

The Contribution of Mobile Telecommunication Technology to Sustainable Development in Selected Countries in Africa

by

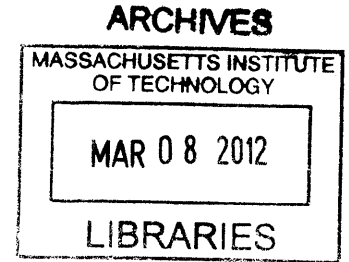
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Submitted to the System Design and Management Program and the Technology and Policy Program
in Partial Fulfillment of the Requirements for the Degrees of

Master of Science in Engineering and Management and
Master of Science in Technology and Policy
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Abstract

While most of the world's population resides in countries that are wealthy or developing, the rest reside in low-income and least developed countries (LDCs), left behind and growing more disconnected. At the same time, mobile phones are widely adopted in these underdeveloped areas and demonstrate potential for economic development. However, technological innovation and policies have often addressed narrow dimensions of poverty and development. Sustainable development, on the other hand, assesses the welfare of a country in its entirety. This then begs the question of how mobile telephony technology, given its pervasiveness, can be beneficial on a systemic and sustainable level.

This document presents evidence that mobile phones can contribute to sustainable development in several ways. The focus is on selected countries in the sub-Saharan Africa region: Kenya, Tanzania, Uganda, and Nigeria, each of which is categorized as a LDC. The Sustainable Development framework is used to analyze data from case studies and existing technology, institutional and policy trends in the mobile telecommunication industry.

The evidence from literature demonstrates that mobile initiatives focused on niche areas, such as banking and health, have benefited on the community level and improved operations within firms. Mobile industry policies have created a healthy system of innovation in these countries. However, environmental development has been secondary or even ignored. Thus, the recommendations focus on prioritizing sustainability, specific policies continuing diffusion and adoption, technology transfer mechanisms, increased robustness in data-tracking and countering external economic shocks.

The data presented is not meant to be comprehensive nor complete. Consequently, suggested future work addresses short-term, mid-term, and long-term strategies. Specific areas include examining causal linkages for mobile phone adoption, designing technology initiatives around sustainability goals, and drivers that facilitate technology transfer.

Mobile telecommunication technology offers real opportunities for development and growth in Africa. If the focus of development shifts from mere economic growth to sustainable development, countries can not only transform their economic fortunes but also enhance the quality of their environment.

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1. Introduction

1.1 Development and Growth: An Overview

1.1.1. A Tale of Three Worlds: Developed, Developing, and Least Developed

While the world is in many ways connected, there is a population, often called the *bottom billion* or *least developed countries (LDCs)*, that is becoming increasingly *disconnected* from the global economy. During the period between 1960 and 2004, real per capita income in the developing world such as India and China grew at an average rate of 2.1% per year – a fairly considerable growth rate (Rodrik, 2007). Rich countries grew at a rate of 2.5% per year during the same period. However, the LDCs¹ experienced stagnant growth or even declining growth (UN, 2003), increasing the economic gap between themselves and the rest of the world.

There is a paradox in our world today. Eighty-five percent of the world's population resides in countries that are wealthy or developing with upward growth. The rest reside in low-income and underdeveloped states, left behind and continually falling behind. This interconnected web of our world has high-growth countries and no-growth countries; countries that have grown rapidly throughout and countries that have been declining.

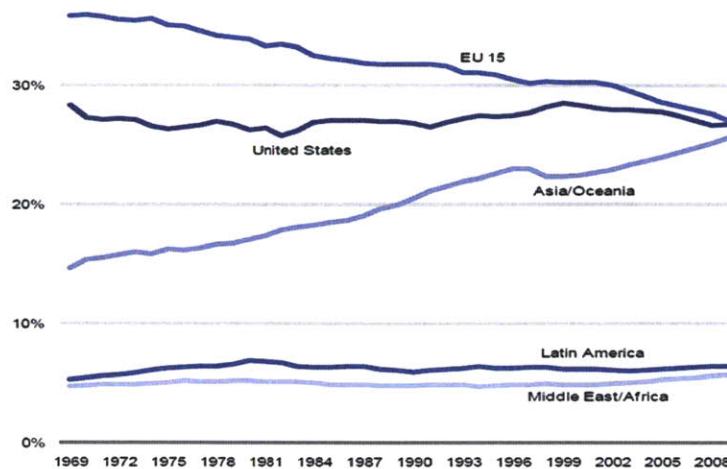
1.1.2. The Development Experience of the Developing Economies

