESCO, UNCTAD, IDRC, the Swedish Agency for Research Co-operation with Developing Countries (SAREC), etc. African governments have also taken strides in developing S&T in order to enhance contribution towards socio-economic development in their respective countries. In most of the countries this was envisaged to be achieved through the development and application of S&T in order to improve the people's living standards and quality of life. However, it is observed that these initiatives mostly focused on the development of science and technology without or with minimal emphasis on identification of characteristics in the public research systems that could have increased learning and innovation performance. Since the most effective policies in spurring growth seem to be the ones directed to support investment in education and innovation (Di Maio, 2008). The level of education among entails the ability of African countries to transform and integrate into the global knowledge economy in terms of human capacity development and their ability to convert knowledge and innovation into economic growth and development. Education is the key element of a knowledge-based, innovation driven economy as it affects both the supply and demand for innovation (Dahlman, 2005). Human capital and skilled labour complement technological advances in this regard. New technologies cannot be adopted in production without a sufficiently educated and trained workforce. The demand side is also important since innovations may not take place in the absence of educated and therefore demanding customers and consumers. This calls for a critical look at the educational development trends in Africa in order to make sure emphasis is placed on educational levels and skills development that have a significant impact on knowledge and innovation as they contribute to the growth of these economies.

Educational systems, particularly higher education systems, increasingly play a critical role in the innovation system of a country. Some of the key trends that have driven this belief include the increasing collaboration between the private sector and research universities, increasing protection of knowledge generated in universities (e.g. patent applications and grants), changing mandates of research universities and commercialization of university knowledge. The performance of a research university is no longer measured just in terms of courses offered, research undertaken and numbers of students graduated or size of faculty. Instead, universities are increasingly competing in terms of patent applications and patents granted, papers published in top journals, number of licenses issues and start-ups or spin-offs seeded. It has been observed that the mandates of educational institutions have increasingly taken on board the need to perform R&D activities and entrepreneurship.

The current speed and magnitude of technical change makes the ability to innovate and use of new technologies critical to industrial development. Manufacturers or service providers have to continuously innovate to remain competitive given the short life-cycle of products on the global market and the continuously changing technological developments. This entails the need for African countries to build the necessary capacity required to continuously absorb, utilize, adapt and upgrade new and existing technologies to improve the production processes and diversify their product ranges in order to remain competitive. As such, innovation becomes a critical driver in industrial development on the continent, especially through academia-industry-government partnerships. For example, in 2006 alone, the United States Federal Government R&D support to industry and universities was about $20.9 billion and $30.1 billion, respectively. At the same time, industry supported R&D expenditure in United States universities stood at $2.4 billion. It indirectly shows the presence of university-industry-government relations in R&D projects.

Traditionally, innovation is seen as the process of combining resources in new or unusual ways to generate new or improved products (goods and services) and processes. These improvements or advancements may range from slight improvements on existing ones to major leaps in performance and changes in technology systems and economic paradigms. These technological innovations will not be possible without significant investment in R&D and education, which generate basic scientific and technological knowledge upon which the creation and dissemination of innovation are based. Innovations may also be non-technological. Non-technological innovations may refer to new and improved ways of organizing internal business practices, external relations and market approaches. In simple

terms, non-technological innovation could be viewed as changes in the way organizations undertake their activities as well as new rules that facilitate improved cooperation among stakeholders. For example, the ability of customers to book tickets and hotels, access bank accounts and apply for entry visa over the Internet is enabled by new business models and practices that permit these activities to occur via virtual contacts in addition to or instead of physical presence.

These advancements are made possible by investment in knowledge generation, supportive policies that promote experimentation, market conditions that encourage the entry of new and innovative products, business methods and entrepreneurs. Nowadays, producers of products and processes have to continuously innovate in order to remain competitive, which to a greater extent calls for an increasing role of end-users (consumers) to participate in the development of desired products and services (see Yusuf and Evenett, 2002). Innovation therefore must be regarded as a core objective of a country seeking to develop a competitive and sustainable industrial base.

3. Challenges to innovation for industrial development

In order to apply new innovative ideas and knowledge to tackle development challenges, knowledge needs to be created first. Hence, investment in education, especially in S&T is fundamental in generating ideas that stimulate or drive innovation. An assessment of Africa's current conditions reveal that primary education of many African countries has greatly expanded in the last two decades However, its secondary and tertiary education levels, which are vital in promoting technological innovations, lag behind most of the global regions. Africa, especially sub-Saharan Africa tops all the five regions of the world in terms of primary school enrolment, especially due to the emphasis placed by both African governments and donors on promoting primary education. The fact that the region is behind all other regions in terms of secondary and tertiary education (as a level or stage of studies beyond secondary education) may account for the relatively low technological outputs from Africa, especially if captured in terms of the number of scientific and technical journal articles, number of researchers in R&D, patent applications and high technology exports (see GeSCI, 2010). However, this might also have been exacerbated by the non-existence or weak innovation systems in many African countries.

Africa continues to lack the basic infrastructure and facilities that are essential in supporting an innovative knowledge economy. The skills level of its people, technological sophistication and innovative capabilities of its institutions and firms remain low on the continent. It should be emphasized that both the supply and quality of education and skill underpin the long term ability of countries to assimilate and master new technologies. Education helps to increase the S&T absorptive capacity of a nation, enabling it to benefit from S&T inputs from a multitude of sources such as capital goods imports, licensing, spill-over effects of foreign direct investment (FDI) etc. (Yusuf and Evenett, 2002). The continent has also registered limited increase in R&D expenditures by foreign affiliates, it has attracted very few R&D projects and recorded the lowest growth in foreign patent applications and trademarks registered. Existing data also suggests that Africa lacks or is still in the early stages of developing some of the key institutions needed to promote investments in STI, such as R&D centres, venture capital firms, patent offices, S&T academies etc. These institutions help in providing a clear leadership that appreciates and promotes creativity, innovation and entrepreneurship (UNECA, 2010). Very few African countries have strengthened these institutions to exploit existing opportunities and meet emerging development challenges.

With reference to technological knowledge and innovation outputs, as shown in Figure 1, Africa is the only region that spends more than 10 times on imports of capital goods than it earns in exports of similar goods. Asia's capital trade balance has increased from about US$33 billion in 1995 to US$59 billion – emerging as a net exporter. Although Latin America and the Caribbean (LAC) region is still a net importer of capital goods, its exports of capital goods have grown at the same speed as Asia (3-fold). Africa is not just behind in the production of capital goods and other high-technology products, it also has the lowest number of researchers and least number of authors of peer-reviewed scientific and technical journal articles in comparison to other regions (Hill, 2004 and VTT, 2010). This suggests that Africa is not investing heavily in acquisition, use and generation of knowledge, and therefore may not be attracting significant R&D intensive FDI (UNTAD 2005).

AU-NEPAD (2010) has shown that funding levels for scientific research remain low in sub-Saharan Africa. It showed that only three – Malawi, Uganda and South Africa – topped the 1 percent spending threshold in 2007. The report also reveals that apart from funding problems, many scientific labs are poorly equipped and science students get little practical research training because research centres are often separated from universities, with most of the countries relying intermittently on foreign funding. Sometimes even when research is successful, it is difficult to bring the developments or outputs to the marketplace, due to lack of coordination between research institutions and the industries, signifying lack of strong and effective national innovation systems on the continent.

Africa is, however, not short of talented innovators and entrepreneurs as demonstrated recently in some sectors such as ICT and education. The growth of the mobile telecommunication industry in Africa was led by firms that were born on the continent. Some of the leading firms, such as Vodacom, MTN, Orascom, were all headquartered on African soil while CelTel (now Airtel) had mainly African investors (Kelly, 2004). Similarly, entrepreneurs are driving growth in the African education sector. In countries such as Ethiopia and Kenya, private colleges and universities are starting to rival those run by the government at least in terms of number of establishments. A study by UNCTAD stated that domestic investment growth in Africa was truly remark-

able especially over the period 2000-2007, during which Africa outpaced even Asia (UNCTAD, 2008).

The role of innovation in industrial and economic development could also be assessed through technology transfer. For example, UNECA (2010) has shown that Botswana, Korea, Mauritius and Tunisia had a GDP per capita of less than $300 in 1970. Today, all these countries are regarded as successful examples in their own rights. By 2007, the GDP per capita of Korea had increased nearly 70 times (from $280 to $19,500) while that of Botswana, Mauritius and Tunisia stood at $5,200, $6000 and $3,300 in 2007, respectively. Today, Korea is home to some of the world's largest transnational corporations such as Hyundai, LG and Samsung. One of the major differences is the rate at which these countries acquired and adapted foreign technologies.

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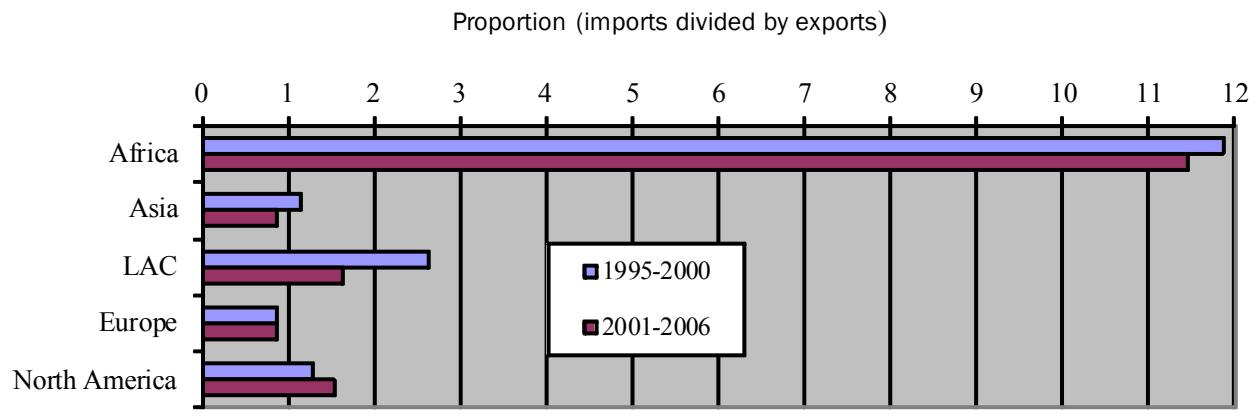
Figure 2 shows that despite Korea leading the selected African countries over the period under consideration, all the countries experienced on average an increasing trend in royalty and licensing fee payments. Also it is observed that Botswana bypassed Korea over the period 1989-1993 before dropping between 1993 and 1996. These increasing tends may entail to some extent the increasing trend in transfer of technology to these countries, while some of these assets such as trade marks, who do not necessarily represent technology transfer, may signal the existence of the growing confidence and trust in domestic industrial processing cooperation. In 1978 Korea's royalty and licensing fee payments (about $2,000,000) were about 17 times higher than that of Botswana ($121,000). As of 2007, Botswana paid $11 million while Korea paid about $5 billion (about 450 times) in royalties and licensing fees (UNECA, 2010). This indirectly reflects the differences in the industrial and technological base of the countries. Specifically, it reflects the fact that Korea has developed firms that produce sophisticated products while Botswana has not yet developed a sophisticated industrial base. It also indirectly shows that African countries are largely relying on basic knowledge and technologies for which no or little technology transfer related transactions are required (e.g. tractors, seed driers and cleaners). In order to produce cars, computers and cellular phones, a company will need to use technology developed by others to remain competitive as technology evolves very fast.

In terms of patent applications, it has been observed that Africa is the only region where patent applications have fallen between 1990 and 2004. Based on national reports to WIPO, the number of patent appli-

Figure 1. Annual average imports of capital goods as a proportion capital goods exports



Source: UNCTAD Handbook of Statistics

cations granted worldwide grew rapidly after 1990 and 1996. Since then the number of patents granted per year have grown only marginally during the period 1997 to 2004. The number of patent applications has grown rapidly in Asia, LAC and industrialized nations but only marginally in Africa (See Figure 3). However, the drop in Africa's data after 1995 are due to the missing data from Sudan and South Africa, as they have not reported their resident patenting activities since these dates. The number of patents filed by foreign firms indicate the presence of foreign affiliated firms that undertake R&D activities in the country (UNECA, 2010).

Studies have shown that political commitment to the development of STI for development is a challenge. This is evidenced through the analysis of the synoptic review of the national Poverty Reduction Strategy Papers (PRSPs), which reveal that the incorporation of S&T issues in PRSP is weak (Warren-Rodriguez, 2007) . This is further exacerbated by poor governance ranging from corruption to ineffective bureaucracy, which stymies progress in many countries. This signifies, to a greater extent, the lack of appreciation by policy makers with regard to the significance of innovation in economic growth and development.

Countries such as Thailand have successfully transformed their economic structure from being agricultural to industrial based, with the share of agriculture in gross domestic product (GDP) declining from an average of 32.2 percent in the 1960's to an average of 10.4 percent over the period 2000-2010 while manufacturing sector contribution to merchandise exports increased from an average of 2.5 percent in the 1960's to an average of 75.4 percent over the period 2000-2010. African countries seeking to achieve similar transformation in their socio-economic development have to pay significant attention to current trends in innovation, emerging industrial trends, business practices and value chains. This entails harnessing innovation capability of individuals and institutions to build industries that could help transform Africa from an agrarian continent to a producer of value-added goods and services. This could be achieved by putting emphasis on supporting innovators and entrepreneurs seeking to bring new and improved goods, services and processes to the market. This could be done through the provision of financial as well as technical support by exposing the innovators to emerging technological developments and initiatives.

Despite the many problems confronting scientists in Africa, there are signs that they are starting to build momentum. After a relatively slow growth during the 1990s and 2000s, the output of publications is now rising rapidly. In 1996, sub-Saharan researchers produced roughly 0.8% of the total papers in the Scopus database. By 2009, that fraction had reached 1%. This to some extent due to the increasing joint collaborations with researchers in Africa and between those in Africa the developed world (Nature, 2011). Africa's royalties and licensing fee payments have risen from a ltle over $250 million in 1990 to about $2.45 billion 2008 before dropping marginally to $2.37 billion in 2009, due to the financial and economic crisis. This pace of growth is comparable to that of Europe and Central Asia but lower than that of East Asia and the Pacific.

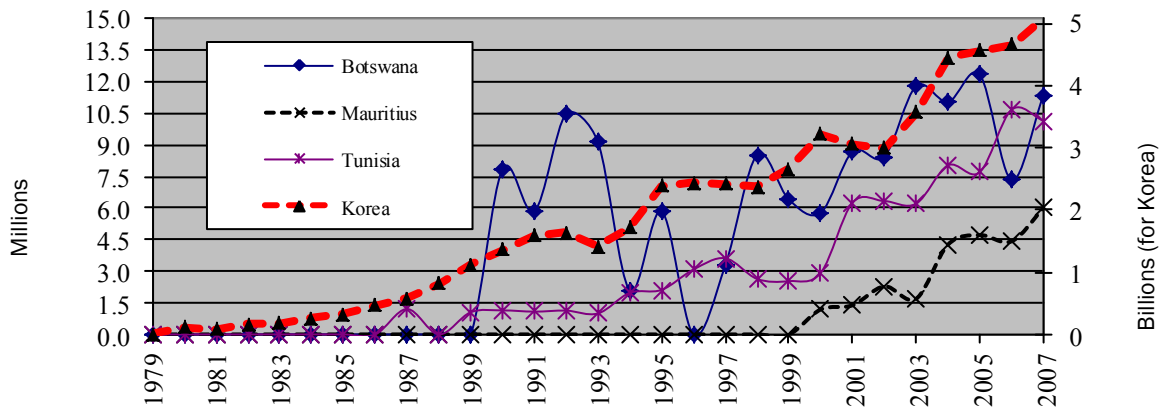
4 Strategies for building an innovative industrial sector

The issues raised in the previous section could be achieved, among others, if there exists a conducive economic and institutional environment; relevant skills and education; infrastructure; and political leadership and support.

4.1 Economic environment

Although it is difficult to define an economic environment that favours growth in innovation, it is generally seen as one which ensures that competition, procurement, financial and intellectual policies, among others, are supportive and facilitative to innovation and industrial development. Such an environment will enhance

Figure 2. Royalty and licensing fee payments



Source: UNECA, 2010

knowledge and technology transfer, generation and diffusion in industry and society in general. For example, increasing innovation financing through provision of special grants, loans and guarantees, subsidies and tax incentives for R&D could promote innovation by encouraging individuals, start-ups and existing firms to invest in innovation and bring their products to the market. Similarly, procurement and competition policies could be used to encourage firms to improve the quality of their products and meet international standards.

There is need to have an effective legal and regulatory framework that encourages fair competition, promotes innovative firms, attracts foreign innovative investors and removes administrative entry barriers. In addition, countries may also need to develop clear technology commercialization rules, including ownership of intellectual property rights on products of publicly funded research. In general, the main goal is to reduce the costs of innovation and entrepreneurship related activities to the individual and the business in a country.

4.2 Human capital development

Advanced skills development and higher education play a complementary role to technological advances in a knowledge economy if the educational institutions respond to the needs in the private sector and the prevailing technological challenges. Improved higher education allows workers to use existing physical capital more efficiently. However, developing countries need to expand not only primary education, but also secondary and tertiary education in order to enhance the diffusion and utilization of knowledge for economic development. In a global economy where technology literacy is becoming important, increasing and improving higher education will lead to a rapid development and dissemination of knowledge, and in turn advancements in technological innovation which is a critical element of the countries' competitiveness. There may be a need to reshape higher education to introduce entrepreneurial training and internships into their curricula as well as encouraging students to commercialize university research. This could be accomplished by ensuring that national development plans incorporate platforms which strengthen the linkages between universities, industry and government (Juma, 2005) in order to promote industry-academia dialogue and exchange. For instance, making it compulsory for higher education students to serve as interns in industrial institutions and academic staff to keep up with developments in innovative companies through exchange programmes as is the case in some highly developed economies. Government financial support is necessary to enable these exchange programmes to work efficiently. This academia-industry-government partnering arrangement, often referred to as the Triple Helix, needs to be operationalized and promoted to function well in Africa. African countries should put in place mechanisms that will encourage them to refrain from relying on intermittent foreign financial and logistical support, so that they are able to develop innovations that are designed to tackle the prevalent challenges on the continent without the interference of donor interests.

As stated earlier, human capital is needed not only to undertake R&D but also to navigate complex regulatory requirements and to successfully nurture and manage start-ups. In particular, Africa needs R&D managers capable of identifying potentially useful and marketable research. In a way, countries need to develop not only science and engineering talents but also technology entrepreneurs and S&T managers to ensure a complete and effective innovation value chain from idea generation to research output commercialization. The availability of experienced S&T managers helps to ensure that the limited human, financial and institutional resources are efficiently mobilized and allocated and potentially useful research outputs are well-protected and exploited to obtain their full potential benefits.

For instance, Africa accounts for about 2.4% of the global researchers – slightly higher than the number of researchers in India. Yet, India was granted three times more patents than Africa, by the United States Patent Office in 2008. More importantly, India is an established information technology powerhouse with software exports in excess of US$48 billion. While it is difficult to make conclusions on such scanty information, it however begs the question on the efficiency of Africa's innovation system and entrepreneurship.