The pattern of economic performance has varied greatly across different time periods. China and India have been major success stories since the late 1970s, with China experiencing a growth rate of 8.0% since 1978 and India roughly doubling its growth rate since the early 1980s (pulling South Asia's growth rate up to 3.3% between 1980 and 2000 from 1.1% between 1960 and 1980). The developing countries that are not part of the bottom billion, the middle four billion, have experienced rapid and accelerating growth in per capita income. During the 1970s, they grew at 2.5% per year. During the 1980s and 1990s, their growth rate accelerated to 4% per year. During the early 21st century, it accelerated again to 4.5% per year (Collier, 2007). Between 1981 and 2005, the number of people in poverty has fallen by around 600 million in China alone.

While there has been great progress in reducing poverty, it has been far from uniform. The global picture masks large, regional differences. Figure 1.1 below illustrates the growing gap between the developed and least developed countries during the last four decades (Schill, 2010).

¹ A country is classified as a LDC if it meets three criteria:

- low-income (three-year average GNI per capita of under USD \$905, which must exceed \$1,086 to exit the list)
- human resource weakness (based on indicators of nutrition, health, education and adult literacy)
- economic vulnerability (based on instability of agricultural production, instability of exports of goods and services, economic importance of non-traditional activities, merchandise export concentration, handicap of economic smallness, and the percentage of population displaced by natural disasters)



Sources: USDA Economic Research Service; World Bank World Development Indicators; International Financial Statistics of the IMF; Global Insight; Oxford Economic Forecasting.

Figure 1.1: Share of the World GDP by developed, developing, and least developed countries.

During the 1970s, the bottom billion diverged in growth from the rest of the developing world by 2% a year. This divergence accelerated to 4.4% a year during the 1980s and further to 5% during the 1990s. In sub-Saharan Africa (SSA), the \$1.25 a day poverty rate has shown no sustained decline over the whole period since 1981, starting and ending at around 50%. In absolute terms, the number of poor people has nearly doubled, from 200 million in 1981 to 380 million in 2005.

1.1.3. Mobile Technology in Sub-Saharan Africa as a Focus of Study

The geography that this thesis centers on is the sub-Saharan Africa region. Several countries in this geography are categorized as LDCs, according to the United Nations, exhibiting some of the lowest indicators of socioeconomic development and lowest Human Development Index (HDI) ratings of all countries in the world. A detailed regional assessment will be in Chapter 4.

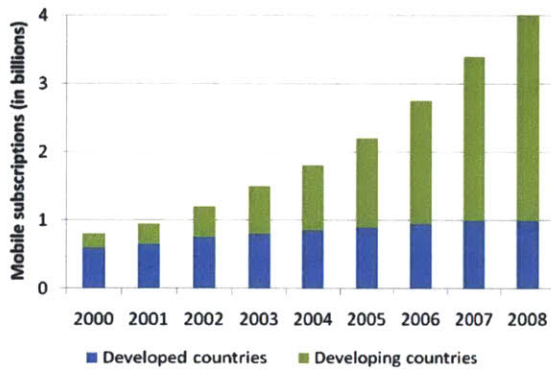
The value of mobile phones is arguably higher for LDCs. The main benefits, which will be expanded on in Chapter 5, are that they overcome systemic constraints, such as unpredictable environments, lack of infrastructure, lack of transport, and high social barriers. While the rural poor are not homogenous, consisting of artisans, farmers, fishermen, migrant workers, and indigenous people, a common element is their lack of affordable access to relevant information and knowledge services. The lack of access to such services can lead to contributors of poverty, such as ignorance of income-earning or market opportunities.