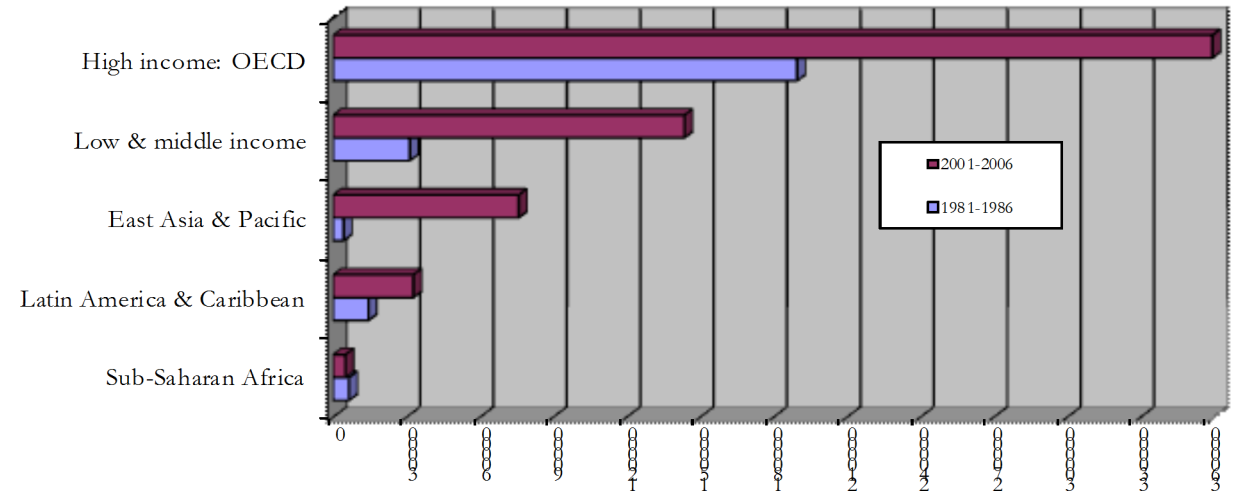
In the United States, it was observed that many of the technology clusters are in regions with most of the critical skills needed to develop the industry. For example, the biotechnology clusters of California and New England (Boston area) have generated a number of biotechnology firms due to the high concentration of top life science research universities which are rich in qualified and experienced scientists, managers and service providers that have been involved in the development of biotechnology firms over the last three decades (Konde, 2009). Their success seems to partly lie in the presence of human capital with the necessary skills to undertake and manage research groups as well as entrepreneurial talent to bring research outputs to the market.

4.3 Academia-industry-government cooperation

In Africa, the private sector is still relatively small and is largely not technologically sophisticated (e.g. most of the SMEs are in the informal sector facing a lot of financial and technological challenges to upscale their businesses). However, promoting cooperation through joint projects and programmes of mutual interest to R&D centres and SMEs/large firms could stimulate generation of research ideas and products/services that are demand-driven. Over time, such cooperation will demonstrate the importance of R&D, especially to SMEs and encourage joint funding and implementation of projects. This relationship would also develop a private sector that can influence training and research agenda of technical colleges, universities and R&D centres and fuel investment in R&D and technology acquisition, enabling African firms to become competitive.

Governments could also require ministries to reserve a fraction of their budgets for promoting STI joint initiatives between their R&D centres and SMEs. For ex-

Figure 3. Average annual patent applications by non-residents



Source: WIPO, 2009

ample, United States agencies with external budgets (for R&D) in excess of $100 million per year are required to set aside 2.5% of that budget for contracts with small businesses. Those with external budgets for R&D that exceed $1 billion per year are required to set aside 0.3% of that budget for cooperative research between small businesses and a federal laboratory or a non-profit laboratory under the Small Business Innovation Research (SBIR) and the Small Business Technology Transfer (STTR) programmes, respectively.

4.4 Innovation infrastructure

STI infrastructure is critical in addressing the financial and knowledge gaps mentioned above. Infrastructure, on one hand, includes networks and information technology which could provide access to management, intellectual and R&D resources as well as key information on sources of knowledge, technologies, market opportunities and potential partners in the sector within and across national borders. On the other, infrastructure, such as well-equipped centres, science and technology parks, technology and business incubators in the vicinity of higher education and research institutions, among other common facilities, could reduce the costs for innovators and entrepreneurs in the process of taking research and new products to the market, increase cross fertilization of knowledge, improve chances of being funded and encourage entrepreneurship. These could include cluster-based industrial development focusing on SMEs which offer a good learning and knowledge exchange avenues, as well as promoting technological innovation. It should be noted that the development scope of STI infrastructure should not be limited to laboratories in universities and R&D centres

There is no single definition of a centre of excellence, but it is often described as one capable of undertaking and producing comprehensive high-quality R&D activities relevant to its mandate and with high economic impact. They possess sufficient scientific critical mass, infrastructure, steady or broad-based funding portfolio and skilled managers. Often, they are focused on one or few areas of specialization such as a single problem or technology field and are expected to generate useful solutions (Araoz, A. (1996). Therefore, centres of excellence in industrial innovation consist of those centres that conduct research and development and provide innovative solutions to industrial development.

For example, the stated aim of the Korea Institute of Industrial Technology (KITECH), a fully government-funded research institute, is to support industrial technology development of SMEs. Since 1989, KITECH has focused on technology commercialization, SME support and development of the nation's strategic industrial technology. KITECH is one of the major research institutes in Korea that helps SMEs acquire industrial technologies and penetrate international markets.

Many African countries invested significant proportions of their meager resources in developing R&D centres whose mandates were to turn natural resources and primary commodities into high-value industrial products through the application of technology. Overtime, some of these centres have transformed into self-sustaining service providers while others are largely dependent on development partners for survival. If industrial development is to be attained, Africa may wish to revitalize its R&D centres to work closely with emerging firms in the various industries. Countries such as South Africa and their R&D centres, such as the Council for Scientific and Industrial Research (CSIR) could help serve as models as well as offer leadership to this regard.

For all these processes to perform effectively and efficiently, an intelligent, reliable and enabling information infrastructure is needed. ICT provides essential infrastructures and tools for knowledge creation, sharing and diffusion thereby boosting innovation capacity of all sec-

tors hence contributing to productivity growth. ICTs play a critical role in organization and coordination of global production networks, and the integration of firms into the global supply chains (Dahlman, 2007). They are key enablers of business innovation and transformation and play a pivotal role in helping countries' economic sectors stay ahead and be globally competitive. To achieve this, the industrial sector as well as the countries themselves should have a vision of where they want to be with regard to the challenges ahead in terms of technological changes and the countries' priorities and needs. This calls for collaborative efforts with sectoral champions to enable the adoption of strategies to enhance ICT innovations and new technologies for greater productivity and economic benefits, hence contributing significantly towards growth and development.

4.5 Political leadership

The development and effective utilization of STI is an essential issue that requires political leadership. The call for political leadership to the development of STI is one of the key and persistent challenges facing the STI sector. Political leadership and support play a vital role in the mainstreaming or incorporating STI issues into the countries' national development plans and strategies. This entails the participation of high-level individuals such as Heads of States and government, cabinet ministers, parliamentarians and STI committees/taskforces with enough knowledge with regard to the role that STI plays in national development, with the core responsibility being that of promoting STI for development in the country. For instance, Thailand's national information technology board was chaired by the Prime Minister. The country carefully screened FDI projects to identify their technological contribution, its investment promotion agency linked SMEs to foreign investor firms and government provided direct support to enable SMEs become competent partners to foreign firms in the electronics industry. As a result, Thailand is a major manufacturer and the electronics industry accounts for about 40 percent of the country's exports.

5. Conclusion

The historical and empirical evidence reviewed shows that industrial policies are necessary for economic growth and development in Africa. However, despite the several initiatives taken by African countries, these economies have remained sluggish and uncompetitive on the global market. Research studies have shown that Africa has performed poorly in the acquisition, adoption, dissemination and utilization of new and emerging knowledge in the past few years in relation to other regions. This has mostly been attributed to the lack of support on elements that are regarded to be the foundations of innovative economic activities such as investments in education, science and technology as well as linkages between the government, industries and research institutions, mainly due to lack of vibrant national learning and innovation systems among African countries. Finally the paper suggests strategies that African countries could take into consideration in designing their innovation policies and strategies in order to remain competitive. The different countries and their institutions should be able to acquire, assimilate, use, adapt, change and even create technologies by putting in place strong national learning and innovation systems. Macro-economic, industrial and educational policies should be appropriate for the generation of an environment suitable for the development of active learning systems in this regard. The African governments are expected to play a pivotal role both on the demand and supply side of the technological learning as was the case with Korea in the early stages of technological development. This should be coupled with the necessary infrastructure with the whole process being championed by well informed and knowledgeable strong political leaders with regard to the significance of STI in a country's development.

Notes

i. The views expressed in this paper do not necessarily reflect the views of the UNECA. The comments from colleagues in the ICT, Science and Technology Division (ISTD) on the earlier version of the paper as well as Mr Phillip Aerni are greatly acknowledged.

ii. Etzkowitz, H. and De Mello, J.M.C (2000) The endless transition: relations among social, economic and scientific development in a triple helix of university-industry-government relations, Rio 2000 Triple Helix III Conference.

iii. For details and break down, see the National Science Foundation Science and Engineering Indicators 2007

iv. Using World Bank data GeSCI, 2010 in their study observed that sub-Saharan Africa experienced the highest primary school gross enrolment rate trends over the period 1990-2008 beating Middle East and North Africa, Latin America and the Caribean, South Asia and East Asia and the Pacific regions.

v. Unless explicitly stated, the term patent as used in this paper refers to utility patents (i.e. patents for inventions) and therefore may not include design and plant patents or utility models. In the United States, utility patent applications and granted represent over 90% of all patent applications. WIPO data generally reflect utility patents.

vi. Calculations are based on the data from the World Development Indicators database.

vii. The term 'global value chain' as used here refers to firms and institutions involved in the conception, design, production, distribution, marketing and delivery of products and services until it is in the hands of the final consumer. E.g. a computer design in the US has components manufactured in Singapore, uses technology sourced from Russia, assembled in Ireland, financed by bank in Japan and sold by retailers in South Africa to end users.

viii. For more details see the upcoming UNECA (2011), African STI Report.

ix. The relationship between the university–industry–government can be considered as a triple helix of evolving networks or an evolutionary model of innovations. See Loet Leydesdorff at http://www.rvm.gatech.edu/bozeman/rp/read/31701.pdf

x. For details, see http://www.sbir.gov/

xi. See Kim, Linsu (1997) Imitation to Innovation: The Dynamics of Korea's Technological Learning, Havard Business School Press, Boston, Massachisetts.

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Empowering micro-entrepreneurs and small businesses through mobile phones in emerging markets and developing countries

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Abstract:

Mobile phones are becoming increasingly affordable for people at the lower end of the income pyramid. This article illustrates by means of two case studies in India and Kenya how user-friendly mobile phone applications have increased access to finance and relevant business information for the poor. As a result, millions of local entrepreneurs in developing countries are able to expand their small-scale businesses by overcoming institutional hurdles and infrastructure constraints. Even though there are still many challenges that have to be addressed, existing experience with mobile phone technology clearly shows that it is able to add more value to local knowledge and thus lead to social and economic empowerment.

In the subsequent sections, three critical success factors are discussed: Overcoming inherent technology risks, the need for educated customers, and the need for providers and governments to collaborate. The article also discusses the potential of mobile phones to contribute to sustainable development by jump-starting an empowerment process that reduces poverty, creates more employment and helps regions to better cope with their social and environmental problems.

1. Introduction

In the past years, access to financial services in emerging markets and developing countries has increased tremendously. IFC, a member of the World Bank Group, alone provided access to finance to 6 million in 2011. The World Bank Development Indicator shows for the years 2006 to 2010 that the poverty ratio, i.e. people living with less than USD 1.25 (PPP) per day, has been significantly reduced in some countries. For example, Peru was at about 45% in 2006, in 2010 the poverty ratio was at 31%. Bangladesh was at over 40% and in 2010 at about 31.5% or Kyrgyz Republic at over 60% and in 2010 achieved a poverty ratio of 34%.

Still, in 2010, about 2.7 billion people–most of whom live in developing countries–did not have a bank account. This largely excludes them from doing business in the formal economy because they cannot count on a safe environment for money deposit, they cannot save for long-term business investments and they are unable to transfer money and make safe payments.

Without access to finance, poor people cannot acquire tools to increase productivity, start a microenterprise or small business, invest in education or health, or even take time to search for better opportunities. Inadequate, inaccessible financial services are undoubtedly one of the reasons why low income people are trapped in poverty.

In the past, monetary transactions required a physical location and people needed transportation to get to the location, both of which can be problematic in infrastructure-constrained countries, particularly in rural areas. Therefore, costs for money transactions have been prohibitive, if possible at all. The same is true for information-based transaction costs. Therefore, we have to assume that about four billion people at the lower end of the income pyramid pay a higher price for services and products. This so-called poverty premium in infrastructure-constrained countries is even more articulated in, e.g. healthcare, energy use.

The empowering potential embedded in enabling technologies such as mobile phones is the focus of this article. We look at mobile phones from mainly three aspects: First, the lower transaction costs leading to access to financial services to large segments of people at the low end of the income pyramid such as micro-entrepreneurs, smallholder farmers, and small businesses. Second, we highlight how mobile phones contribute to reducing the poverty premium through lower information-based transaction costs. And third, we highlight how participation in communities leads to educated, empowered decisions. In other words, mobile phones allow people to empower themselves, access knowledge and contribute to communities – within their reach and capability. This will also be illustrated and discussed in the two case studies below.

Opportunities and challenges of enabling technology such as mobile phones can play a crucial role in working towards a better world or initiating such development.

2. Opportunities created by Mobile Phones

At the end of 2010, about 73 percent of the world's mobile phones were used in developing countries. In the African region, the penetration rate has reached an estimated 41 percent (compared to 76 percent globally), leaving a significant potential for growth. A key opportunity in this development is to provide financial services at lowest possible transactions costs in an environment where most people make one to two transactions a month with very small amounts transferred.

Let us take a close look at the cost of money transactions, i.e. getting cash into and out of brick and mortar banks. The Gates Foundation recently published the results of a survey conducted with seven service providers in Asia, Africa, and Latin America that compares the costs of servicing a transactional savings account in the traditional way—that is, by facilitating transactions at bank branches—with the cost of doing so using third-party service providers such as mobile phone companies that are empowering users to perform cash-in and cash-out transactions.

The magnitude of the difference is striking. The monthly cost of servicing a savings account using a cashier in a bank branch, even assuming full utilization, was roughly four times greater than doing so using mobile phone company services. The big driver, as one might expect, is the allocation of fixed costs associated with branch construction and setup: According to the Foundation's analysis, "a branch cashier incurs more than 78 cents in fixed costs per transaction, compared to just... 4 cents or less for a mobile-enabled transaction or mobile wallet".

Also, unlike a brick & mortar bank, which typically distinguishes between profitable and unprofitable customers based on the likely size of their account balances and ability to absorb credit, the business model for mobile money looks differently. For example M-Pesa, where M stands for mobile, Pesa for money in Swahili, serves any Safaricom mobile customer who pays for an account. M-Pesa is the product name of a mobile-phone based money transfer service of Safaricom, which is a Telkom Kenya and Vodafone affiliate.

The high cost of facilitating deposits and withdrawals in bank branches is a major stumbling block for financial inclusion. You don't have to be a banker to think that it will be hard to make money offering poor people accounts when it costs you 78 cents to facilitate every deposit and withdrawal, particularly since poor people's account balances are typically small, meaning you can't earn much by lending those deposits out. Banks can solve this puzzle by charging customers fees; but fees drive price-sensitive poor customers away.

Using low-cost agents to facilitate cash-in and cash-out transactions is therefore an obvious way to make financial services more affordable to micro-entrepreneurs and small businesses. Some banks, mostly in Latin America, are using networks of cash-in/cash-out points such as Globokas Peru. This network serves users from different financial institutions, for example BBVA Continental, Mibanco, various Peruvian Cajas, Banca Financiera. Others are leveraging networks built by other partners; a number of banks in Kenya allow their customers for example, to make deposits and withdrawals via M-Pesa.

Reducing the cost of deposits and withdrawals by setting up networks of independent retail agents is one of the most important roles that non-banks can play in financial inclusion - and it's one of the reasons that banks and non-banks alike need to be able to set up networks of independent agents. If they can't, bank branches will remain the sole gateways to financial access - at the expense of those who lack it.

2.1. The potential of mobile phones to reduce poverty

Another key opportunity of adopting mobile phones lies in reducing the poverty premium through lower information-based transaction costs. While these costs have continued to keep farmers and small businesses entrenched in their subsistence or shadow economy, the mentioned penetration of mobile phones may change this even in rural areas, where communication and transportation infrastructure are often non-existant or unreliable. Mobile phones have the potential to leap-frog these obstacles by delivering valuable information to people in hard-to-reach places. For example, farmers can get information on micro-climate, local market prices and other subjects of relevance in a rich-content format. At the same time, applications on mobile phones, such as the Tata Consultancy Services Mobile Agro Advisory System enables farmers to send queries in their local languages specific to their land and crops, and receive personalized replies from agricultural experts on their phones.

John Jagwe concluded in his research thesis about impact of transaction costs on the participation of smallholder farmers that access to market information is extremely critical to decide about market participation. As regards the intensity of participation, the study established that price is an incentive to sell. Perishable goods are also more sensitive to the effects of transaction costs.

Studies have shown that mobile phones can play a role in reducing information-based transaction costs. For example, Jensen illustrated that the adoption of mobile phones by fishermen and buyers in Kerala (India) resulted in a dramatic reduction of price dispersion and the complete elimination of waste. Similarly, mobile phone usage among grain sellers led to significant reductions in grain-price dispersion net of transport costs across markets in Niger.

Information-based transaction costs as well as other costs related to seeking this information, which are defined as "search costs" can be reduced throughout the stages of the value chain. Harsha de Silva et al have shown that on average, 15% of the cost of production for vegetables account for transaction costs of which 11% are search costs.

Evidence from literature suggests that transaction costs are the main obstacles that prevent people from participating in markets. With the increasing concern in regard to reducing poverty in the world, lowering transaction costs within the value chain is one of the key elements to ensure sustainable growth, which will in turn have an impact in reducing poverty. Micro-entrepreneurs, small businesses or small-holder farmers reducing costs throughout their value chain will be able to realize higher profits and greater efficiencies.

2.2. Participation and empowerment in local communities through mobile communication

As a third opportunity, we would like to highlight, how participation in communities leads to educated and empowered decisions. A group at the University of Illinois has produced several videos that demonstrate simple, low-cost ways to improve the lives of people in the developing world. One video shows farmers how to make a natural insecticide out of seeds from a local tree. That visual information includes a video of how to close specially-designed storage bags so that they are airtight and protect crops from insect pests. "Closing the bags is something that, if you see it, you will understand it very quickly, and most people do. But explaining it in words is quite difficult". The research team concluded that one of the most remarkable things about mobile phone videos is how fast they can spread. It is interesting, not surprisingly though, that locally developed videos where people are able see their local landscape, for example the way they build houses, their granaries have a higher adoption rate and culturally, it is more appropriate.

2.3. Mobile phones and health care

In addition, mobile phones have the potential to revolutionize health care in developing and emerging countries, particularly in the area of health awareness and training health care professionals. Mobile phones are generally affordable and available, making them more accessible than computers and far more cost-effective than hospital beds.