1.2. Factor Endowments: Innovation Systems and Mobile Technology

While many regions in the SSA region are described as least developed or underdeveloped, they also exhibit a baseline of physical, industrial, political, and institutional infrastructure for an emerging economy and for development to ignite and sustain. They exhibit many variables, namely factor endowments, which demonstrate potential for development and growth. Specifically, they have innovation systems and a capacity for technological innovation with mobile telephony. Innovation systems are enabling institutions fostering technological innovation, a complex *system* of interacting determinants, reflecting different political, social, and economic development cultures and traditions. According to the International Monetary Fund (IMF), development entails a modern infrastructure, and a potential to shift away from low value added sectors such as agriculture and natural resource

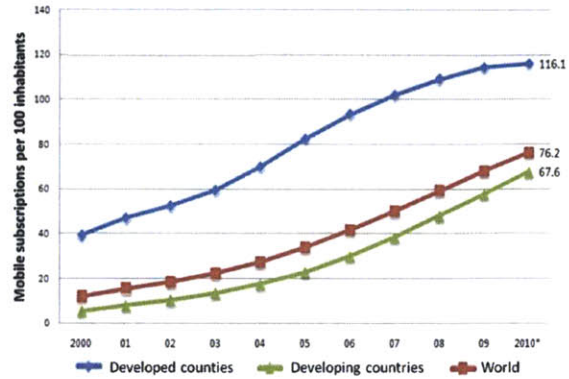
extraction (IMF, 2010).

The African mobile market exceeded half a billion subscribers during 2010, hitting about 506 million (Nwankwo, 2010). This is a 20% increase since 2008 and an exponential growth since the 16 million users in 2000. The mobile subscriber base is projected to grow to 842 million by 2015. Figures 1.2 and 1.3 illustrate the rapid growth of mobile telephony in the developing world.



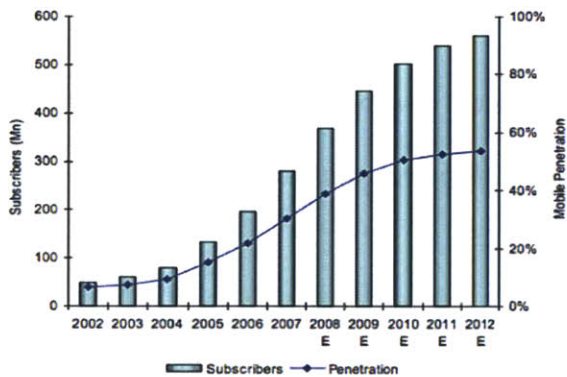
Sources: World Bank; ITU.

Figure 1.2: Total mobile phone subscriptions; Figure 1.3: Mobile phone subscriptions/100 inhabitants.



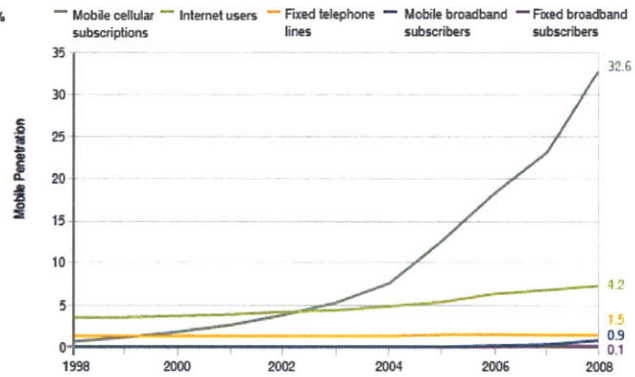
Sources: ITU; ICT indicators database.

Figures 1.4 and 1.5 show the growth of mobile phone subscribers in Africa.



Sources: ITU World Telecommunication; ICT indicators database

Figure 1.4: Mobile subscriptions and penetration in Africa; Figure 1.5: Comm. growth in Africa/100 inhabitants.



From a wide range of uses, whether it's checking market prices of crops, transferring money, diagnosing medical conditions, or simply making a call, mobile phones are transforming Africa. For example, productivity gains from mobile telephony operations can be substantial. This can be evaluated through a range of factors, from the number of workers relying on mobile phones to revenue and time savings due to mobile phones, with benefits including business expansion, employment search, entrepreneurship, money transfer, and transaction costs (Deloitte and Touche, 2007). Case studies and reports have also demonstrated GDP per capita increases with the addition of mobile phones into a community, given a certain baseline, and opportunities have increased due to access to employment and market information (ITU, 2009). The growth of mobile phone subscribers and associated mobile applications in Africa has received claims that the technology will be Africa's "silver bullet" for economic growth (Perkins, 2010).

However, the only way for this technology to have an economic and social impact on the world's developing and least developed populations, the crux of the development challenge, is through appropriate and complementary technological and policy innovations that facilitate entrepreneurship and development initiatives, and ensure distributive benefits. Otherwise, those living in extreme poverty (under USD \$1 a day) will be left out of the benefits reaped from this technological boom.

BRIC countries, specifically India and China, can play an important role in the development of the selected LDCs, serving as a role model for lesser developed countries. But India's and China's growing presence may also deprive the latter nations from global integration. As the emergence of energy and mobile technology grows, only with the appropriate policies and careful monitoring will these LDCs truly benefit from innovation.

1.3. Sustainable Development in the Underdeveloped Scene

The problem of a lack in development contains multiple dimensions, with economic development as just one of those dimensions. Solutions that enable economic and social development in all societies, according to economists M. P. Todaro and S. C. Smith should aim (Todaro and Smith, 2009):

- To increase the availability and widen the distribution of basic life-sustaining goods such as food, shelter, health, and protection.
- To raise the quality of life (securing more meaningful jobs and enhancing cultural and human values).
- To expand the range of economic and social choices available to individuals and nations, by freeing them from dependence on other nations, but also from the forces of ignorance and human misery.

Thus, sustainable development incorporates economic and social development and centers on the interdependence and interaction of three dimensions:

- Employment Growth: *increasing rewarded and rewarding opportunities*
- Economic Development: *increasing access to capital*
- Environmental Protection: *increasing quality of life*

This thesis will use Massachusetts Institute of Technology Professor Nicholas Ashford's Sustainable Development Framework to assess the performance of mobile telephony innovation against the three dimensions of sustainability: Economy, Employment, and Environment.

1.4. Risks and Opportunities

As the adoption of mobile technology increases in sub-Saharan Africa and the supporting infrastructure develops, there will also be a growing costs, namely real costs such as environmental damage and opportunity costs related to equitable wealth and information distribution.

To truly have a positive impact, the mobile technology boom will require complementary access to public infrastructure, such as reliable electricity, with appropriate policies that will not hinder further adoption and use, especially by the poorest. The taxes levied by national governments on these technologies have the power to make their adoption and use cost prohibitive. For Africans living in extreme poverty, cell phones still remain inaccessible and unaffordable. The lack of adequate transportation infrastructure is still a major obstacle. In SSA, only 29% of roads are paved and barely 25% of the population has access to electricity.

Thus, the real opportunity is not solely technological. While creative and innovative uses of mobile technology that benefit the economic livelihood of the world's poor can be attractive, complementary policies and institutional arrangements are absolutely necessary. This includes top-level, supply-side policies that ensure market competition to grow the mobile industry, such as designing appropriate antitrust laws for the industry players, as well as demand-side policies to ensure affordability and accessibility for those in need. The rise of mobile telephony usage has led to growing concerns over information and cyber security and environmental dangers due to e-waste. With these new risks, local governments are designing legislation to regulate usage and minimize the potential harmful effects. Collaborations between public, private, and NGO institutions are also forming to address these risks. Both domestic and international policies will need to promote the development of mobile technology and protect users and entrepreneurs from economic disincentives.

The challenges of developing such policies include the capacity to do so, the ability to consult with all the relevant stakeholders, and the communication process. Currently, many policies being developed in these countries do not address the needs of the people, often seen as irrelevant to the society. International organizations and domestic institutions need to diligently implement, monitor, and evaluate the effectiveness of policies, managing where investments are distributed and ensuring that the incentives are in place to spread mobile penetration to the most rural of villages, and that the economic benefits are distributed appropriately. This is the only way that emerging technology has a chance to positively impact the livelihoods of Africans in the long run.

1.5. Structure of Thesis

Poverty cannot disappear unless the bottom billion grow. They will not grow unless development is ignited and sustained. And it can't be done with a one-size-fits-all solution as previously prescribed with the Washington Consensus. Development strategies must acquire mastery over a broader range of activities, instead of concentrating on what one does best. The most significant instances of productive diversification are indeed the result of concerted government action and of public-private collaboration. Entrepreneurs must experiment with new product lines. They must experiment with technologies from established producers abroad and adapt them to local conditions. The type of discovery that matters in these contexts differ from innovation and R&D as traditionally understood. The development process in LDCs is largely about structural change: it's characterized by economist Dani Rodrik as one in which an economy finds out – or *self-discovers* – what it can be good at, out of many products and processes that already exist. What is involved is not just inventing new products or processes, but “discovering” a certain good, which can already be established in global markets, that can be produced at home and at low cost (Rodrik, 2009). Each country and each environment needs uniquely tailored solutions that mix top-down frameworks with local knowledge.