A United Nations Foundation Partnership with the Vodafone Foundation focusing on mHealth for three years came to the conclusion that mobile phones are so ubiquitous in emerging markets that they are now being used to enable patients adhere to their prescriptions, to convey education programs to improve health awareness, or to conduct data collection and training of health care workers.

Educational awareness can be improved by using simple text messaging to disseminate information. A group called Text to Change operating in Uganda sends small text messages (SMS) to the population to improve awareness of HIV Aids treatment and prevention. SIMpill is another example of an SMS service, being used to help combat diseases. This time it is about making sure people take their medication. It was used during a 2007 trial in South Africa to ensure people took their medication for tuberculosis (TB). In the pilot, 90% of patients complied with their TB medication compared to 22% to 60% take -up without it.

To conclude, mobile phones empower people at the lower end of the income pyramid to become better integrated into the formal economy. Mobile phones allow them to significantly reduce transaction costs, to participate in markets through lower information-based transaction costs, and most important, to allow them to engage more actively in their communities, which in turn, leads to educated decisions in local business and politics.

3. Critical success factors

Mobile phones are a great tool of empowerment for the reasons discussed above. Nevertheless there are three critical success factors that have to be taken into consideration:

First, the challenge to overcome inherent technology risk associated to mobile phone users. Second, the need for customers to be informed and what that means for service providers, and third, the need for collaboration between providers and governments for reliable infrastructure and support of services for users, i.e. the right balance between customer protection and facilitating access to a new market has to be found.

Technology risk such as fraud or theft is one of the critical factors when it comes to mobile phones offering access to financial services. Fraud can take place both at the customer level where his/her account is being compromised by the fraudster or at the system level where the fraudster is able to overcome security measures and thus gains access to financial information and money. This factor is of particular importance for mainly two reasons: First, customers are new to the services provided and due to their unfamiliarity with the system might often be more prone to fraud. Second, in countries where transparency at the government or company level is not always guaranteed, fraud will be difficult to detect and assess in magnitude and scale. This makes it particularly dangerous for customers. Third, infrastructure that supports mobile phones and payment systems in emerging countries is less dependable. A reliable infrastructure is often taken for granted in the developed countries and damaged systems are expected to be quickly fixed. This is not necessarily the case in emerging markets. Mobile networks often are at higher risks of breaking down due to the tougher environments. Also, it is more difficult to repair them due to lack of supporting infrastructure.

The second critical factor is related to the usage of the new services. Being able to use mobile services cannot be taken for granted. Illiteracy, for instance, can be a major obstacle to the usage of mobile phones and its related services. Usage also needs to be widespread to reach its full benefit. In communities where mobile phones are only accessed by a limited group, this group is at risk of taking advantage of the information asymmetry against other members. The risk is particularly

important in communities already prone to such exclusions, so we observed. Also, people at the lower end of the income pyramid need the ability to understand and use the credit offerings provided on mobile phones in a correct way. For example, accessing a loan via mobile phone from a microfinance institution can be a great benefit to micro-entrepreneurs and small businesses. However, procedures need to be in place to make sure the offerings are properly understood. In case of a loan, this would mean that the users know the difference between cumulative interest rates and simple interest rate so that they can understand the actual cost of the loan. Many other aspects of the loan would have to be clearly communicated such as terms of lending, penalty of no or delayed repayment, risk of default, contact person in case of problems, etc. Moreover, electricity might be shut down or not be available in the customer location creating potential problems to complete a transaction or recharge a phone. Mobile operator signal strength might not reach a region or the operator of the financial service (where separated of the operator) might experience downtime. These factors are risks to the customers that need to be taken into account when considering the virtues of the technology.

That brings us to the third critical success factor, namely that throughout the value chain, the different participants need rules and regulations for fair play: Customers should draw as much benefit as possible from the technology but keep safeguards in case of technology failure. Companies involved should understand the situation of their customers and the importance of building reliable and easily understandable offerings.

4. Selected cases shedding light on technology serving development

Case Study 1: Voice technology revolution in India

Financial inclusion is a major challenge in India. Today 41 per cent of the population is unbanked and the number of loan accounts constituted is a mere 14 per cent of the adult population. This exclusion from payment and credit is due to different factors. On the supply side, a lack of infrastructure, government regulation and high management costs act as major barriers to entry. On the demand side, distances to bank branches, lack of awareness, social exclusion, cumbersome documentation and procedures, unsuitable products and language barriers act as main impediments.

These challenges are now in the process of being overcome. The first push was made by the government. A major move was made in September 2010 when the Reserve Bank of India (RBI), decided to allow banks to engage for-profit companies as Business Correspondents' (BCs). These BCs, such as small shop owners, are now allowed to provide banking services that used to be performed at the branch level of the bank. As a result, the use of existing local distribution channels enabled a dramatic reduction in the cost of implementation of banking services. The second major push comes from the technology side. Mobile phones subscription in India has soared in 2012 to 65% of the total population and is now adding a staggering 20 million new subscribers every month. This is a crucial change as mobile phones today can be used to perform both the customer's unique identification and the interactive communication necessary to perform a transaction. Some of the most innovative technologies allowing for such purposes are Voice Recognition Technologies. Uniphore, a Chennai based start-up, is developing such technology. This technology uses Voice Biometrics in vernacular languages to identify users. Furthermore a speech recognition technology is used at Uniphore to recognize customers' requests and answer them in real time. Both together are allowing for the first time for a full transaction to take place over the phone. The final enabler can be found in the ecosystem that one can find in India. Looking at Umesh and Ravi, the two founders of Uniphore, we see key ingredients for a company to reach excellence. This includes a highly skilled and trained team, a strong board with deep industry know-how and understanding on regulations, a work environment filled with successful entrepreneurs and privileged access to know-how, mentors and finance to be found in different incubators and investors reaching the business.

The results have been impressive and Uniphore technology is now being used by more than half a million users while the company has been building relationships with over five banks including the State Bank of India. The impact on the community has also been strong. Take Alam, a Business Correspondent that is now using Uniphore technology. Alam describes how in the past, villagers used to travel over 40 kilometers outside of their village to reach the closest place with banking facilities. Villagers are now coming to him in Khathalguri offering him a customer base of over 800 people. Not only did his financial position improve but it created him a new identity. Indeed, he became more than just a banking outlet and is now seen as a trusted authority, teaching his customers about the importance of savings and the use of banking services. Also, villagers using the technology can now make more transactions and reduce their cost of transactions thanks to less travelling. Besides new customers, particularly illiterate people that used to be excluded due to their inability to fill the required forms, have also joined the service and have now the chance to access fully fledged financial services. Although Uniphore technology is now empowering people in more than five industries including Agriculture, Education, Retail, Healthcare and Finance, there are still many challenges ahead.

At the start, Uniphore's greatest challenge was to understand its customers' needs and requirements. For instance, many transactions were not going through for no apparent reasons and customers stopped using the service. Some reasons were found in customers' cultural habits where for instance clients asked to give their names were systematically adding a greeting before speaking. This was confusing and causing a "false negative", i.e., the right client was not correctly recognized by the system. Other environmental issues such as heavy background noise and changes in mobile phones have also been major causes of false negatives. Yet Uniphore has now improved its technology and is now only counting 3% false negatives and a staggering 0% false positive

(wrong person being rightly identified). The main challenge now remains in clients' education. This not only includes teaching clients how to use the technology but also teaching the clients to trust the system. Voice technologies are very new in India and customer's adoption remains slow due to the lack of awareness on the technology safety and usability as for many it will be the first time they use a service with Interactive Voice Response (IVR) where a computer is used to communicate with them. New challenges are also to come as scale increases. The main ones are found around the technology that needs to ensure low cost transactions, reliability and uptime. The sole use of mobile phones to complete transactions have allowed for cost to remain low. This will need to be further sustained in an environment where Voice Technologies are subject to patents and royalties. Any change in this cost base could negatively affect both the company using it as well as its customers. Besides, the lack of reliability and the ability to have a service constantly running are in many ways the biggest threat for clients. Working poor have a very high sensitivity to failure; most of their earnings are used in daily expenses while only a fraction is saved. Adding to this the fact that these people are often excluded socially and geographically, any problem in the technology causing for their savings to be lost or a payment to be blocked or unavailable could have terrible consequences for the customer and his or her dependents. These challenges need to be overcome if Uniphore aims to fully deliver on customer expectations and reach for the 900 million mobile phone subscribers India has to offer.

Case Study 2: M-Agriculture revolution in Kenya

With 60% of the population living in rural areas, farmers in Kenya encompass the majority of the population. Yet, they face very difficult conditions and over half are subsistence farmers. These farmers often lack information. For example, they do not have access to crop prices and as a result have to sell their products at giveaway prices to eventually abusive middlemen. Farm inputs are also very expensive due to the low quantity purchased and again the obligation to go through a middleman. Last, this lack of information prevents farmers to get access to weather forecast, new cultivation techniques or new crops that might be more suitable for them.

Mobile phones and a young start up called Mfarm are changing the situation for many farmers in Kenya where the mobile phone penetration rate jumped from 5% to 42% from 2003 to 2008, experiencing a growth rate of over 50% per annum. It is via this channel that Mfarm is trying to address farmers' challenges. To do so, Mfarm has developed three main products. The first one allows farmers to check crop prices via their mobile phones. Farmers send a premium SMS to a predefined number and receive in return their selected crop price for the city they chose. Premium SMS is used to insure that Mfarm is being paid for its service but also to allow customers to access the information through any type of handset. The second product developed by Mfarm is a group buying solution. This solution allows farmers to get together and order in groups farm inputs such as fertilizers. The demand is made again via premium SMS while the payment is completed via M-Pesa, Kenya's largest mobile payment system. This model allows farmers not only to cut off the middleman but also get better prices and terms when buying their products. The last product developed by Mfarm is an e-commerce platform enabling farmers to directly sell their products online to buyers in Kenya or abroad. This again allows them to cut the middleman and increase their margins.

The results have been impressive. Mfarm serves over 2000 farmers that are already subscribed to the system and are paying for the service. Mfarm records claim a 50% increase in their profit and a 30% saving on the cost of inputs. This was experienced by John Nderitu, a young farmer living at the outskirt of Nairobi, Kenya capital city. When interviewed by CCTV Nairobi, he explained to have greatly gained from being able to sell his product directly to customers and to lower his purchasing costs. Initiatives like Mfarm are therefore crucial for the development and of self-sufficient food markets in Kenya. Yet it is not only the farmers that are empowered. Mobile technologies are directly empowering entrepreneurs by allowing them to start promising companies at very low cost (Mfarm start up funding was for instance a mere 10'000$). This was the case for Jamila, Susaneve and Linda, Mfarm co-founders and fervent social entrepreneurs.

Mfarms also had to overcome many challenges. The first challenge was to develop an affordable solution that could be easily understood and accessible to all farmers. The second was to offer reliable information. Prices in the markets varies even within a market, finding the right price for a crop hence requires careful attention and extensive work over different cities and markets. Bringing the technology to farmers and showing them how to use it has been another key challenge. Today the main challenge is to scale up operations. This is particularly demanding in a country where Venture Capital investments are not as developed as in Europe or America and where skilled labor is in high demand and expensive. Yet Mfarm developments have been promising. Mfarm emerged as the winner of the Startups Bootcamp event IPO48 in October 2010 and has recently been accepted by the "Unreasonable Institute", a US based institution that aims at "solving the world's biggest problems by arming the entrepreneurs who can take them on with the mentorship, capital, and network to make it happen". They considered the development of Mfarm and how it changes farm business in Kenya and Africa by mobile technologies is of utmost interest.

5) Conclusions

In this article we have shown by means of selected examples in India and Kenya how mobile phones can help empowering the poor by ensuring access to valuable information and dramatic cost reductions for financial transactions. These are very critical aspect considering the small amounts transferred by the poor in remote areas.

We have illustrated that this leap-frogging technology goes beyond improved access to finance but also includes lower transaction costs in the search for business-relevant information. Both are unprecedented enablers to economic and social development in areas most in need for change. The selected case studies point out how people at the lower end of the income pyramid are allowed to become active participants in business that are treated with dignity and equality.

This type of bottom-up development that also leads to an increase in efficiency throughout the value chain of financial transactions must become the backbone of long-term sustainability. Governments, however have to assume their role as facilitators in order to reach continuity and predictability in a highly dynamic environment. They have to ensure a regulatory environment that effectively protects consumers and contracting parties but also enables small entrepreneurs to cope with the cost of regulation. For that purpose, governments should also support an entrepreneurial infrastructure that makes it possible for small entrepreneurs in the informal sector to make the successful transaction to the formal sector allowing them to scale-up their business and grow.

Reliable mobile phone networks and affordable mobile phone services have become an essential part of this entrepreneurial infrastructure. It allows millions of small businesses and micro-entrepreneurs in developing countries and emerging markets to thrive and thus help to meet the many needs in their local environment.

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Exploring the potential of new technologies to facilitate economic empowerment in developing countries: a focus on online networking

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Abstract

2 billion people across the globe have now access to the internet. More than 900 million are using Facebook. In developing countries as well, web connectivity and usage of new, online services are changing the way individuals, companies and governments interact, exchange and trade.

In particular, the emergence of social networks entails the opportunity to explore new ways of doing business. It promises to make the access and exchange of business information and knowledge more efficient and thus allow entrepreneurs who operate in challenging institutional environments to succeed in scaling up their businesses.

Social networks, however, have not become a panacea to solve economic development issues and their sustainability is not guaranteed if they do not meet specific success criteria. This paper will look at different examples of business-oriented social networks. It will analyse their strengths and weaknesses and suggest ways to leverage the networking power of the internet to foster remote capacity building of managers in developing countries by experts working on a pro-bono basis.

1. *The state of ICTs in developing countries*

Massive Infrastructure Roll-Out Drives Access and Usage

The digital-access divide is narrowing down: over the last few years, both the Internet and mobile networks have been rapidly expanding in the world's emerging economies and developing countries, as infrastructure is being deployed and hardware prices are continuously decreasing. The most spectacular growth has been observed in the number of mobile phone users, which has increased from 200 million in 2000 to 3.6 billion mobile subscribers in 2011 (GSM Association). Mobile phones are no longer a luxury good but an essential utility for the poor including those in low-income countries.

This translates directly into economic growth: according to the World Bank, a 10% increase in mobile penetration drives a 0.6% increase in a developed country's GDP and a 0.8% increase in a developing country's GDP. Moreover, a 10% increase in mobile broadband penetration drives a 1.4% increase in a low- to middle-income country's GDP .

Urban areas across the globe are mostly benefiting from the trend, as equipment roll-out is encouraged by high population density which allows for economies of scale and competitive pricing of "pre-paid", or "pay as you go" services. In contrast, the next two billion mobile subscribers will be found in the rural areas of low-income countries, especially in low-density countries such as in sub-Saharan Africa, which remain largely under-covered in terms of mobile networks.

In parallel, the computing capacity of mobile phones is steadily growing and supporting the usage of advanced software applications for business and leisure. Known as "smartphones", these mobile devices are becoming a serious alternative to desktop and laptop computers, offering advanced functionalities and applications deployed on dedicated operating systems (OS), mainly Google's Android OS, Apple's iOS and MS Windows Mobile OS. The very popular Android OS, which is available at no cost, will most likely contribute to the rapid decrease in prices of smartphones in a context of ever-decreasing hardware costs. According to a recent Credit-Suisse study, global annual sales of smartphones will top one billion in 2014, driven by cost-competitive, low-end devices and growth markets such as China. Africa will also massively benefit from the upgrade in phones as new users get access to the technology and others replace low-end devices.

These phenomena significantly accelerate the expansion of the internet. Even in least developed economies, the estimated number of internet users is growing through mobile access and, to a lesser extent, to other wireless connectivity solutions such as WIMAX, while fixed (or wired) broadband subscriptions are increasing much slower. In Africa alone, access to intercontinental telecommunication networks (materialized by undersea fiber optic cables) has seen a sharp rise in so called "landing points", in particular in East Africa, which was until recently depending on satellite connectivity.

As a result, an estimated 2.08 billion people were accessing the Internet across the globe in 2010 according to the International Telecommunications Union (ITU), which leads the effort of measuring the information society. While overall trends are bullish, figures have to be considered with care: measuring Internet access largely depends on usage estimates. People access the web at work, pub-

lic facilities such as libraries or at internet cafés, without actually being formally a subscriber to a service.

With connectivity improving globally, usage keeps growing in parallel. The web now counts over 200 million websites, with thousands of new domain names being registered every day. Some websites attract dozens of millions of visitors a day. While the web still is dominated by its Western origins, it is gradually becoming more diverse and multilingual. Content can be uploaded to the web in Arabic, Hindu or Chinese without the intermediation of English and the Latin alphabet.

2. Advanced Business Networking Usage Yet to Grow in Low-Income Countries

Despite the improving connectivity and the increase in local content, SMEs in low-income countries like in sub-Saharan Africa frequently lack the skills and connections to link up with global markets, leveraging mobile and web technologies. They suffer from their low exposure to international best business-to-business (B2B) practice and are often not able to market themselves in an innovative, cost-efficient manner. As shown in research provided by UNCTAD's Information Economy Report 2011, entrepreneurs in low-income countries still predominately use the web for basic operations such as email as opposed to more sophisticated usages such as cloud-based productivity solutions in developed countries.

It is still unclear whether the above-mentioned usage gap, i.e. the different levels of usage sophistication between small- and medium-sized enterprises (SME) in the North and the South, is being narrowed or widened by the rise of the so-called "Web 2.0", which defines a more dynamic and interactive web. Over the last five years or so, creating web sites, web pages and uploading content has become extremely simple, leading to the explosion of "user-generated contents" and to the web becoming a "conversation" between peers. The conversation distinguishes the one-way, top-down corporate communication seen in the (recent) past from the horizontal interaction between members of online social media. Conversations take place in the developed North as well as in the emerging and developing South. However, to what extent are SMEs in Africa actually leapfrogging "Web 1.0", which they had just started venturing in?

Actually, web and mobile-based social media have emerged as powerful platforms to enhance the competitiveness of enterprises (SMEs and MSMEs) from developing economies, mostly by enabling their marketing & sales capacities.

The diffusion of ICTs in Africa has also lead to the emergence of innovative services, especially in the area of mobile services and applications. Applications and services are being developed for users according to their local needs and habits. M-Pesa, for instance, which is the most well-known mobile banking service in Africa, emerged in Kenya because of the need to provide banking services to a population, which did not have access to traditional banking. It also emerged because the Kenyan financial regulator opted for a laisser-faire approach, as opposed to the more restrictive approaches adopted elsewhere, where monetary control and regulation are slowing down the deployment of similar services.

Other emerging forms of innovative ICT usage with positive economic effects on African business activities are micro-work, sometimes also called "crowdsourcing" and freelancing. Professionals with skills, which can be performed remotely such as the transcription of medical records, logo design and website development, are able to offer their services on web platforms, such as oDesk (www.odesk.com) and Elance (www.elance.com). Their clients can be based anywhere in the world and the transaction takes place online. African freelancers can become substantial contributors to the development of the trade in services in their countries. These online platforms offer advanced networking features, as each user has to create a profile. Buyers and sellers meet online and agree on the terms of the contract on the platform.