The purpose of this thesis is to examine the role of mobile telephony technology and mobile applications, and institutional and policy instruments within this technology's broader social, economic, and political system for addressing development challenges in least developed countries, focusing on sub-Saharan Africa. The outcome is to propose a systematic but customized approach to identifying innovation opportunities in low-income countries and fashioning appropriate pathways to achieve sustainable development through technology, institutional activity, and policy mechanisms. Integral to the analysis of the system in which these technologies operate would be to investigate any commonalities, pathways, and connections with emerging economies such as India and China.

The research begins with an analysis of the relationship between existing models of economic development and growth in the context of factor endowments (Chapter 2). The discussion then advances to the effects of economic growth on sustainability (Chapter 3). This includes an analysis of the limits of the GDP growth paradigm, but also of the effects of growth LDCs and the interconnection of economic growth and ecological collapse. The focus of analysis then shifts to the regional analysis of sub-Saharan Africa and its mobile telecommunication industry (Chapter 4). Mobile telephony technology and their effects on sustainable development are examined through case studies and industry reports (Chapter 5). The performance of the technological options, institutions, and policies are presented and analyzed and assessed against the indicators of the Sustainable Development Framework (Chapter 6). Synthesis of the relationship between mobile telephony technology and sustainable development is presented, including options for technology, institutions, and policies that promote sustainability. The discussion is concluded by recommendations on appropriate and effective options and pathways that could be employed so that mobile telephony technology can facilitate sustainability (Chapter 7). Additionally, an examination of current and potential barriers preventing mobile telecommunication technology to contribute to sustainable development in the selected countries along with suggested future work concludes this document.

2. Development and Growth

2.1. Overview of Development and Growth

Theories of development and its challenges has been around for awhile and is most recently associated with the work of development economists like Jeffrey Sachs, who has focused on the consequences of poverty traps such as health problems. For example, malaria keeps countries poor, and because they are poor, the potential market for a vaccine is not sufficiently valuable to warrant drug companies making the huge investment in research that is necessary. Economist and author Paul Collier writes that the failure of the growth process in these least developed countries (LDCs) needs to be our core concern, and curing it the core challenge of development. In other words, economic growth will only occur through the igniting and sustaining of a development process.

Economic growth has been at the center of analysis since the origins of economic theory. Growth, however, should not be considered as an end goal in itself because it does not account for non-traded goods, services, and cultural attributes. Economists have focused their efforts on analyzing the causes of growth for centuries since it has the potential to decrease poverty, increase the standard of living, support goals such as education and healthcare, and substantially affect the quality of life of a country's citizens. The metrics used to measure growth are typically in terms of increased GNP and GDP. However, not all increases in these metrics are necessarily good. There is "good GDP" and "bad GDP" (Ashford and Hall, 2011). For example, the GDP of a region might increase as a result of activities related to disaster and crisis mitigation, but it is clear that this kind of increase in GDP is not the main goal, even if service-providers profited from the activity. Increased economic activity (involving expenditures for goods and services) due to natural or human-made disasters is not part of any deliberate growth strategy of government in its trusteeship role for its people.

Furthermore, economic growth is generally used to describe how already-developed nations further enhance their economies. Development, on the other hand, is not a purely economic phenomenon, but is most necessary and applicable for LDCs. Economists M. P. Todaro and S. C. Smith describe that the objectives of economic and social development in all societies should aim to (Todaro and Smith, 2009):

- To increase the availability and widen the distribution of basic life-sustaining goods such as food, shelter, health, and protection.
- To raise the quality of life (securing more meaningful jobs and enhancing cultural and human values).
- To expand the range of economic and social choices available to individuals and nations, by freeing them from dependence to other nations, but also from the forces of ignorance and human misery.

Thus, development strategies should take on a multidimensional approach, involving the reorganization and reorientation of entire economic and social systems. In addition to improvements in inputs and outputs, development typically involves radical changes in institutional, social and administrative structures, as well as in popular attitudes and even customs and beliefs. Furthermore, while development is usually defined in a national context, its widespread realization may necessitate fundamental modification of the international economic and social system (Todaro and Smith, 2009).

There are also other positive attributes of development that are not captured by GNP and GDP. For this reason, other indexes of human development, such as the Happy Planet Index (HPI)², such as health and education, have received increased attention. Many contributions to economic growth are desirable and require a government's economic or industrial policy. However, the role of national governments in the context of economic development is essential. Contrary to the view of many neoclassical economists, this role should not be limited to ensuring the proper functioning of markets and the correction of market failures. They are contributing elements systems that foster innovation, or innovation systems, which often functions on a national level and embody technological, institutional, and policy components.

2.2. Factor Endowments

A country's factor endowment is commonly referred to as the amount of land, labor, capital – its factors of production – and entrepreneurship that they might possess to be exploited for economic growth (Ashford and Hall, 2011). Countries with a large endowment of resources tend to be more prosperous than those with a small endowment, with all other variables being equal. When a nation's economy is driven mostly by the agrarian sector, land is the most highly valued factor. After industrialization, material resources, energy, and more skilled labor take on higher importance. This is especially relevant when describing some of the shortcomings of economic development in sub-Saharan Africa (SSA) where there is a lack in building a labor force through education and income-generation (Collier, 2007).

A comprehensive list of factor endowments, which captures the growing importance of services and knowledge-based work, would generally include (Ashford and Hall, 2011): Land, Material Resources (natural and physical capital), Energy, Labor (capable of performing physical work), Know-How (intellectual human capital), Built capital (i.e., infrastructure such as railways, bridges, roads, ports, airports, dams, etc.), Health and Environment³, Structural Capital (knowledge and productive routines held by organizations), Networks and Outsiders (linking organizations, people, and entrepreneurs), Social Capital (knowledge held by consumers and citizens), Systems of Innovation, and Information and Communication Technology (ICT).

Systems of innovation, or innovation systems, and mobile telephony technology (a subset of ICT) are the factor endowments most relevant to this research, but there are certainly other factor endowments important for development and diffusion of technology. Innovation systems are discussed in the context of the institutions fostering technological innovation. It is important to remember that unlike other factors that can be easily acquired, innovation systems describe a complex *system* of interacting determinants, reflecting different political, social, and economic cultures and traditions. In general, industrialized nations have highly-developed innovation systems, while LDCs differ markedly in their infrastructure, legal institutions, and political systems that could enhance more optimal use their other factor endowments that they possess. Harvard Kennedy School Professor and author Dani Rodrik argues for more "self-discovery," through the experimentation of technology, coordination of government policies, and government-private sector communication in these less developed nations (Rodrik, 2007).

² The HPI is an innovative measurement index that combines environment impact with well-being to show ecological efficiency with which human well-being is delivered (www.happyplanetindex.org).

³ Good human health (both physical and mental) and an unpolluted and preserved environment (what could be called "environmental capital") are increasingly regarded as essential for maintaining the productiveness of human and natural/physical capital even if they are not factors of production *per se* (Ashford and Hall, 2011).

The development of institutions to access and equitably distribute these resources is necessary in order for a country to obtain the greatest benefit from its factor endowments.

In neoclassical economics, markets are considered “perfect” and the consumer is perceived as a rational utility-maximizer. The focus is on the most efficient and cost-effective allocation of resources and factor endowments and their optimal growth over time for the production of goods and services (Todaro and Smith, 2009). However, development economics has a more extensive scope. It also deals with the innovation systems (the economic, social, political, and institutional mechanisms) necessary to bring about rapid and large-scale improvements for developing countries (Todaro and Smith, 2009). In this context, market imperfections and limited consumer rationality are widespread and common, leaving the neoclassical assumption invalid, while disequilibria often prevail in the economy, emphasizing the importance of public-private collaborations.

2.3. Systems of Innovation

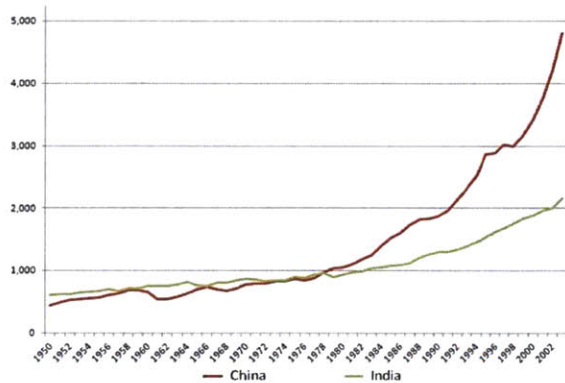
A system that fosters and nurtures innovation facilitates the flow of technology and information among people, enterprises and institutions that enables an innovative process. It contains the interaction between the actors who are needed in order to turn an idea into a process, product or service on the market. Charles Edquist defines a system of innovation as *“all important economic, social, political, organizational, and other factors that influence the development, diffusion, and use of innovation”* (Edquist and Johnson, 1997). He observes that while systems of innovation capture the importance of the political and social aspects of innovative processes, they should also capture the role of the state, including its physical institutions and the system of laws, rules, and infrastructure (Edquist, 2005).