Deploying such services has been increasingly easy to do and turn-key services are available at low cost. Users of these services are able to create branded, closed or open networks with many features, such as profile creation, discussion threads, document sharing, multimedia galleries... The UN Global Alliance on ICT and Development (UN GAID), for instance, uses Ning, a cloud-based service provider, to host a customized network of more than 1900 members.

As a matter of fact, online networking has emerged as a powerful and affordable channel for SMEs to expand reach and connect with clients and leads. Global networking platforms like Facebook (900 million users), LinkedIn (150 million users) or Viadeo (45 million users) offer tremendous and mostly untapped opportunities. Similar networks exist at the regional or national level, such as VKontakte in the former Soviet Union and Sina Weibo in China, with already 300 million users.

In Africa, however, the penetration of Facebook was only 5.28% in early 2012, with 41 million users across the continent. It is the most popular social network, while no local player has yet emerged with user numbers on a similar scale. In this context, what is the potential of these networks for African entrepreneurs? How can they be used as tools for economic empowerment? The next section will look closer at the underlying principles of online networking and potential benefits for entrepreneurs, but also challenges in terms of network sustainability.

The way forward: a networked economy building on a networked business community

3. Business-oriented social networks grow increasingly popular

Let us take a step back and understand how these online social networks represent and how they function. "When a computer network connects people or organizations, it is a social network". The quoted re-

search considers that "relations are characterized by content, direction and strength". Content is the information shared by both parties: it can be for instance an update on one's Viadeo profile like "working on a paper on the development potential of social networks: any thoughts?", which will be shared with the person's network. The direction is related to the flow of information. It can be unidirectional (like an update on Twitter, called a "tweet") or bidirectional, and symmetric or asymmetric. The third element – the strength – is related to the intensity of the relation, both over time and in terms of contents exchanged: daily exchanges on Facebook as opposed to an occasional contribution to a small group on LinkedIn. Maximizing the three elements (content, direction and strength) in a social network is likely to ensure its sustainable success.

Moreover, the above-mentioned research showed that people are connected by a set of social relationships, such as friendship, co-working or information exchange. These define the nature of the network. Friendship, and to a certain extent, information sharing, are the underlying motivations for the participation in social networks such as Facebook. Twitter offers a social networking feature (following people and being followed by them and/or others) on top of its main micro-blogging feature (sharing 140-characters of information, analysis, mood). The service has been gaining ground rapidly over the last two years and counts more than 200 million users.

Business-oriented social networks, on the other hand, gather people who are interested in working together and exchanging business information like events, trends, leads... We will review three such social networks, which are used for business purposes, where the emphasis is on working together and exchanging information. We will analyze how they integrate – or not - the success criteria mentioned above. The first one is LinkedIn, a global social network for business people. The second is Com4Dev. It is also professionally oriented but has a narrower geographic footprint (companies listed are either from Africa or from the Caribbean) and a much smaller marketing capacity. The third example is the still small, but very innovative networking platform focusing on e-mentoring, http://match.atdforum.org.

4. LinkedIn, the online business network giant

LinkedIn is a business-oriented social networking service that was launched in 2003. Its users create a profile, which they can easily update, and then are able to access groups, which are open, or can apply to join closed ones. LinkedIn focuses on professional networking so the individual user profile is heavily weighted towards details of qualifications and work experience. Users can connect to a group of contacts based on knowing them from their professional experience, and can receive recommendations from people they have worked with.

LinkedIn allows very powerful business networking, based on company, type of job, or industry. The service also encourages discussions and business questions to be answered by users.

Moreover, LinkedIn allows the creation of open and closed groups, which can be used as discussion forums. It also gives users the opportunity to create company profile pages, featuring information on companies such as news and who has recently joined or left the organisation. Creating a profile page for a company can be a very powerful way of ensuring that related information can be found online. Business partners are able to "follow" a company, i.e. receive information about updates to the company's page. For African companies, this offers new networking opportunities, which so far local online yellow-pages or directories managed by trade-support institutions could hardly provide.

Obviously, the growing popularity of LinkedIn builds on the relevance of information it provides and its relative accuracy. More than 2 million companies have LinkedIn Company Pages and members are sharing insights and knowledge in more than one million LinkedIn Groups. LinkedIn generates revenues by selling hiring services (53% of revenues in Q2 2012) and marketing solutions (25%), while premium subscriptions account for 20% of revenues. Statistics about inactive groups and members, who never or only sporadically update their profiles, are not provided by LinkedIn and little research has been done so far on the topic. Exponential growth in revenue, however, seems to indicate that the network is considered as reliable.

5. Lack of critical mass and value addition jeopardize the sustainability of online networks

While LinkedIn relies on private funding and its stock is being traded at the New-York Stock Exchange since 2011, the "community of opportunities for development", better known as Com4Dev (http://www.com4dev.com/), is a web-based platform, which was set up in the framework of the ProInvest programme, funded by the European Union. Com4Dev offers standard features of social networks such as the creation of a profile, the creation of groups, the sharing of profile updates... There is also a very interesting feature under http://observe.com4dev.com, which visualizes news and events on a dynamic map.

It only requires users to register and create a rather basic profile consisting of the name, country, email address, password and confirmation of password. Registering preferred areas of interest, such as type of actions, focus areas, sectors, products or countries are optional. As a result, most profiles hardly give any information about the user. Many of them are not even linked to an organization or a company. The obvious benefit of giving a maximum level of authenticating information, which will generate the required trust to build a virtual business relation has not been taken into account.

As the platform was launched late in the implementation of the ProInvest programme, its promotion was too short to mobilize and retain users, which needed to be convinced to actually create yet another online profile. Moreover, the marketing of the platform did not leverage all

Region/Country	Total, in millions	Region/Country	Total, in millions
Europe, Middle East and Africa (EMEA)	**44**	**USA**	**63**
	of which:	**Asia and Pacific**	**25**
Europe	**34**		mainly in:
	mainly in:	India	14
UK	9	Southeast Asia	4
France	3	Indonesia	1
Netherlands	3	Philippines	1
Italy	2		Rest of the world, mostly in:
DACH	2	Canada	5
Spain	3	Brazil	8
Belgium	1	Australia	3
Turkey	1	**Total**	**161**

LinkedIn use per region and in selected countries

Source: LinkedIn statistics, March 2012

available channels, online and offline, which are used by private ventures with strong communication planning capacities.

Upon the completion of the Proinvest programme in late 2011, the management of the Com4Dev platform was handed over to the Centre for the Development of Enterprises (CDE). The platform is still being updated, and new users keep registering. Appealing, innovative features like the visualisation of relevant news on a dynamic map could have them actually use the service. An optimistic evolution would be that Com4Dev reaches a critical mass and will be properly maintained by CDE. Another outcome could be the fate of the Global Broadband initiative, an ICT4D portal managed by USAID, which will be not be updated anymore at the end of the summer of 2012, despite its impressive start and sophisticated design.

To summarize the findings from the comparison of the two social networks described above, one can say that there are basically two main networking concepts that can draw on these experiences: building on an established social network such as LinkedIn, by creating a closed or open group. The UK Trade and Investment agency has done so, as well as the Dutch Centre for the Promotion of Imports from Developing Countries. Both set up large networks of LinkedIn members in open groups, where they share information and encourage discussions amongst their members. The other option is to establish a stand-alone networking platform, like Com4Dev. The latter can be fully customized and branded, but is exposed to never reaching the required critical mass to survive, while the former benefits from the fact that it builds on an enormous mass of users, which are exposed to privacy issues and to the fact that social networks like LinkedIn monetize the ownership of their members' data.

6. Leveraging online networks with advanced features: a case for e-mentoring

As shown above, establishing an online network has become extremely easy. Ensuring its sustainability, on the other hand, is getting increasingly difficult for new platforms, which are competing for attention with more established social networks such as Facebook and LinkedIn. Any new online network needs to reach a critical mass of active users to ensure its sustainability. Users keep using online services, which they see as offering value, ideally a value they cannot get elsewhere.

At the same time, as shown in UNCTAD's Information Economy Report 2011, "ICT use can help improve access to advice and training in business skills". Leveraging social networks to that end is likely to yield substantial results for entrepreneurs in developing countries who had previously no access to this kind of support. In view of the above, the "e-mentoring platform" experiment conducted by the National Centre of Competence Research on Trade Regulation (NCCR II) under the World Trade Institute (WTI) with ATDF is certainly an interesting experiment with serious potential to succeed in delivering a useful service, which will ensure its scaling-up and sustainability.

The initiative was funded on a small-scale project from 2009 to 2011 to address the challenges of entrepreneurs by means of an E-mentoring platform that matches searching entrepreneurs in the developing world with supporting mentors in the developed world (see http://match.atdforum.org). The platform links entrepreneurs to possible mentors, i.e. problem-solvers, business partners and investors in Switzerland and other parts of the world. In this regard, it is a powerful tool to promote aid for trade and trade facilitation. The main advantages of this e-platform are (see also Aerni and Rüegger 2012):

(1) The empirical foundation of its design (based on the ATDF experience with an entrepreneurship hub in Zambia),

(2) The numerous and valuable feedbacks to the test-platform in 2010, which were subsequently integrated into the final version

(3) The extensive network of entrepreneur coaching- and mentoring organizations in developed and developing countries that will assist the project team in the creation of a large database of registered entrepreneurs and mentors as well as support activities on the ground.

However, these advantages still need to be confirmed as the platform gets marketed on a large scale and its usage goes beyond the pilot level. If it fails to provide its members with the features they can expect from similar social networks, and if it does not deliver the provision of innovative, differentiating features, such as a functioning online mentoring service with relevant

matches suggested and actually available mentors, it is likely to struggle to gain market share. Its promotion will also need to be as large as possible, leveraging all communication channels. The support of the EMPRETEC network looks promising, as it will also contribute to making the service commercial and sustainable.

7. Conclusion

As illustrated by the above, business-oriented social networks allow users to create profiles, which they can use to promote themselves and their organization, but their value goes beyond mere marketing activities. Groups on LinkedIn, for instance, allow users to exchange information, where more senior users are sharing "pro bono" with less experienced ones; they also allow for discussions among peers. Equally, the Answers section of Linkedin illustrates the tremendous potential of social networks in terms of coaching and mentoring: members can ask questions related to topics such as management and offshoring, and experts are offering answers, which are then rated by the LinkedIn community. Nevertheless, further research is needed to get a better understanding of the actual percentage of members who engage, which will be useful for smaller platforms as they try to build up their membership base.

In any case, LinkedIn owes its success to its considerable resources that enable it to create a critical mass and promote its services. For start-ups such as the e-mentoring platform, which do not have the same level of resources, their success arguably depends mainly on their operating staff and networks of local partner institutions that can help to mobilize potential members online. Hence, the question of financial resources really is at the heart of any such initiative, as illustrated by the case of Com4Dev. Ultimately, a sustainable source of funding, or at least a long-term commitment to manage and promote such platforms, is certainly required.

In the future, we are likely to see a dramatic growth in online networking, which goes beyond merely establishing and maintaining relations. The provision of advisory services, for instance, can, to a large extent, take place online.

The regular growth in connectivity across the African continent will most likely contribute to enlarging the user base for such services. Managing such platforms will benefit from the lessons learnt from successful networking sites such as LinkedIn, and by pondering the difficulties faced by newcomers such as Com4Dev in establishing a network of active users. As discussed in this paper, offering specific advantages such as value-added information and contacts relevant for business to users is key, which in turn will ensure high retention and usage rates.

Footnotes

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iii) http://www.reuters.com/article/2012/04/12/us-smartphonemakers-research-creditsuiss-idUSBRE83B0LS20120412

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Rural housing

Skill transfer and the milestones for scaling-up: The case of Sustainable Rural Dwelling Units (SRDU) in Ethiopia

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Abstract

It is a glaring fact that the Ethiopian rural population, about 80% of the estimated eighty million people, is living in housing units that are substandard and inadequate. This dire situation calls for an immediate intervention for systematic improvement. However, the issue of rural housing is largely neglected by both academics and policy makers. Observing this gap a research project was initiated at the Housing Chair of the Ethiopian Institute of Architecture, Building construction and City development (EiABC). This essay discusses the research project, which is entitled "Sustainable Rural Dwelling Unit" (SRDU). The focus of the research is on developing, constructing and disseminating improved housing units using alternative building materials and construction techniques. The essay discusses the hands-on research and its implementation with emphasis on strategies for capacity building, scaling-up and scaling-out. More often than not projects are prone to remain as one-time interventions short of dissemination. Transferring skill is relatively easier than fostering innovation getting it accepted by the wider population. Achieving scale may take a long period of time and a careful, culturally adjusted strategy. So far the findings of the research indicate that giving hands-on training to farmers, recruited from different parts of the project area, is one of the key methods for scaling-up.

1. Project background

The Sustainable Rural Dwelling Unit (SRDU) research series is initiated and coordinated by the Housing Chair of the Ethiopian Institute of Architecture, Building construction and City development (EiABC). It was started in October 2010 and is still ongoing. The project is supported by the Arthur Waser Foundation of Switzerland and facilitated by the ETH-Zurich North-South Centre. The research project has also local partners, namely: the Bete-Guraghe Cultural Centre (BGCC), the Guraghe Administration Zone and Wolkite University. BGCC is a voluntary association established by Guraghe people to promote the Guraghe culture, while the Guraghe Administration zone is the highest political authority of the area in which the research is located.

The project has three phases: Phase- 1 deals with the documentation and study of the existing rural housing (vernacular architecture) and the construction of SRDU-I, Phase-2 deals with the construction of SRDU-II, and Phase -3 deals with the up-scaling and out-scaling of the SRDUs. As of now SRDU-I is completed (see Fig. 1) and SRDU-II is under construction while SRDU-III is just launched.

2. Location of project

The research area is located in Gubrie, Guraghe Zone. It is 175 kms from Addis Ababa and 15 kms from Wolkite, the capital of the Guraghe Zone. Guraghe zone is one of the 13 zones of Southern Nation's Nationalities and Peoples, Regional State (SNNPRS) (See Fig.2).The Guraghe zone extends from 7.76^0—8.45^0 north latitude and 37.45^0—38.71^0 east longitude. It is structured into thirteen Woredas, and three regional administrations located in the towns of Wolkite, Butajira and Gubrie. The zone contains 437 rural Kebeles (municipial units) and fifteen urban centers. According to the Central Statistical Agency (2007) the total population of Guraghe zone is 1,280,484. It shares 8.5 percent of the southern region population i.e. 15,042,531. The total land area of Guraghe zone is 5,932 square kilometers. The zone is among the densely populated areas of southern region. According to finance and economy development bureau statistical abstract and Central Statistics Agency (2007) the average population of Guraghe zone is 216 persons per km^2, which is almost two times that of the southern region average density (136 persons per km^2).

Fig.1: The completed SRDU

Gubrie town, in which the research project is located, has a population of about 5000. Gubrie is expected to grow fast as many facilities are either under construction or are planned to be constructed soon. For example, the Wolkite University is being constructed. A referral hospital and the Guraghe cultural centre will follow suite. These complex facilities will definitely attract a large number of migrants, which will eventually demand housing. As in the rest of the Guraghe area the livelihood of the Gubrie population is based on the Ensete (false banana) culture.

3. Research objective

The research aims to contribute towards the improvement of the rural housing in Ethiopia. It seeks to draw lessons from the vernacular architecture of a rural area and incorporate it into improved rural housing. The focus of the research is on capacity building through hands-on training on a one-to-one construction of housing units. The typical Guraghe traditional house or vernacular architecture is one-roomed space built of wood and mud wall and straw roof. Those who can afford usually build separate houses for livestock and guests. Otherwise, the one-roomed house accommodates both animals and humans. They live together with sometimes wooden partition in-between. The space has a small window or none at all. As a result it is dark and lacking ventilation. The smoke from the hearth, placed at the centre of the room, though important to kill insects, usually affects the health of the eyes and lungs of its inhabitants. Despite these disadvantages, however, the Guraghe vernacular architecture boasts a sturdy construction and unique character. Particularly, the central umbrella-like wooden structure that supports the roof is one of the main elements that express the Guraghe culture.

The Guraghes are fond of their traditional house type. But these days, not only, for lack of wood and straw but also because of the ease of maintenance and speed of construction, many locals who can afford it decide to build tin-roofed rectangular houses, *which they also consider to be 'modern'. Therefore, it is increasingly becoming common to see tin*-roofed houses side by side with the traditional houses (See Fig.3).

The traditional house is good in protecting heat and cold while the reverse is true for the tin-roofed house. The traditional house also expresses the identity of the Guraghe people, for example the umbrella-structured central pole, expresses the oneness of the family and the responsibility of the household head in supporting it. On the other hand, the modern house is advantageous considering the availability of materials and speeds of construction, though it lacks identity and is not comfortable. Hence, the objective of the SRDU research has been to design and implement housing types that include both the advantages of the traditional house and the so called modern house while simultaneously maintaining the Guraghe identity.

4. The research process

Data collection: The research started by collecting data on the vernacular architecture of the Guraghe zone. The survey was conducted in four settlements namely: Gassore or Chancho, Ewan, Yerugeta, and Gubrie. The settlements were selected after days of reconnaissance by two student apprentices in consultation with the Guraghe Zonal Administration. 13 Master students and 33 undergraduate students of EiABC were subsequently involved in data gathering. The undergraduate and master students were deployed in Gubrie in the third week of November 2010 and second week of Jan-

Fig.2: Map showing the location of SNNPRS (Southern Nations, Nationalities and People's Regional State), where the Guraghe Zone is located

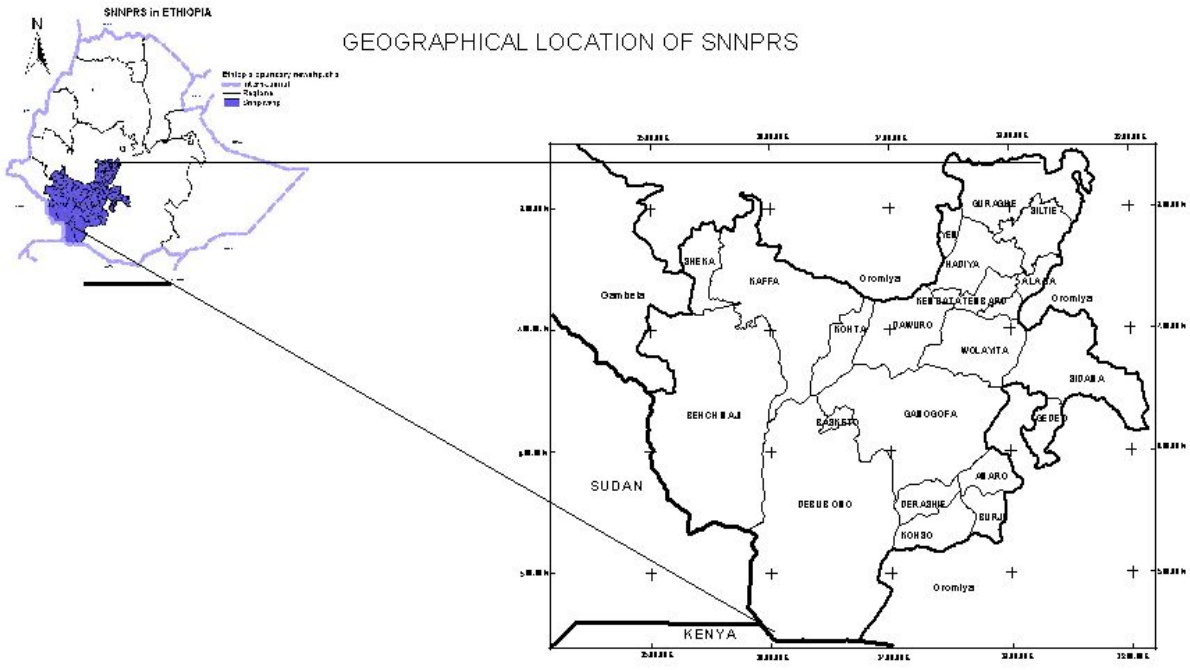

Fig.3 Showing "modern" tin-roofed house and traditional Guraghe houses

uary 2011, respectively. Based on the findings of the data collection, alternative improved housing types and settlements were designed.

5. Housing Design:

Parallel to the work of the students the SRDU's core research team has been continuously engaged in analyzing the data gathered. Informed by the findings of the study on the vernacular architecture the research team has thus far developed two housing types. The new designs included separate living and dining area, kitchen, bedrooms and barn. A provision was also made for toilet, shower and storage areas. Different kinds of material testing were carried out in order to decide the appropriate type of building material and construction technique. A structural analysis was also carried. Accordingly, a test was done to investigate the compressive strength capacity of the earth blocks which are used for wall construction. The results have shown that the blocks have sufficient compressive strength. As a result, sun-dried soil blocks and bamboo were used for walls and roof respectively while the umbrella type structure central pole is maintained for cultural reasons. To enhance the lateral stability and earthquake resistance of the building; bamboo studs which connect the foundation with the wall were introduced.

6. Local participation in the project design and implementation:

From the outset it was understood that participation and partnership are crucial, not only in developing a sense of belongingness, but also for the future continuity of the project. From the very beginning 13 local farmers were recruited to participate in the research not only as trainees but also as insiders giving constant feedback to the research. In addition to the farmer trainees, key stakeholder meetings have been held at critical stages of the research and its implementation. The stakeholder meetings include discussion with the Bete Guraghe Cultural Centre (BGCC), the Guraghe development Association, Federal and local politicians, representatives from the ministry for Urban development and Construction, the ministry of Education, and elders and prominent people of the Gurghe Zone.

Capacity building and the first milestone in the process of scaling-up: Through the instrumentality of the Guraghe Zone administration and Bete-Guraghe cultural Centre, as stated earlier, 13 trainees were recruited from 10 Woredas of the Guraghe Zone. The local trainees were recruited from the different Woredas with the vision that they would train more people upon their return. Further, a cross-cultural transfer of knowledge and skill is achieved by involving four roof makers from Chencha area (500 kms from Addis Ababa) to provide hands-on training on the technique of bamboo construction.

By June 2011, 75% of the construction of the first housing unit (SRDU-I) was completed. Following this, since the remaining task was not that big, 10 out of the total 12 local trainees were temporarily sent back home. Just before they returned, on September 2011, a small event was organized whereby each of the trainees received three different-sized metal moulds and a manual prepared in the local language, Amharic (See.Fig.4). The metal moulds are necessary for molding the soil blocks used for the construction of walls while the manual describes the step-by-step construction of the housing unit. The purpose for the issuance of the moulds and the manual was to encourage the trainees for them to start implementing what they have been learning. They were advised to just try to construct some structure in their localities using the SRDU building materials and construction technique. At this stage emphasis was not put in replicating the SRDU in its totality, as the trainees had only passed through the first round of training.

Interestingly, in a period of six months, four of the trainees managed to produce hundreds of soil blocks while one of them constructed a toilet using the SRDU technique (See Fig.5). This was the first milestone in the process of scaling-up. It indicated that the trainees had taken the idea of the research seriously and that they are committed to scaling it up as far as possible.

As of January 2012 all the trainees had returned back to the Gubrie research site and they are constructing SRDU-II. SRDU-II is a circular housing proto-type as opposed to SRDU-I, which was rectangular. The wisdom of changing

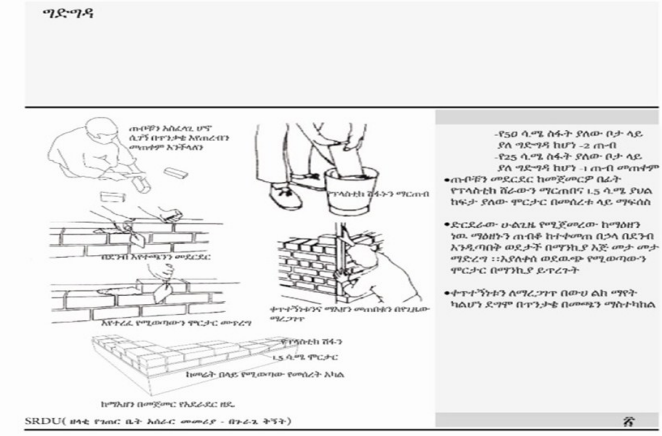

Fig.4: Sample page of SRDU construction manual in Amharic (local language)

the form of the original SRDU is to show the local people and the trainees that it is possible to have various options using the same materials and construction technique. While undertaking SRDU-II the third stage of the SRDU research series is now launched under the title "Contextualization of vocational training for the building sector in Ethiopia", hereafter, SRDU-III. SRDU-III focuses on consolidating and enhancing the key issues of capacity building, scaling-out and the scaling-up process initiated in SRDU-I and II. The envisioned strategies and further milestones are discussed below.

Enhancing Capacity building

In view of the widespread desire to consolidate and enhance the process of capacity building, with the ultimate goal of scaling-up and scaling-out the SRDUs, the concept of a 'capacity building pyramid' was introduced. The capacity building pyramid includes the components of PhD researches and curriculum development for a local university and TVET (Technical Vocational and Education Training). The capacity building pyramid is envisioned to function in a cascading knowledge-transfer with the following actors from top to bottom:

1. Professors from SingCoRe (Construction Research at the Singapore ETH Centre) and EiABC (Ethiopian Institute for Architecture, Building construction and City development)
2. PhD candidates from ETH-Zurich and EiABC
3. Trainees from Wolkite University
4. Trainees from Wolkite TVET
5. Local semi-skilled or non-skilled trainees

The professors and a PhD candidate from SingCoRe are involved for specialized inputs and experience sharing.

The key strategy of the capacity building pyramid is the development of curricula that is informed by the PhD researches, mentioned above item 2. The PhD researchers, three in number, are further expected to transfer skill through practical experiments involving trainees. The curricula are sought to be developed both at the Wolkite University and TVET levels. The objective is that at the end of SRDU-III, the university and TVET trainees would continue to give training to the local farmers, using the newly developed curricula, and thus becoming part of the mainstream academic training system.

The challenge of scaling out and scaling up in Ethiopia

Ethiopia comprises a wide range of cultural, lingual and climatic diversity. The country is divided into nine administrative regional states and two chartered cities (Addis Ababa and Diredawa) each with its own distinctive culture and language. More that 80 languages are spoken in the country by more than 80 ethnic groups. Based on elevation, the climate is divided into three zones, namely: Dega (Cool zone), Woinadega (Subtropical zone) and Kolla (Tropical zone).

The diversity of the country may pose great challenge in out-scaling the findings of the SRDU research to other parts of the country. The climatic and cultural diversity calls for a specific substantive approach for each locality. In other words one-to-one replication of a housing unit, developed for the Guraghe region, may not be possible in other regions. The availability of building materials, cultural outlook and local temperature and rainfall will call for a corresponding construction technique, using different materials for different house form. Cognizant of these the SRDU research will focus on developing application methodologies and generic strategies that could be applicable, and easily adaptable if and when necessary, for each region.

So far the lessons learned from SRDU-I and II could be summarized below:

1. Studying both the existing vernacular architecture of the locality and the current trend of house construction. The purpose, here, is to learn the prospects and challenges of each type of construction.
2. Incorporating the lessons learned in studying the vernacular architecture into a new house typology, in this case SRDU-I and II.
3. Kick-start the first milestone in the scaling-up and scaling-out continuum by recruiting local trainees and giving them hands-on training while constructing the new housing types. This will also give a preliminary input as to how the local trainees perceive the whole construction process and skill transfer.

The next steps for scaling-out, which are envisioned to be part of SRDU-III are:

4. Develop curricula for a university and TVET college located in a specific region
5. In addition to the local workers, include trainees from both the local university and TVET, while constructing a housing type

Fig.5: Toilet constructed by the one of the SRDU trainees as seen in the picture

6. Test and implement the developed curricula and integrate it in the mainstream academic training given to university and TVET students

In short, the above steps could be summarized into three main components:

- Study of vernacular architecture
- Construct a housing unit (prototype) exploring alternative materials and construction techniques while kick starting the process of scaling-out
- Develop curriculum to "mainstream" research findings

Up-Scaling: One of the main objective of the research is to disseminate the SRDU findings on alternative materials and construction techniques and thereby multiplying/up-scaling the housing typologies and/or their components at a larger scale of a rural settlement or emerging town. The main strategy planned for up-scaling the finding of the SRDUs is through entrepreneurship. Graduates who have completed the SRDU curricula are expected to organize themselves into co-operatives and business entities. The purpose of these business entities would be to create small scale industries in order to produce the components of the housing units. Therefore, the SRDU curricula should incorporate entrepreneurship modules that should be given in collaboration to entrepreneurship experts and experienced business men.

The basis for the functioning of the small scale industries would be the scientific outputs of the research. The basic knowledge of the building materials and tested construction techniques will be the input for the small-scale industries. The industries are thus expected to produce rationalized building elements for the larger population that will eventually result in the construction of large scale housing and settlements.

Conclusion

The research project seeks to scale-up and scale-out the findings of the research mainly through the process that can be summarized as:

1. The creation of context-based innovative building materials and construction techniques
2. Skill transfer though capacity building pyramid
3. Entrepreneurship

The strategies to implement this process are:

1. The study of the existing vernacular architecture of the specific locality in order to come-up with context-informed alternative housing type
2. Development of a hands-on practical curriculum that involves all levels of education starting from the university level up to the local unskilled workers in a cascading fashion. Here, skill transfer is not imagined as linear but rather interactive and circular in such a way that each actor is ready to be informed and is in a learning mode. Here, the involvement of local construction companies and the public sector would be crucial not only in transferring their expertise, but also in the formation of new businesses by graduates as indicated below.
3. The graduates of the trainees are expected to get organized into co-operatives/business entities creating market for the production of the alternative building materials and construction techniques.

In a relatively short time two types of context-based alternative houses were implemented by means of SRDU-I and II. In the course of implementation the important actors in the capacity building pyramid became actively involved, including the staff of Wolkite University and TVET graduates. Thus far, the result with regard to scaling-out is that the trainees have managed to produce soil blocks and a toilet in their respective localities. With the implementation of SRDU-III, it is hoped that, more milestones will be achieved, especially in the scaling-up dimension, through the ongoing learning process of this progressive, participatory and practical type of academic research.

Abbreviations

ETH-Zurich	Eidgenoessische Technische Hochschule Zurich
SingCoRe	Construction Research Singapore - Chair of Architecture and Construction of the Future Cities Laboratory at the Singapore ETH Centre (FCL/SEC)
SNNPRS	(Southern Nations, Nationalities and People's Regional State),
SRDU	Sustainable Rural Dwelling Unit
TVET	Technical and Vocational Education and Training

Connecting catch-up growth to sustainable development-a new theoretical perspective

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Abstract

The theory of comparative advantage implicitly assumes that the world consists of a fixed amount of ideas, goods and services that are produced wherever there is a comparative advantage with respect to the availability of scarce rival inputs such as land, labor and capital. There is however one crucial non-rival input called 'knowledge'. It is embedded in rival goods in the form ideas that have been written down as instructions, protocols, designs and formulas. The effective use of ideas in an innovation-driven economy depends however on the availability of skilled labor and public policies that encourage investment in economic and technological change. The effective pursuit of such public policies explains the success of East Asia in catching up with Western economies. However, such policies are not based on the principles of orthodox neoclassical economics but on the insights gained from economic history. In this article, we review the recent history of economic theory and practice and conclude that Western countries need to revisit their economics textbooks and public policy strategies in order to better take advantage the opportunities of the global knowledge economy and cope with the sustainability challenges of the 21st century.

1. Introduction

In his book "Knowledge and the Wealth of Nations: A Story of Economic Discovery" [1] David Warsh discusses the question why the discipline of economics has failed to revise its textbooks in light of the successful formalization of the endogenous process of economic development by Paul Romer in 1990 [2, 3] and overwhelming empirical evidence, that the rise of Asia is strongly related to economic policies that are derived from New Growth Theory [4]. Today's textbooks continue to rely on Samuelson's rather ahistorical 'Economics' [5] which was first published in 1948 and is now in its 18th edition. Greg Mankiw, whose textbook [6] is widely seen as the successor of Samuelson's classic, continues to be attached to the same principles and convictions. Warsh [1] documented that throughout the 20th century many eminent scholars in economics have indirectly criticized the baseline assumptions of this textbook canon through their empirical research but without much effect. In an article in 1997, the economist Mark Skousen [7] focused his criticism directly on Samuelson's textbook, arguing that it consists of an uneasy mix of laissez faire on the micro level and government interventionism on the macro level. He rebutted Samuelson's claim to provide a unified approach to economics and warned that it would create a false sense of a single way of thinking about how economies work [8]. Moreover, its Keynesian basis of "Economics" tended to ignore other aspects of economic development and lead to dubious policy prescriptions. In 2011, Mankiw's students at Harvard rebelled against the dogmas of Post-Cold War economics. In view of the changing circumstances in the global knowledge economy and the financial crisis, they accused Mankiw of teaching ideology rather than social science [9]. Yet, it is likely that they will be ignored once again since maverick economists often tend to leave economics faculties because they lose patience with the firmly entrenched and habitual modes of thinking of economists [1]. Moreover, policy makers, for a long time, did not really bother about the consistency of the underlying economic theory of their public policies as long as the economy was humming. Economists proudly talked of the era of great moderation that would be mainly due to their sophisticated economic equilibrium models. Federal Reserve Chairman Ben Bernanke still argued confidently in 2004 that thanks to a better understanding of macroeconomics in theory and public policy, economic life has ushered an era of not just reduced volatility of inflation but also reduced volatility of output and that this trend is likely to continue far into the future. It can be safely assumed today, that he would not make this claim anymore after the global financial crisis. Many principles of neoclassical economics have fallen into disgrace since then because the underlying models have not just failed to predict the crisis in Western countries [10], they also failed to explain the success of state capitalism in the rest of the World [11]. The crisis of economic theory is also reflected in recent book publications [12, 13, 14] and the call to revisit the importance of history in economics even comes from established economists such as Acemoglu and Rodrik [15, 16]. Finally, new economics textbooks have just been published that focus on the basic insights of New Growth theory and the formal falsification of the basic principles of neoclassical economics [17, 18].

All these changes may implications for public policy in general and trade policies in particular. In the following paper, we discuss the question how trade policy would look like today if governments would embrace New Growth Theory rather than neoclassical economics as their guiding theory in the design of their trade policies. We deliberately use the term 'New Growth Theory' rather than endogenous growth theory or modern growth theory since apart from some advances in further formalizing the theory in very specialized policy fields, not many bold insights have been added since the two seminal articles published by Romer [2, 3]. Moreover, many economists that shaped the field of endogenous growth theory after Romer, such as Elhanan Helpmann [19], Philippe Aghion

[20] and Daron Acemoglu [21] tended to ignore many of the bold claims made by Romer by formalizing them away for fear of striking at the foundations of neoclassical economic models [1]. Romer himself built on his previous insights in recent articles [22, 23] to emphasize the importance of institutions in facilitating the process of endogenous economic growth. His recent initiative to promote Charter Cities in the developing world must be understood in this context [24]. Charter cities would allow entrepreneurs to take advantage of an institutional environment that enables them to flourish and grow through innovation. It is essentially a lesson learned from economic history (Hanseatic League, Hongkong, etc). The urgency for action becomes obvious if we consider that 200 million people already live in countries that are not their country of origin and more 600 million people still intend to migrate. But where are they to migrate? In the 19th century, during the first wave of industrial globalization, they did not need a passport or visa to migrate to another continent or region. Australia, New Zealand, Eastern Europe, Canada and the United States welcomed migrants who often even received an initial cash advance from their original countries to seek their fulfilment elsewhere. Today, the barriers to migration have become a major humanitarian disaster and youth unemployment is one of the major challenges to political stability (e.g. Arab spring). Charter cities suggest that, based on historical experience, something could be done about it.

Economic historians such as Angus Maddison [25] may also contribute to a better understanding of endogenous growth and the importance of trade and exchange in human development than economists. Maddison traced back data related to technological innovation and growth to ancient times. He highlighted the "hockey stick" pattern that shows both population and per capita GDP to remain essentially flat for nearly two thousand years and then, all of a sudden, to steeply rise in the past two centuries. Nordhaus [26] illustrates the trend with the 'price of light' calculation. The real price of light fell by a total of about 17% between 38,000 B.C. and 1750 B.C due to the transition from animal or vegetable fat to sesame oil as a fuel. In the early 19th century, the development of improved candles and whale oil reduced the price by a further 87%. Between 1800 and 1900, the introduction of the carbon filament lamp induced the price of light to fall at an annual rate of 2.3% (38 times faster than before). And then in the 20th century, the price of light has fallen by 6.3% per year with the use of tungsten filaments and fluorescent lighting. In addition, the development of LED (low-emitting diode) technology has caused efficiency and light output to rise exponentially, with a doubling occurring about every 36 months since the 1960s, similar do Moore's law in the recent history of computing hardware. As Jones and Romer point out in a recent paper, new ideas are very clearly at the heart of this accelerating productivity growth [22].

Historical research therefore provides clear evidence that governments today should focus on investing in technological and economic change if they want to cope with the doubly challenge of reducing poverty and lessening the environmental impact of human activity. Policies would then move away from social and environmental planning towards more progressive policy strategies as they were already pursued 19th century, when governments impact [27]. The nationalist policies in Europe and the United States back then might have been driven by mercantilist views but they were focused on catch-up growth rather than the protection of domestic markets. Among the industrialized countries today, only New Zealand [28], and to some extent the Scandinavian countries [29, 30], embraced the basic insights of New Growth Theory in public policy. They skipped neoclassical economics and instead embraced the basic lessons learned from economic history. As a consequence, they have rediscovered the role of government as a facilitator of sustainable technological and economic change, in addition to its responsibility as a regulator. The rise of the Asian economies followed the same principles but from a different stage of economic development [11]. For these countries, open trade in itself is not necessarily a desirable end in itself, but instead considered to be a means to an end, namely to ensure access to non-rival as well as rival goods that help the domestic private sector to innovate, advance human development and help coping with the environmental challenges. Despite the global financial crisis, most economists continue to cling to what they have learned from conventional economics textbooks, relying mostly on ahistorical equilibrium models. These highly abstract models, even though useful as an additional source of economic information, are hardly able to explain the complexity and often irrationality of the history of economic development.

2. Why we need to move beyond neoclassical economics in public policy

'Economics is the study of how society manages its scarce resources' (Mankiw 2006). However, is this textbook definition of economics still appropriate to describe economic change in the global knowledge economy? Can such a definition help us design public policies that enable catch-up growth and thus economic convergence within and between countries? Can it help to design environmental and agricultural policies that enable us to produce more with less?