Innovation is *“seen as a continuous cumulative process involving not only radical and incremental innovation but also the diffusion, absorption and use of innovation”* (Johnson et al, 2003). According to Richard Nelson and Nathan Rosenberg, the term “innovation” is the processes by which firms master and practice product designs and manufacturing processes that are new to them, if not to the universe or even to the nation (Nelson, 1993). In defining innovation as such, Nelson and Rosenberg reason that first, the activities and investments associated with becoming the leader in the introduction of a new product or process, and those associated with staying near the head of the pack, or catching up, are much less sharply distinguishable than is commonly presumed. Moreover, the strictly Schumpeterian innovator, the first mover, is frequently not the firm that ultimately captures most of the economic rents associated with the innovation (Todaro and Smith, 2009/Ashford and Hall, 2011). Second, much of the interest in innovative capability is tied to concern about economic performance. The definition is not limited to the behavior of firms at the forefront of world’s technology, or to institutions doing the most advanced scientific research, but is more broadly on the factors influencing national technological capabilities.

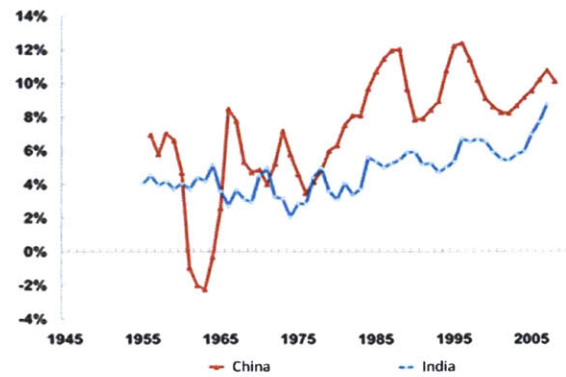
The concept of “system” in this context is a set of institutions whose interactions determine the innovative performance of firms or entrepreneurial entities. There is no presumption that the system was consciously designed, or even that the set of institutions involved works together smoothly and coherently. Rather, the “system” concept is that of a set of institutions that, together, play the major role in influencing innovative performance.

The development stories of China and India serve as appropriate examples for applicable experiences and lessons for LDCs. China and India are generally regarded “success” stories of the developing world in terms of both domestic development and as a result of globalization. The Chinese economy has grown

at an average annual rate of 9.8% for two and a half decades, while India’s economy has grown at around 5-6% per year over the same period (see Figures 2.1 and 2.2).



Source: Zlatovcica.



Source: Deutsche.

Figure 2.1: GDP of China and India⁴; Figure 2.2: GDP growth rates of China and India (5 yr moving average)

This success has been defined by the high and sustained rates of growth of aggregate and per capita national income, and the substantial reduction in income poverty. Furthermore, they both are seen as heralding a major shift in the international division of labor through changes in their own output and employment patterns; China is typically described as becoming the “workshop” or “factory” of the world through the expansion of manufacturing production, and India as becoming the “office” of the world, in particular because of its ability to take advantage of IT-enabled services remotely (Ghosh, 2010). These results, in turn, are viewed as the consequences of a combination of a prudent yet extensive program of global participation and integration, domestic deregulation and sound macroeconomic management. Although there are superficial attributes in common, such as large populations covering substantial geographical areas, regional diversity, relatively high rates of growth over the recent period, etc., the institutional conditions and experiences in the two countries were very different. The presumed success of these two countries can be used to indicate the potential benefits that other developing countries, and especially LDCs, can reap. However, in order to understand how these two countries created systems of innovation to enable development and growth, it is essential to detail how technological advance occurs, and the key institutions and policies involved.

2.3.1. Technology

Technological change is a broad term that encompasses invention, innovation, diffusion, and technology transfer. Innovation is the first commercially successful application of a new technical idea. It should be distinguished from invention, which is the development of a new technical idea, and from diffusion, which is the subsequent widespread adoption of an innovation beyond those who developed it (Ashford and Hall, 2011).