Even though focusing on the optimal allocation of scarce resources has its merits in explaining the circular flow of goods and services in a stationary economy, there are three major reasons why it is unlikely to serve as a theoretical guide to sustainable policies in the 21st century:

1. Benefits from trade are explained in neoclassical economics through the concept of marginal utility: marginal gains and losses occur when one thing is traded -away and another is acquired. Since both parties agreed to the trade due to their different preferences, everyone must better off. This Pareto efficient state would represent an economic equilibrium and any divergence from this equilibrium would eventually lead back to the Pareto optimal point. The problem of 'marginal utility economics' is that this Pareto efficiency is based on highly restrictive assumptions. It

implicitly assumes perfect competition, negligible transaction costs (assuming transparency and thus nearly perfect access to information) and all markets to be in full equilibrium. Pigou [31] already recognized that even if pareto efficient outcomes would be achieved, they do not take into account the externalities generated by private sector activities. Yet, Pigou himself tended to ignore the positive externalities that the private sector can generate for society and the environment (e.g. employment, producing more with less, etc) focusing instead on the social costs that result from private sector activities (negative externalities). Consequently, according to Pigou, the goal of government must be to avoid a divergence between the marginal private interest and the marginal social interest through the internalization of external costs via regulation and subsidies. A pareto-efficient outcome for society as a whole would then be possible again. Based on this view Kenneth Arrow [32] and other welfare economists portrayed the state as a rational social planner that looks at aggregated social preferences and allocates the scarce public resources in a pareto-optimal way (making at least someone better off without putting anyone worse off). Buchanan and Tullock [33] pointed out however that there can be different intensities of preferences. Moreover, the whole process of preference formation is endogenous in nature [34]. The aggregation of social preferences would therefore be highly problematic. Moreover Buchanan and Tullock showed that the democratic decision-making process is not a rational process on an aggregated level as Arrow assumes. Politicians are not rational social planners but primarily pursue their self-interest (e.g. they want to be re-elected) and are not necessarily driven by the desire to maximize social welfare. As a consequence, they try to frame everything that goes against their interest as a negative externality and to ensure that whatever serves their private interest generally also perceived to be in the public interest [35, 36]. Consequently, there is no such thing as a rational social planner unless it refers to an all-knowing and benevolent dictator. What matters instead is the role of institutions and the law. If the constitutional and operational rules of a democracy are able to channel the pursuit of self-interest in a way that allows for constructive compromises, it benefits society and the environment as a whole. Such rules can therefore be considered a public good that is based on non-rivalry and non-excludability [37]. In view of the importance of understanding the political economy in political decision-making processes, Buchanan and Tullock recommended in their noble-prize winning book 'The Calculus of Consent' [33] a shift in economics from neoclassical welfare economics to institutional economics. Yet, based on the new empirical insights in cognitive psychology [34], modern institutional economics will also have to move away from the concept of a purely rational and utility-maximizing homo oeconomicus and instead build upon a more complex and ambiguous understanding of human nature. It would then also be more in line with the recent findings in neuroscience, experimental psychology and anthropology [38].

2. The definition of economics as the study of the optimal allocation of scarce resources ignores that there is one resource that is not scarce: knowledge. Knowledge is not subject to the laws of scarcity and diminishing returns and since it is a non-rival good its increased use does not undermine its value but actually enhances it [37]. If it is employed to either continuously improve existing goods and services or to create discrete innovation that result in entirely new goods and services. It can generate value not just for the respective company that applies new knowledge but for society at large, especially if innovation spreads through international trade. These welfare gains generated through the introduction of new goods and services were demonstrated by Paul Romer [3] but largely ignored in neoclassical economics. As a consequence the public good character of private goods and services has hardly been discussed in the discipline of economics. Technological change is not just enhancing the potential of the private sector to contribute to the creation of public goods but also to public bads. Effective public policies therefore make use of public-private partnerships to maximize the public benefits and minimize the public risks of private sector activities [39], especially by providing incentives for companies to invest in new knowledge that helps solving problems that are of public concern. Once new knowledge is produced in the form of ideas, instructions, protocols, designs etc. that lead to innovative products and innovative solutions, this knowledge assumes the character of a non-rival good. Consequently, complete property rights and perfect competition that work so well in a world consisting solely of rival goods may no longer desirable because they is likely to stifle innovation and prevent the optimal allocation of resources. Yet the increasing returns resulting from the creation of product innovation will only be realized if a company can reasonable expect to be able to reimburse the fix costs for research and development (R&D) by selling the product for a price that is above the marginal cost of production per unit [2, 3]. In other words, the company must be able to extract a temporary monopolist rent (profit) which enables them to remain competitive, not in a market of perfect but monopolistic competition. It is this price-setting power in monopolistic competition that provides the main incentive to make use of new knowledge and invest in new goods and services that produce not just profits but welfare effects for the public at large. A single price, set by many buyers in a market of perfect competition is unable to simultaneously allocate goods to their most efficient uses and provide the appropriate incentives for innovation.

3. The amount of ideas to address technological, social, economic and environmental problems is not fixed but increases in proportion to population growth [22]. Governments and the private sector must therefore recognize that population growth can be an asset if it is translated into a higher share of qualified human capital that is able to make use of and generate new ideas that help to meet the needs and challenges of a growing population. Esther Boserup was the first scholar who discovered through her comparative field research in Kenya that population growth must not neces-

sarily be bad for sustainability if institutions are conducive to technological change [40]. Therefore, it is of crucial importance to design institutions that provide the necessary incentives to invest in people and their respective talents and allow them to engage in trade and exchange [41].

What could possibly replace neoclassical economics as the theoretical guide for national trade policies that aim to take advantage of the global knowledge economy to enable sustainable economic change on the domestic level and improved cooperation on the global level? One answer is to revisit the comprehensive and interdisciplinary theories of prominent economists that have been ignored by the guild due to their unorthodox dynamic views of economic development, the most prominent one is probably Joseph Schumpeter.

3. The early insights of Joseph Schumpeter

The opposition to comparative static formalism in economics has a long history by itself. One of the most prominent opponents was the great economist Josef Schumpeter who described the flaws in neoclassical economics already in the first half of the 20th century [27]. He suggested a more dynamic view of economics taking into account history and anthropology.

Schumpeter divided economic processes into three different classes [42]:

1. The circular flow of economic life as conditioned by given circumstances. This part comprises basic textbooks economics that illustrates the mutual interrelations of economic variables and phenomena under stationary conditions by means of a general equilibrium system. The stability and certainty of such a stationary economy would however eventually lead to standstill. Small and gradual increases in the labor force, savings and capital accumulation would merely lead to marginal economic expansion with no qualitatively new phenomena, but only processes of adaptation. The business man in this system is just the 'Economic Man' that manages and adjusts the system in response to external changes.

2. The concept of economic development. It portrays economics as an evolutionary science and as such discusses the irreversible processes of economic development while highlighting some of the reoccurring patterns. Some basic insights from this research are that (a) economic development comes from within the economic system, it is not an external factor, (b) it occurs discontinuously through qualitative changes (innovation, technical revolutions) which fundamentally displace old equilibria and create new ones, and, (c) economic development is accompanied by growth in national income, saving and population. The great innovations are supply-side driven and cannot be derived from a sovereign consumer demand. The process of innovation requires not an 'Economic Man' but an 'Entrepreneur' that is willing to take risks and cope with uncertainty. He must deal with uncertain factors about the potential market, lack of accurate data, subjective reluctance to strike out into the unknown, and possible public resistance to change (habits, vested interests).

3. The importance of business cycles. Economic growth emerges from and as a consequence of cyclical development. Discontinuous bursts of innovative investment are the basic cause of these business cycles. Economic development comprises not just technological but also organizational and resource changes. They raise productivity, improve quality and reduce costs and thus constitute the foundation of economic growth causing and driven by the interruptions of the business cycles.

Policy makers often fail to take all three dimensions of economics into account. Instead they tend to implicitly assume an economy under stationary conditions (1) while considering disruptive technological change in economic development (2) and cyclical development (3) as something undesirable that has to be regulated. This is particularly so in trade regulation in affluent countries that are fearful of economic decline. Trade liberalization tends to be associated with unpredictable social and environmental changes, more exposure to global business cycles, a displacement of less competitive domestic companies by more competitive foreign companies and a general loss of national autonomy. Yet, if opponents to trade would long-term effects, they would realize that the foundation of poverty reduction, employment creation, economic empowerment and effective environmental management is actually based on economic and technological change fuelled through open international trade. Most developing countries, as well as small developed countries in the periphery, are still aware of these long-term benefits. They carried out economic reforms and underwent an economic transformation moving away from heavy-handed socialist policies and costly subsidies towards innovation-based economies. These countries did however not consider trade to be desirable by itself, instead they just looked at it as a vehicle to promote economic and technological change that would eventually also help to better cope with the sustainability challenges of the 21st century [28].

Schumpeter had the broad knowledge base and the curiosity to recognize that the foundations of economic development are based, first of all, on informal institutions (habits, behaviour, private enterprise, customary practices) and, second, on formal institutions (government, property, contract law, etc) that were necessary to extend collaboration beyond the in-group (e.g. tribe, extended family, village). These are insights gained from research in history, sociology, anthropology and psychology, rather than economics. Schumpeter admired Marx precisely because of his combination of economic analysis with economic sociology and history. Unlike Marx and Keynes however, Schumpeter did not necessarily consider economic inequality as a flaw or failure of capitalism. Profits are the expected reward for commercially viable innovation. They are the result of a temporary monopoly position that gives the entrepre-

neur price-setting power up to the moment when cheaper competitors enter the market. The expected profits are an essential driver in the motivation of the entrepreneur. Yet, as Paul Romer, who largely built his New Growth Theory upon the ideas of Schumpeter, illustrated in his article in 1994 [3], the welfare effects that the entrepreneur produces through the introduction of new goods and services are not captured in a partial equilibrium model that reflects the price-setting power of a monopoly. Since the entrepreneur is limited in his power to set the price by the willingness of consumers to buy the new product for the respective price, he or she cannot capture the whole benefit – thus part of it goes to the public at large. These public welfare gains which Romer calls the ignored 'Dupuit' triangle in the partial equilibrium model must also be taken into account in welfare economics. Otherwise it leaves the misleading impression that the private sector does not make any contribution to public welfare.

Based on his analysis, Romer suggests that economists should at least learn to distinguish between a monopoly position that was obtained through political lobbying for market protectionism and a monopoly that was achieved through the creation of an innovation that created a new market in which no one else has yet the ability to compete. The former does not produce any welfare gains while the latter does.

Schumpeter accepts that such innovation-based monopolies can generate short-run inefficiencies in resource allocation, inequalities in income distribution and social exposure to new risks. All these negative effects are the result of the disruption of the circular flow of goods and services in a stationary economy. But eventually such temporary monopolies enable technological change that benefits the poor more than the rich on the long run [42]. Yet, since people tend to take the benefits of technological change for granted while the risks are increasingly considered to be unbearable, governments tend to respond by merely regulating change induced through entrepreneurship and innovation rather than facilitating it. Schumpeter predicted that this would lead to a world of large public and private bureaucracies that would essentially deprive the entrepreneur of his or her nutrient medium [27].

4. Schumpeter and global trade in the 21st century

Looking at the broader trends in economic life in the 21st century, Schumpeter proved to be prescient in many ways. Large Corporations in cooperation with large non-governmental organizations (NGOs) increasingly assume government functions through self-regulation, comprising private standards, best practices, codes of conduct, certification, as well as accountability and transparency mechanisms [43]. It may be understandable that these large and globally active non-state organizations cannot wait until the different national governments pass adequate environmental and food safety regulation. Moreover, the different agencies of the United Nations in charge of the global management of public goods such as health, food security and the environment are not designed to facilitate action but to slow things down and when necessary to prevent things. This makes sense when we consider that the original purpose of the creation of the United Nations after World War II was to prevent action, particularly if such action could lead to war [44]. However, in view of the end of the Cold War and its bipolar world, the preventive character of the institutional design of the UN and the fear of assuming public leadership in national governments have led to a power vacuum that is increasingly filled by powerful non-state actors that recruit politicians to frame change as risky and thus ensure their power as incumbents in the field of business, politics and civil society. In order to win public trust, these actors tend to wrap their private interests into a morally objective language that allows them to appear as representatives of the public interest while ensuring the growth and prosperity of their private organization [45, 36]. The particular brand that was created through this public-attention seeking and PR activities by the respective international NGOs or corporations also gives them the symbolic power to set the agenda with regard to their respective field of activity. In both cases these non-state actors have an interest to impose regulation on others that entrench their own power as de facto policy makers. At the same time the grip on regulation allows them to prevent the emergence of competitors that may try to win over their constituency or customer base through innovation. The result of the process may lead to decreasing growth rates. As a consequence, the cake size that is up for redistribution in politics is not getting bigger while the fight over the different shares is growing ever more grim [46].

5. Growing regulatory constraints to bottom-up innovation and entrepreneurship

Mancur Olson argues in his book 'The rise and decline of nations' [46] that Japan and Germany were able to produce economic miracles after World War II because all the established interest groups in domestic politics that previously focused on preventing change and taking part in the redistributive arrangements of public policy were destroyed. The ensuing lean regulatory environment gave entrepreneurs the freedom to respond rapidly to the countless unmet needs in the ravaged countries by investing in the production of new products and services. There were of course risks involved in bringing largely untested products on the market but it was widely perceived that the benefits outweighed the risks in view of the general poverty of the masses. As a result, entrepreneurs generated increasing returns through economies of scale and scope and further invested their profits in the development or further improvement of products.

In the 1970s, many newly founded environmental organizations protested against the new form of capitalism that created a lot of products with lots of undesirable side effects for society and the environment. The oil crisis further added to public grievance. Protesters found that the moment has been reached when the benefits of economic and technological change have stopped to outweigh the risks. Back then, the forms of protest as well as the political agenda of protest organizations were bottom-up, progressive and bold, and, as a result, policy makers responded by passing new laws and establishing new insti-

tutions for the protection of society and the environment. Today, these previously subversive protest organizations have grown themselves into large organizations (Greenpeace has a budget that is greater than the one of the World Trade Organization). As a result, they may have become more concerned with self-preseration than the environmental and social issues they claim to fight for. In this sense, it becomes increasingly hard to distinguish a global retail franchising chain from a globally active environmental organization [28]. Both pursue top-down strategies where regional representatives are instructed to follow the political line defined in the headquarters in Europe and the United States. This political line is meant to reflect the preferences of affluent donors and consumers in developed countries but are often not encouraging local people in developing countries to become active themselves.

These increasingly powerful public and corporate stakeholders that primarily focus on pleasing their respective constituencies would also show little interest in further trade liberalization, especially if the public associates it with undesirable change. Moreover, global trade is increasingly dominated by intra-firm trade anyway due to the trend towards global vertical integration [47]. The regulation of intra-firm trade is beyond the power of national governments and the World Trade Organization (WTO). Large corporations are not bound by the Most Favoured Nation (MFN) and National Treatment Principles of the WTO. Instead they have the power to set private standards that aim at the strict control and enforcement of process-oriented standardization, tend to discourage innovation among suppliers and further entrench their power as gatekeepers in the value chain [43]. As a result, entrepreneurship, experimentation and product innovation are being discouraged (apart from improvements in logistics). Large corporations are risk-averse and primarily concerned about their public image, especially if their brand is well known. Eventually, as Schumpeter rightly predicted, the entrepreneur will be replaced by the economic man and with it comes a transition from a dynamic towards a more stationary economy. This trend may eventually have a larger negative impact on the free exchange of goods and ideas, effective environmental management and economic empowerment than the failure of the Doha Round itself. Yet, this threats cannot be recognized by an economic theory that is unable to facture in the lessons from the history of economic development. As a consequence, public policy will not be up the challenges of the 21st century unless theory adjusts to economic reality.

6. Some adjustments in economic theory

Neoclassical economics is in crises but still remains in the mindset of most policy makers and economics. If there is any lesson to learn from past experience it is that Schumpeter and later on Paul Romer and his New Growth Theory were much more accurate in predicting global economic development over the past two decades that textbook economics.

Some economists like Aghion [48], Greenwald & Stiglitz [49], Rodriguez-Clare [50], Haussman and Rodrik [51], and Acemoglu [52] increasingly agree with this finding. They are primarily concerned with the adjustment of economic theory to the new reality of Asia rising. The move of Asia from the periphery towards the centre of the global knowledge economy could not be deduced from the classical theory of comparative advantage. However, despite accurate and sophisticated formalizations, most economists continue to use fuzzy terms that are derived from these neoclassical concepts such as externalities, spillovers, multiple equilibria and public goods. The problem of using such terms is that they mean different things to different people. Romer proposes therefore to skip them and mainly focus on the less ambiguous and continuous terms of rivalry and excludability to define the private and the public good character of certain products and services [53].

Indirectly, Haussmann and Rodrik have embraced many of the ideas of Paul Romer even though they do not quote him. In their paper [51] they highlight the problems of economics when trying to understand the bottom-up process of economic and technological change. They admit that neither neoclassical economic theory nor management science is of much use in helping entrepreneurs (and the state) choosing appropriate investments among the full range of modern-sector activities that go beyond labor-intensive products or natural resource-based products. Yet, the move from a traditional and primarily domestic economic sector towards a modern one that is characterized by strong global economic integration, requires the role of the state as a facilitator of endogenous economic change. Unlike in routine economic activities in the traditional sector, Haussmann and Rodrik argue that the launching of a new product or service that has the potential of creating a new market with increasing returns, mostly fails in the initial stage because the costs of production and thus the production function are not yet known. They point out, as Paul Romer did before [3], that there is a role for industrial policy to create incentives for the private sector to invest in new knowledge and product development and thus go beyond routine business. However, the model used by Rodrik and Haussmann excludes the political economy dimension by assuming that the state acts as a rational social planner designing policies independent of established interest groups. Ideally, governments induce companies to invest in the creation of new markets (e.g. allowing them to have an initial temporary monopoly that allows them to appropriate the profits from increasing returns and thus cover the costs of launching a new product) and then withdraw support once the companies prove to be able to stand on their own feet. As a result, a country would become innovative as well as competitive and thus ensure long-term growth. In this context, the authors assume that the social planner is still aware of failed import substitution policies in the past and consequently would make sure that subsidies end in a second phase. This would make the profits from the temporary monopoly vanish unless the company further invests in product improvement. But as Buchanan and Tullock already argued: there is no such thing as a rational social planner in democratic government unless there is a benevolent and all-knowing dictator, and that is not even the case in China.

Institutions that govern economic life are primarily shaped by the perceptions, preferences and interests of the stakeholders in the formal economy that also participate in the political decision making process. Their rational strategies are first of all focused on pleasing the constituency that ensures their economic survival and political legitimacy [45]. Innovative entrepreneurs, in return, are mostly driven by irrational motives and their primary concern is not politics. They become obsessed with proving to the rest that they can succeed by doing things differently. They do so against all odds and often at the expense of tremendous social tension [54]. Whether they succeed or not depends less on the existence of a rational social planner than the institutional setting in which they operate [55]. The institutional setting largely determines whether the pursuit of private interests leads to relative welfare gains or welfare losses for the public at large. If the institutional setting and the infrastructure for entrepreneurs are able to keep the costs of launching a new product or service relatively low, then there will be investment in innovation and economic integration [3], otherwise the economy will remain in a routine and stationary circular flow as Schumpeter would explain it, or a low-productivity equilibrium, as the neoclassical economist would call it. Romer also showed that the establishment of charter cities that triggered economic development and cultural change throughout history (e.g. Lübeck, Philadelphia, Hongkong) were never really linked to the implementation of a rational master plan of economic development but rather to bold experimentation and learning from history.

7. Paul Romer's recent contribution to a better understanding of economic globalization

Paul Romer challenged the orthodox views in economics already in the 1980s and 1990s by using the formal language of neoclassic economics to disqualify some of its most essential baseline assumptions. In his New Growth Theory [2, 3], he explains long-run economic growth through endogenous factors such as human capital, knowledge and the process of technological change. He was certainly not the first one to do so, but the most radical one. His theory did not allow for a compromise with the incumbent doyens in economic growth theory [1]. Romer's central point was that the use of marginal concepts in economics and the focus on efficiency gains are unable to convincingly explain why we are better off today than hundred years ago. Economics should not be the science of the optimal allocation of scarce resources but the science of making best use of the only non-scarce resource, which is knowledge. Public and private investment in knowledge and human capital may lead to continuous product improvement and the introduction of new goods and services with increasing rather than decreasing returns. It would build upon the traditional economic sector that dominates the production and trade of commodities. These traditional markets are characterized by perfect competition, price-taking, decreasing marginal returns, and low profit margins. In return, the dynamic new markets of the knowledge-based economy are characterized by a relentless process of innovation. It is shaped by monopolistic competition where profits are used to invest in new products where the innovating companies enjoy temporary price-setting power. This process results in increasing returns to scale and scope on the microeconomic level. On the macroeconomic level it eventually leads to economic growth, a transition from low-productivity to high-productivity employment and welfare gains for the public at large thanks to the introduction of new goods and services that better meet the needs of the people. Economic prosperity is therefore not primarily based on the efficiency gains and the optimal allocation of scarce resources (rival goods) but the increasing returns generated through the effective use of non-rival goods (new knowledge) in the production process of rival goods. It requires institutions that encourage the investment in knowledge-intensive industries. This growth-oriented and innovative industries can emerge in all three economic sectors (mining and agriculture, manufacturing, and services) if the regulation of the respective sector is conducive to economic and technological change [28].

Institutions that are conducive to growth evolve through learning by doing rather than being derived from a historically detached theory. History therefore plays a crucial role in New Growth Theory, and this can be considered as being the most significant advance compared to the old comparative-static model of economic growth designed by Solow [56]. Yet, the Solow model and its implicit assumption that technological change is an exogenous factor that produces constant returns to scale may have been a convenient theory to explain economic development in the rather static bi-polar World of Cold War period. It is however no more applicable to the global knowledge economy of the 21st century. Empirical evidence over the past 20 years clearly shows that New Growth theory is better able to explain the success of the state-led capitalist models in Asia [4, 11] as well as endogenous economic growth in the manufacturing sector of OECD countries after the end of the Cold War [57, 58].

Recent papers by Jones and Romer [22] and Romer [53] provide evidence that thanks to population growth, increasing levels of human capital, growing urbanization rates and the revolution in information technology, catch-up growth in lagging developing countries happens much faster in the 21st century than any time before; provided that historically well-tested national institutions are in place that permit countries to take advantage of global economic and technological change and thus enable the economic empowerment of its people. If governments however reject institutions that enable trade and exchange with other countries or do no more allow for economic experimentation with new technologies and institutions (non-rival goods), then they are likely to stay poor and thus contribute to the trend of global economic divergence. Economic divergence is a process that puzzled economists in the mid 20th century as much as it puzzles economists in the 21st century who continue to predict economic convergence based on their comparative static equilibrium models.

8. Why is there global economic divergence and not convergence?

In some of today's developing economies the majority of people is almost as poor or even poorer than they were fifty years ago. Others experienced however rapid catch-up growth and a massive reduction in poverty rates. The result is increasing economic divergence. This divergence in income and total factor productivity was observed as one of the stylized facts by Kaldor in 1961 and considered already back then to stand in contradiction to the predictions of neoclassical economics [59]. This divergence was even more pronounced over the past two decades as the new stylized facts proposed by Jones and Romer suggest [22]. But unlike Kaldor, Jones and Romer are able to explain this divergence based on the insights of new growth theory. Kaldor's original stylized facts focused primarily on physical capital (rival goods), whereas in the new growth theory of Jones and Romer it is human capital and ideas that account most for economic growth and institutional change. They argue that it is the interaction between ideas, institutions, population, and human capital that determines whether a country seizes on or misses out on the economic opportunities of the global knowledge economy and international trade. If institutions are conducive to economic change these institutions are likely to enable rapid catch-up growth by closing the distance to the global technological frontier. The virtuous circle between population and ideas does not just enable the rapid adoption and local adjustment of new technologies and the resulting acceleration of endogenous economic growth but helps countries to better cope with the growing social and environmental challenges of the 21st century [28].

Whether economic globalization turns vicious or virtuous depends on institutional change. Institutions may hinder the adoption and utilization of ideas - or facilitate it. Even though institutions that proved to facilitate sustainable change are well known thanks to the historical record, they are not necessarily widely adopted because they sound counterintuitive to the public (why should private profits also increase public welfare? Why should trade be different from theft?) and the education system often fails to explain the long-term benefits of institutions that encourage trade, exchange, entrepreneurship and innovation. Even though institutions are themselves non-rival goods that can be adopted elsewhere [53] they often lack public support and therefore the political majority to be adopted. Instead the response to economic challenges in highly developed countries with less bottom-up pressure for economic change is often a sort of muddling through that is primarily designed to appease public anger with short-term gestures and the attribution of economic problems to external factors (technological change, the rise of China, global trade, intellectual property rights, greed, etc).

9. State failure or market failure?

The financial and sovereign debt crises in Europe largely reflect the lack of political will to embark on institutional reform [60]. The same trend can be observed with the trade negotiations in the World Trade Organization (WTO). The Doha Round, the latest round of trade negotiations, is currently put on ice because governments tend to regard gains from multilateral trade as marginal and they are concerned about stiff domestic opposition to any multilateral trade deals [61]. It is not that trade liberalization was ever very popular in any country. But since it was obvious during the Cold war that socialist and protectionist policies are unable to deliver, governments agreed to strengthen the role of international trade by making the Uruguay Round succeed and thus enable the establishment of the WTO in 1995. Yet, while almost every national economy has an economic sector that is well-endowed with advanced human capital and highly integrated into the global economy, the majority of economic activities remain rather local [62]. But whereas the local economic activities in developed countries are firmly embedded in the formal economy and therefore able to grow through investment, most local economic activities in developing countries are stuck in the informal sector. Business in the informal sector is able to meet some of the needs in the respective neighbourhood but once an entrepreneur would like to offer his products and services on a regional or national scale, he or she has to comply with all the requirements of the formal economy. Even though a transition from informal to formal is associated with increasing costs of compliance and taxation, it also enables the respective business to attract investment to improve the quantity and quality of production, to enhance its customer base and eventually to grow and employ more people [63].

Arthur Lewis argued already in 1955 [64] that poverty in developing countries will eventually be reduced by bringing all the poor people in the informal sector into the formal economy that allows for investment, growth and the creation of more formal employment. This development did not happen and most people in the developing world remain locked-in in the informal economy. They are largely excluded from the benefits of trade and the exchange of ideas and this failure to embrace modern institutions to facilitate economic integration probably accounts most for the failure of the global economy to stop economic divergence. Yet many experts in development assistance continue to see poverty, inequality and environmental degradation as a result of global economic integration. This also helps explain why most university programs that deal with development and the environment frame technological and economic change as part of the problem rather than part of the solution. It is linked to the failure of the education systems in developed and developing countries to explain students the positive externalities generated by entrepreneurs that take advantage of non-rival goods to do things differently and produce things more cheaply or in better quality. There is overwhelming evidence that entrepreneurship and innovation must become one of the pillars of sustainable development and human empowerment [65]. They are the drivers of economic change and economic integration. Even though this process may lead to short-term regional economic divergence, it eventually contributes to economic convergence because it is the only way that a lagging developing country is able to catch-up and close the gap to the developed economies.

10. The stunning facts about global integration and to put them into a economic formula

International trade almost doubled in size from 1960 to 2006, but foreign direct investment increased by a factor of thirty in the same period. The same applies to the spread of innovation: in the 1960s, 83% of patents granted by the U.S. Patent and Trademark Office went to domestic entities. In the first decade of the 21st century it is only about 50%. Finally, the share of people living in cities increased from 30% to 50% in the past 50 years and the share is likely to be 70% in 2050 [22]. All these indicators hint at the fact that the extent of global economic integration is much larger than any economic model is able to capture. Efficiency gains from trade in existing goods are marginal compared to the benefits that result from the continuous introduction of new goods, services, technologies and ideas into the global knowledge economy. Often it is in fact not trade in goods and services that contributed to local development but the trade and exchange in new ideas (instructions, protocols, recipes, designs) that allow local entrepreneurs to produce things more cost-effective on the local level instead of importing the finished good. Yet, in order to be able to take advantage of non-rival goods (ideas) such as ideas elsewhere there need to be institutions in place that provide incentives to invest by means of awarding innovation and reducing risk and uncertainty.

Paul Romer highlighted the link between institutions and technological change in order to explain the gap between a developed and a developing country in a recent paper in the American Economic Review [53]. There is a world stock of technologies T* and the stock of technologies T in a particular country. A country-specific factor R for 'rules' influences the rate at which ideas from the rest of the world enter a certain local economy. With good rules, T could catch-up with T* very quickly. With bad rules, T might not grow at all and the country's economic stagnation becomes increasingly detached from global economic growth thus accounting for increasing economic inequality.

Paul Romer's new production function consists of a function A that captures the factors of productivity (non-rival goods such as ideas related to rules (R) and technologies (T), and function F (conventional production function homogenous of degree 1 in the standard of rival inputs such as physical capital, skilled labor, unskilled labor).

In this context the local stock of ideas depends on the stock of technologies in the rest of the world (T*) and the local rules > T(T*(T*, R). Because foreign technologies T* are non-rival it is possible for T to equal T*. Since components of T* have some degree of excludability, the right incentives in the right local institutional design is crucial.

$$Y= A(T(T^*, R), R) F(.)$$

Yet, there are different types of technologies that have different interactions with rules. Rules may let in technologies that reduce mortality (R facilitating T*=T) even as they keep out other technologies (R preventing T*=T) that can lift income per capita. This explains why progress in global average life expectancy and decrease in child mortality (especially in Africa) is much more impressive than growth in global income per capita over the past century, because it is based on the exchange of non-rival and non-excludable goods such as formulas and recipes rather than rival and excludable goods such as imported pills (Bourguignon and Morrison, 2002). A non-rival and non-excludable good such as a formula to fight diarrhea (e.g. oral rehydration therapy) can be precisely defined: If you can explain it on the phone, present it in a lecture, describe it on paper, or send it over the Internet, it is non-rival. If no one has a legal right to exclude anyone from making use of the particular good or idea then it is non-excludable. Yet, in order to make use of such non-rival and non-excludable goods there needs to be human capital that is familiar with the codified knowledge and has the tacit knowledge to apply it. Human capital is however a rival good. It is a rival good (a physical organism) that produces non-rival goods (ideas). Institutions must be designed in a way that lead to the investment in R&D and human capital and create incentives to innovate and disseminate innovation, and to introduce the new knowledge back into the education system to adjust the formation of human capital constantly to the knowledge frontier and the needs of the private sector. This process can only succeed if all stakeholders participate in the implementation of the political strategy. Rather than relying on a social planner it is about relying on institutions that arrange the pursuit of private interests in a way that benefits the public as a whole.

Economic analysis should therefore focus on the institutions that make best use of the creation and dissemination of non-rival goods such as rules and ideas. The introduction of new rules and ideas may however face stiff resistance from incumbents in business and politics. Even these stakeholders may eventually agree to start with a small and temporarily limited pilot-project. Once this succeeds it becomes more likely to reach political momentum for political action. Sweden proved this when it introduced road-pricing in Stockholm [30].

11. Applying new growth theory to environment and agriculture policy

New Growth Theory managed to create an endogenous growth model of technological change that takes into account the special role of knowledge and the increasing returns it generates for society at large [2]. Unfortunately, Western economic and trade policies continue to rely on the mercantilist view that trade liberalization means sacrificing local production in favour of cheaper local consumption. And most domestic actors in developed countries that lobby against economic change because they manage to benefit from the status quo are able to convince that public that trade is a zero-sum game in which they are certain to lose. This is especially the case for agriculture.

The benefits from agricultural trade and the exchange of new ideas for society and the environment at large have

become obvious in the case of New Zealand. It decided to unilaterally liberalize its agricultural economy and increase its investment in domestic institutions that foster investment in human capital, R&D and the development and commercialization of new goods and services. Not surprisingly, all the negative predictions of trade liberalization as suggested by comparative static equilibrium models, did not happen. Instead the country proved that it is able to ensure the multifunctional character of agriculture as a positive side effect of the stimulation of entrepreneurship and innovation in the farming sector [28]. Moreover, it becomes increasingly clear that the biggest threat to sustainable development are often subsidises rather than competition in international trade. EU subsidises in the fisheries industry have delayed sustainable structural change, encouraged over-mechanization and thus the depletion of natural marine resources. The same applies to its subsidies for tomato and olive production in Mediterranean countries. Subsidised farmers care less about the cost-effective use of resources and they tend to focus on politics rather than innovation. In this context, the role of the public sector as a facilitator of the production of scientific and economically relevant knowledge and as a designer of new markets should get increased attention in the theory and practice of law and economics in general and international trade theory in particular [22].

12. Concluding Remarks

This article reviewed the best available recent economic approaches and public policies that prove that the exchange in knowledge and new ideas had a much larger impact on global economic integration than trade and exchange of physical goods and services over the past two decades. The countries that benefited most from this process of globalization tended to embrace a new form of industrial policy that aimed at investing in new knowledge and human capital to strengthen local private sector activities and make it ready for global change. Developed countries such as New Zealand, Finland, Sweden and Denmark that embraced new growth theory in their economic, environmental and agricultural policies tended to fare much better over the past decade than other industrialized countries where established interest groups that prefer to cling to old theory and practice were able to prevent change. In developing countries, China is probably the most striking example to prove that catch-up growth today is possible at a much faster rate than ever before. The recipe of success of China is related to the fact that international trade in itself was not considered to be good by itself but rather a means to achieved the end of national development. The major focus in China's effort was however on the acquisition and application of knowledge in the domestic economy. This strategy required exchange with the Western countries and therefore a selective opening of the Chinese economy. As a consequence, many other developing countries tended to copy the policies of Asian countries and stopped listening to Western policy advisors and their prevailing gospel of neoclassical economics. The result is a massive increase in south-south collaboration that is about to transform global economic trade patterns.

Why have all these changes hardly been noticed in textbook economics? J. Bradford DeLong, a Professor of Economics at the Berkeley University, recently expressed his frustration about the state of economics in the following words "…perhaps economics will remain a discipline that forgets most of what it once knew and allows itself to be continually distracted, confused, and in denial" [66]. One reason for the inertia of economic theory is the fact that paradigm shifts in the social sciences and in economics in particular are almost impossible even in the face of overwhelming empirical evidence. Joseph Schumpeter already pointed out the inconsistencies of neoclassical economics in the 1930s and 1940s but to no avail. Followers of Schumpeter in the discipline of Economics tended to end up at faculties of business schools because they were no more seen as pure economists that acknowledged the discipline gradual approaching toward truth insights through comparative static modelling [1].

The basic message of Joseph Schumpeter and later Paul Romer that trade and exchange in non-rival rather than rival goods has produced the biggest welfare effects in the process of global economic integration is however meeting increasing interest even in Western countries due to the ongoing financial and economic crises. Governments that face an economic crisis realize that fiscal austerity and commodity trade by itself will not be sufficient for economic recovery and new employment. They need growth through innovation converting many of the formely non-tradeable goods into tradeable goods. This kind of growth with its increasing returns must be recognized as the contribution of innovation and entrepreneurship to global welfare. Welfare economics however still ignores the fact that the private sector invests in R&D and often comes up with the most effective solutions not just with regard to business problems but also challenges related to poverty alleviation, improved environmental management or job creation – especially if only public policy sets the right incentives for the private sector to invest in possible solutions to global problems. Such public-private partnerships are likely to improve the acquisition and application of new knowledge to development and consequently improve a country's capacity to participate in global trade on favourable terms. It allows a country to reduce poverty and create employment through the active participation in economic globalization. Yet, often national governments refrain from undertaking the necessary reforms because they are unpopular. The lack of popularity is again a result of an education system that still teaches the old economic ideology that suggests that we live in a stationary economy that is largely concerned with the optimal allocation of scarce resources. If we want therefore to explain why the process of economic globalization did not lead to global economic convergence but rather divergence we need not blame international trade but national policies. Certain national governments have focused on reducing the gap between the global technology frontier and the national level of technology through the implementation of institutional rules that proved to be effective in mobilizing domestic entrepreneurship and innovation for economic growth. Others however preferred to refrain from unpopular reforms that would be necessary for institution-

al rules that are conducive to endogenous growth. As a result growth largely happened due exogenous factors meaning that if the rest of the world is in crisis they immediately become part of it. Since the primary goal of politicians in mature democracies is to get re-elected with the support of the major established stakeholders rather than in response to unpopular support for institutional rules that are conducive to change and long-term growth, reforms are postponed and growth opportunities are missed. Economic divergence may therefore increase as a result of globalization because certain countries are moving backwards rather than forward to please the powerful domestic stakeholders that benefit from the status quo. The consequences may be much more fatal for a country today than in previous times because catch-up growth today occurs at a much faster rate provided that national institutions do not prevent access to new markets, ideas, knowledge, technologies, goods, services. There is no doubt that the risks of economic and technological globalization are also real, but mankind will be unable to address them by economic, environmental and social planning alone. Coping with new challenges will always be a process of trial and error, and often the most effective solutions to sustainability problems do not come from social planners but innovation and entrepreneurship once again. Domestic and international institutions are therefore not just meant to regulate change but also to facilitate sustainable change by investing in necessary infrastructure and the economic incentives that encourage the local private sector to further invest in new markets and eventually participate in international trade with new goods and services. It will be the best way not just to decrease global economic divergence but to effectively address global sustainability problems through managed economic and technological change.

Endnotes

1. An earlier version of this paper was published as NCCR Trade Regulation Working Paper No. 10 (2012), with funding from the Swiss National Science Foundation

2. See http://www.federalreserve.gov/BOARDDOCS/SPEECHES/2004/20040220/default.htm#fig1 (visited in April 2012)

3. Jones and Romer call it 'modern growth theory' in the paper, maybe to seek convergence with the work of other economists such as Rodrik and Haussmann who do not use the term 'New Growth Theory'.

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Green entrepreneurship: the missing link towards a greener economy

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Abstract

Most international organizations - including the World Bank, UNCTAD, OECD, UNIDO, WTO and FAO - share the view that there needs to be a global transformation towards a greener economy. However, in the aftermath of the Rio+20 UN Summit, some key issues about the green economy must be clarified to reach a global consensus for collective action. In this article, it is argued that a Green Economy cannot be mandated from above but needs to be driven by entrepreneurs that respond to policy incentives through innovation in management and technology. These private sector investments in green innovation do not just generate private profits but also (create) large positive externalities for society and the environment as a whole, especially when they do not contribute only to the creation of a small niche market, but have the potential to be scaled up to reach the sustainable transformation of a entire industry. In this article, it is therefore argued that the emphasis of the term 'Green Innovation' must be on 'innovation' rather than what is generally perceived to be 'green'. This would imply that governments focus more on the creation of an enabling environment for large-scale innovations that contribute to the global green transformation of an entire industry rather than merely subsidizing green niche markets.

1. Introduction

In this article, we will address the pressing need to promote new generations of entrepreneurs who are able to identify and take advantage of green business opportunities. The perspectives of developed and developing countries on this issue are often diverging, due to conflicting interests and unanswered questions.

Firstly, there is widespread concern that the need to promote a greener economy will mainly be used by developed countries as a new excuse for protectionism and for imposing conditionalities on developing countries (UNCTAD 2011b). How can we minimize the risk that the term "green economy" will not just become a new vehicle for developed countries governments to re-package their economic interests in the guise of the new language of "sustainable economic development"?

Secondly, until now the development of green products that meet the needs of poor consumers has been limited. Do we have to assume that green entrepreneurship and green innovation are mainly about the production and trade of environmentally friendly but expensive products to affluent consumers in developed countries? Will the large number of green projects currently implemented in developing countries continue once the funding from international donors is withdrawn?

Thirdly, even though niche markets for green products contribute to more sustainable consumption and production patterns, they will not lead to a global transformation towards a green economy until they reach the masses. How can we make sure that the models used in welfare economics take into account the positive externalities generated by social and green entrepreneurship through private sector activities, and acknowledge such welfare gains?

2. Defining Green Entrepreneurship

In the past few years considerable interest and research have been devoted to understanding the determinants of green growth. However, an important and relevant issue seems to have escaped the attention of both economists and policy-makers: ultimately, green products and technologies are to be introduced into the marketplace by 'green' entrepreneurs. These are the economic actors who make it possible to turn ideas into a reality, by transforming prototypes into commercially viable products. However, the majority of policy mechanisms that have tried to enable green growth are aimed at identifying the technological innovations capable of mitigating the human impact on the environment

and addressing global environmental issues - such as climate change, land degradation and loss of biodiversity. From a policy perspective, less attention has been paid to technology commercialization and to the need to subsidize the "public good" component of green entrepreneurship. From an analytical perspective, a series of key questions still remain, namely: what are the traits of green entrepreneurs? In what kind of institutional environment do they best flourish? Are the drivers of green entrepreneurship common in both industrialized and developing countries?

Indeed, there is an essential difference between the way of looking at green entrepreneurship in developed countries and developing countries. Developed countries and international organizations tend to put more emphasis on the term 'green' and on market opportunities, while developing countries tend to focus more on the term 'entrepreneurship' and on market needs. Chinese and Indian entrepreneurs, for example, are genuinely transforming the emerging economies by developing affordable products that meet the needs of the poor, but still need to become more green (Khanna 2011). Developed countries tend to spend large amounts of money on green innovation projects, but then face the missing link of entrepreneurs who move the product from a prototype to a commercially viable product (Macilwain 2011).

Entrepreneurs are business people who envisage new business opportunities and ventures by taking risks and converting their ideas into commercial reality. Entrepreneurs introduce innovation, adoption and new ideas to the economy as well to the society. Entrepreneurial activities are related to Schumpeter's (1934) notion of 'creative destruction', in that entrepreneurs promote change in the economic and business environment and overtake the old ways of operating. Yet, there seems to be no clear definition of entrepreneurship in the literature, especially with regard to the degree of innovation and size of a particular activity that is necessary to count as entrepreneurial (Ulijn & Brown 2003). There is a general consensus that an entrepreneur generally acts on a valuable opportunity and is driven by a special motivation (Miller 2003). Thornton (1999) defines entrepreneurship as the creation of new organizations, which implies a certain degree of innovation and size. This creation occurs as a context-dependent, social and economic process.

The entrepreneurship literature can roughly be divided into a supply side perspective that looks at the availability of individuals with traits that make them potential entrepreneurs, and a demand side perspective, that looks at the number and nature of entrepreneurial roles that need to be filled in a society (Thornton 1999). On the supply side there is a wide body of literature that tries to capture entrepreneurial orientation (Kreiser et al. 2002) and motivational constructs that are linked to individual value orientation (Schwartz 1992). They represent individual traits and personal values that apply across cultures and time. On the demand side, research is mainly focused on how institutions (Williamson 2000) and culture (Hofstede 1980, Hayton et al. 2002, Shane 2003) either enable or hinder entrepreneurial activity in a particular region or country. Often the supply and demand side analyses of entrepreneurship are eventually combined; for example by unearthing the cultural orientation within personal traits. It then reflects the embeddedness of the economic environment in social and structural relationships (Granovetter 1985). All these insights were mainly gained from empirical research in developed countries. There is only scarce research on entrepreneurs in emerging economies (Tan 2001) and even less so in least developed countries.

The research literature on green entrepreneurship is even less widespread and lacks a broad empirical foundation. This may also be related to the difficulty to draw the boundaries between green and non-green entrepreneurship. It was not until 1990s that the studies on green entrepreneurship emerged. Bennett (1991), Berle (1991) and Blue (1990) first adopted the notions 'environmental entrepreneur', 'green entrepreneur', 'eco-entrepreneur' and 'ecopreneur' in their studies. Based on the review of such literature, the basic characteristics of green entrepreneurs are:

- Green entrepreneurs undertake new business opportunities and ventures, which usually involve a very high risk. The outcome of these business ventures is often unpredictable.

- Green entrepreneurs are intrinsically motivated. Their business activities have an overall positive effect on the natural environment and on economic sustainability, and consciously aim at insuring a more sustainable future.

Green entrepreneurs often struggle to survive, due to an unstable commitment from the public sector, whose support is being easily overturned by everyday changes in politics and lobbying.

Just to cite a few examples, the solar and wind energy business emerged in the 1970s, mainly in the United States due to the government's response to the oil crisis. The big improvements in solar and wind energy technology happened in public sector research and policy incentives led the private sector to further invest in the commercialization of these emerging technologies. However, once the oil became cheap again, most government efforts to further strengthen the green economy sector were abandoned and investment in alternative energy technologies decreased rapidly (OECD 2011b). The same is true for the promotion of sustainable intensification in agriculture. Large public sector investments in agricultural research and development took place during the Cold War period. But once the communist threat disappeared at the end of the 1980s, most governments lacked the will to further invest in agriculture and left it to the private sector to further invest in agriculture. The global food crisis combined with the unsustainable agricultural practices is to a great extent the result of this neglect of agriculture over the past two decades (Aerni 2008).

3. Stimulating Green Innovation

The concept of "green innovation" is often associated with renewable energy (e.g. wind power and fuel cells). However, the shift to a post-carbon economy depends on much more than technological improvements in energy related technologies: it needs a watershed on several levels, from innovation in lifestyle to innovation in investment and governance (Kemp, 2011). Additionally, non-technological innovations are at least as relevant, considering the case of new business models that develop new organizational approaches.

Before Prahalad (2004), most economists believed that markets always fail to address the needs of the poor. They doubted that there was any growth opportunity at the bottom of the pyramid. Many of the reports on the green economy today are similarly sceptical about the ability of the market to address environmental concerns and to provide enough stimuli to incentivize green innovations (UNEP 2011, FAO 2011, OECD 2011a). Yet, there is evidence that green innovation existed throughout the 20th century, even in the absence of government interventions (Silverthorne 2011). Successful green innovators had an intrinsic motivation to improve through experimentation and, at the same time, were able to create successful businesses. They also invested most of their profits again in the improvement of their green product or technology. By doing that, they created large social and environmental welfare gains while ensuring the commercial viability of their business (Aerni 2010).

Today, despite the modest results achieved by large international forums and the retreat of public finances, green business is creating new economic opportunities for both multinational corporations and small and medium-size enterprises (SMEs). The private sector, stimulating economic growth and development, is increasingly playing an essential role in bringing solutions to global sustainability challenges (ICC, 2012). Green enterprises are increasingly successful in proving to shareholders and stakeholders that sustainability is not just a cost but rather an opportunity to increase revenues and customer loyalty while protecting the environment. To reinforce the business core for sustainability and promote a culture of innovation within all staff divisions, all kinds of companies have been looking at sustainability comprehensively, taking steps in the direction of water conservation, carbon neutrality, solid waste reduction, post-consumption recycling, while measuring rigorously the costs and benefits of each business unit. In same cases, companies have also managed to leverage governments to improve standards, education and labour skills.

Large and well-established corporations often associate green innovation primarily with 'green labels', corporate social responsibility and private standards, designed to avoid risk and enhance public reputation (Freidberg 2007). New players in the market, instead, are more often focused on investing in R&D in order to launch innovative and more resource-efficient products that have the potential for increasing returns (Shellenberger and Nordhaus 2007, Lovins 2011). Indeed, international corporations, in particular service-oriented companies and big retailers, are undertaking innovative new commitments, investing an increasing amount of their budget to improve systematically the management of internal processes along the entire value chain, often involving suppliers directly. Among many other global companies which have gone green, the giant retailer Wal-Mart, is for instance adopting since 2005 more planet-friendly practices to reduce its footprint and the use of natural resources. As in the case of similar initiatives (Tesco, Migros, Coop, Woolworth, IKEA, etc), green efforts like more efficient trucking fleet, energy-saving lighting and refrigeration, reduced packaging, recycled materials, renewable energy micro-plants and cogeneration, etc., have resulted in enormous cost reductions or even profits as from the reuse of waste (Humes, 2011). Equally, leading clothes and sport footwear global retailers (Nike, Puma, Adidas, H&M, etc.) have joined forces to detox their supply chains from nine classes of hazardous chemicals ("Zero Discharge of Hazardous Chemicals by 2020 – Ø ZDHC"). Nevertheless at Rio+20 Business Day, Carlos Busquets, ICC Deputy Director, has particularly highlighted the fact that SMEs can play a critical role in green growth and environmental responsibility, for being a crucial component of larger corporations' global supply and value chain, as well as a major source of innovation and employment.

It is important to note that although Western-centric approaches might have influenced so far the discussions looking at companies combining profits with debatable green "labels" or arguing that "green" is a rich-world luxury or rather a conspiracy of industrialized countries, green enterprises are also growing in emerging and developing markets. In BRIICS countries, (Brazil, India, China, South Africa, etc.) and rapidly developing countries such as the TIIMBs (Turkey, Indonesia, Mexico, etc) business may suffer from weak infrastructures, not fully reliable supply-chains, limited access to finance, inefficient institutions or burdensome regulations, but domestic SMEs are increasing called to meet the needs of new customers without compromising the local environment, and to increase their organizational and productive efficiency by reducing consumption of natural capital.

To this regard, an increasing number of highly profitable businesses from the developing world are turning eco-consciousness in a competitive advantage, demonstrating that they can be just as green as their Western rivals. They were identified by a new study of the World Economic Forum (WEF) and the Boston Consulting Group (BCG), which argues that these "new sustainability champions" are using unique practices for doing business in resource-constrained and population-stressed environments, pro-actively turning constrains into opportunity through innovation. The study points out that sustainability is often embedded in the company's culture. When benchmarked against their peers these new green champions are demonstrating superior financial performance, and proved that green enterprises creating unconventional and profitable ways to enhance sustainability and new market solutions may achieve higher-than-average margins for economic growth.

The WEF-BCG report includes a few interesting cases of successful emerging-world companies. The Chinese Zhangzidao Fishery Group has, for example, adopted an Integrated Multi-Trophic Aquaculture (IMTA) farming method to increase production and economic diversification while creating a balanced relation with the marine ecosystem, reducing waste and raising levels of carbon sink. The Indian cement company, Shree Cement, in introducing an intelligent energy system to recover heat along with an innovative treatment to reduce waste and use of water, has achieved impressive energy efficiency results, enabling the company to perform well financially and environmentally. The Brazilian cosmetics manufacturer, Natura, promoted the re-use, refill and recycling of its packaging while using sugarcane-based plastic to reduce GHG emissions, and is promoting resource-efficiency and conservation adopting FSC certificated raw materials.

Therefore, while it seems clear that sustainable economic changes need to come from the bottom up, the transition to a green economy requires the simultaneous integration of top down incentives-regulations and bottom up solutions. The holistic vision which underpins the capability of innovation to create new ways and combinations, as well as the interdependency between the economic, social and environmental aspects of development ("the three strands of sustainable development"), and the economy itself, characterized by globally connected and cross-cutting value chains, require combined efforts from the public and private sectors.

As a matter of fact integrated governance and a conducive institutional framework reduces the uncertainties for green entrepreneurs and allows all actors to deliver on their shared responsibilities and to address the missing links within the marketplace. To this regard governments must shape the context creating a supportive Research and Development (R&D) infrastructure. The OECD report 'Fostering Innovation for Green Growth' contains some important policy recommendations. Governments should introduce adequate regulatory incentives to strengthen markets for green innovation, and a well-functioning Intellectual Property Rights (IPR) system to foster private sector investment and diffusion of green innovation. They should also promote more entrepreneurship in the private sector and enhance public sector support for R&D to facilitate sustainable technological change (OECD 2011b).

The OECD report also points out that existing production technology and consumer behaviours can only be expected to produce positive outcomes for the economy and the environment if innovation is able to decouple growth from natural capital depletion. This is also the basic conclusion of New Growth Theory and its more recent emphasis on the importance of institutions (Jones & Romer 2009). The main argument is that population growth as such might not necessarily be a problem, if it also leads to more investment in the education of people. This investment is then likely to increase the number of good ideas on how to address the problem of scarcity, which will universally be adopted if a conducive institutional environment is in place.

Recently many countries, in their transition to a low-carbon economy, have been adopting strategies and policies to develop new opportunities and to attract new green investments. To this regard very diverse economic entities have emphasized the role that the public sector can play to influence markets towards sustainable paths without increasing pressure on tax-payers or altering competition among different industries. Although additional research is needed to understand how to create a more conducive environment for sustainable development and to explore the potential of sovereign wealth funds (SWFs), governments are increasingly encouraging public-private partnerships to attract green investments and creating competitive locations for green Foreign Direct Investments (FDIs). While green special economic zones (SEZs), designed to operate in a sustainable way, usually target specific activities in the value chain creating Cleantech Parks for research, development and commercialization (WIF, 2012), budget-constrained authorities have been opening to private investments and new ways of finance to reduce the environmental and economic bill of public infrastructure. For instance, under the Chicago Infrastructure Trust (CIT), a $1.7b private-public partnership to improve public infrastructure and overcome budget deficit, an initial private investment of $225m is aimed at making city buildings more energy-efficient and is expected to be repaid off by an estimated $20m annual saving in energy costs (Keyser, 2012).

Governments have also provided positive incentives to markets, channelling public expenditure into procedures of Green Public Procurement (GPP). In particular, the European Commission has set specific green criteria for public tendering procedures. Europe's public procurers, with a collective annual budget of €2 trillion or 17% of the EU's GDP, can contribute significantly to foster the establishment of sustainable production and consumption. Given that they encourage consumption by both individuals and organizations of environmentally friendly products and services owing to scientifically proven sustainability advantages (AEA, 2011).

A lesson to be learned from past attempts to promote a green economy is that not all types of government interventions manage to fostering green entrepreneurship and innovation. For example, Germany decided to promote the growth of its solar industry through subsidies and price guarantees for solar electricity rather than investment in R&D. The result is that the German solar industry has not become more but less competitive. In 2011 it suffered from the competition of cheaper solar panels from China (Wiesmann 2012). The relationship between strict environmental regulation and private sector investment in more environmentally friendly products is also not very clear (Bernauer 2006). Often big corporations prefer to invest in green marketing rather than green innovation (Aerni 2009). Therefore, it is all the more important to understand and clearly define the patterns of green entrepreneurship and to make essential distinctions about the degree of innovativeness, the different types of policy in-

tervention to promote it, and the potential for growth and job creation.

Multilateral approaches across countries and sectors as well as integrated governance at all levels to combine economic and social advances while protecting the environment, are fundamental conditions to drive growth in a resource-constrained world. In order to avoid the collision between strong demographic and economic growth, strategies of short-medium-term profits will have to be balanced by longer-term shared values (ICC, 2012).

So far accounting methods have made a substantive progress. Several specific certificate systems and sustainability reporting standards are already broadly diffused in operational corporate schemes to assist green enterprises with lifecycle assessments and to provide relevant, verified and comparable information about the environmental impact from goods and services, e.g. Forest Stewardship Council (FSC), Totally Chlorine Free (TCF), Environmental Product Declaration (EPD), Global Reporting Initiative (GRI), etc. However further analysis, better disclosure and reporting as well as accounting measures and metrics are needed to assess costs and benefits beyond the pure economic single data, including enlarged review of correlated costs. Entire life-cycle assessment approaches and indicators, enabling comparison across nations and sectors, are the way forward to provide more analytical information and to turn the green economy fully operational (ICC, 2012).

4. Conclusions

"Green entrepreneurship" is an increasingly relevant phenomenon from a development perspective, but still largely under-researched. While global inequality and rising unemployment pose major challenges to policy makers, the widespread destruction of wildlife and natural habitats, together with the emerging effects of climate change and the rapid loss of biodiversity, compound the vulnerability of already burdened social groups and ecosystems. The negative impact that environmentally-inefficient economic activities have on the environment and consequently on the economy have induced policy makers and scientists to emphasize the urgent need to move toward a more environmentally-sustainable development path by encouraging the adoption of sustainable practices and "cleaner technologies". In this article, we have argued that fostering the development of green enterprises and enhancing the resilience of economies and natural ecosystems necessitates a more in-depth analysis of conditions and factors that influence green entrepreneurship. This is also inline with the outcomes of the Rio+20 Conference.

In particular, there is a need to define the boundaries of "green entrepreneurship" and "green innovation", to study the impact of system failures and to better understand how formal-informal networks determine the performance of (green) small and medium-sized enterprises (SMEs). These are of crucial importance to the economy as they make significant contributions to job creation, are the engines of change and have been credited for introducing innovation, adapting to new ideas and responding to changes more rapidly, flexibly and efficiently than larger organisations. Moreover, the patterns of technology development and adaptation are considerably influenced by the evolving nature of innovation and its determinants. The recent advance of new information technologies and the globalisation of economic processes have drastically modified the traditional methods used by enterprises to innovate. Although impressive advances have been made with technological research and implementation as well as with environmental accounting and reporting, the gap towards sustainability is still significant. It is important to understand the pre-conditions for the creation of "green innovation", the factors that act as barriers and triggers, and how changes in access to information, new technologies, resources and markets impact on or change the dynamics of innovation and management.

Systemic change is needed to foster progress in economics, accounting and legal frameworks. Although as pointed out by a survey of Accenture (UN Global Compact-Accenture, 2010), sustainability has become a central worldwide component of corporate business plans, acknowledged by executives as being highly relevant for the future of their businesses (98% in Asia Pacific region compared with a 93% average), the global transition to a green economy is only at the beginning and the earth can no longer wait. The next decades will see rapid growth in global population, industrialization and economic development. Resources are limited and we must meet the needs of people. Green entrepreneurs are delivering on their commitments to provide efficient and safe operations while being environmentally and socially responsible.

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