In most industrialized states, R&D facilities attached to business firms, academic institutions, or government agencies, are the principal vehicles through which technological advance proceeds, in fields such as electrical equipment and systems, chemical products and processes. On the other hand, in developing countries, such institutions do not exist, are not as advanced, or do not receive sufficient capital and resources to facilitate leading edge innovation. Much of the innovative process is carried

⁴ GDP per capita (in 1990 Geary-Khamis dollars).

through technology transfer from other regions, as well as some cases through both bottom-up/grass-roots and top-down/institutional collaborations.

2.3.1.1. China and India

Since the economic reforms of 1979, China enjoyed high economic growth for three decades. However, this growth has been driven mainly by export-oriented and labor-intensive manufacturing activities. A crucial feature of this growth was agrarian transformation. In 2008, the total value of China's export accounted for over 30% of its GDP, with millions of its citizens employed in the export sector (*The Economist*, 2008). The recent growth is associated with an increase in the share of the manufacturing sector in both output and employment (Ghosh, 2010). As a result, the Chinese economy is becoming increasingly vulnerable to external shocks such as the 2008 U.S. sub-prime credit crisis, the resulting recession and subsequent decline in demand for Chinese exports.

After India's own independence, the economic development strategy was mostly institution- and policy-based, as opposed to technological innovation, consisting of direct participation of the government in economic activities such as the production, selling and regulation of private sector economic activities through a complex system of controls. The strategy was based primarily on the Mahalanobis model, which gave preference to the investment goods industries sector, with secondary priority for the services and household goods sector (Lai and Clement, 2005). The model placed a strong emphasis on mining, manufacturing and infrastructural development (including electricity generation and transportation). It downplayed the role of the factory goods sector because it was more capital-intensive and would not address the problem of high unemployment in India. Any increase in planned investments in India required a higher level of savings than that which existed. Because of the low average incomes, the necessary higher levels of savings had to be generated mainly by restrictions on the growth of consumption expenditures. Therefore, the Indian government implemented a progressive tax system not only to generate the higher levels of savings but also to restrict increases in income and wealth inequalities.

To sustain future economic growth, China's policy makers are trying to increase the role of technology and innovation in the country's development, demonstrated by the country's "Medium-to-Long Term Plan of National Science and Technology Development (2006-2020)" (The State Council). Studies have also shown a positive correlation between the growth in technology investment and the overall development and growth of the country. Kraemer and Dedrick performed a study of 43 countries including China from 1985-1995 and found that there was an exceptionally high correlation between growth in Information Technology (IT) investment and GDP growth (Kraemer and Dedrick, 1999). China's IT investment and GDP grew annually at 35% and 10% on average, respectively, with empirical findings of factor inputs to China's economic growth during that period, suggesting IT capital contributed to about 30% of the nation's growth rate (Wong).

Similarly, India's IT industry currently accounts for 5.19% of the country's GDP and export earnings, as of 2009 (Y-Axis). More than 2.3 million people are employed in the sector either directly or indirectly, making it one of the biggest job creators in India and critical for the national economy. In 2010, annual revenues from outsourcing operations in India amounted to USD \$54.33 billion compared to China with USD \$35.76 billion (*The Economic Times*, 2010). India's outsourcing industry is expected to increase to USD \$225 billion by 2020. Technological advance for these two "success" cases are clearly essential for their respective future growth.

2.3.2. Institutions

The rise of science-based technology dramatically influenced the nature of the people and institutions involved in technical advance. Universities and academic institutions, in most countries, are the places where much of the basic research in fundamental sciences is undertaken, although the reliance on universities as a locus of basic research, as contrasted with national laboratories, varies across countries. The character and effectiveness of a nation's system of schooling, training, and retraining not only determine the supply of skills from engineer to machine operator, but also influence the perceptions of technical advance.

Industrial research laboratories eventually became the dominant locus of the R&D phase of innovation in most fields. After a technology has been around for a period of time, to orient R&D fruitfully, detailed knowledge of its strengths and weaknesses and areas where improvements would yield large returns is needed. And this knowledge tends to reside with the technology users, generally firms, their customers and suppliers (Ashford and Hall, 2011). Profiting from innovation in many cases requires the integration of activity and planning of R&D, production, and marketing.

Many firms also engage in significant design and development work, yet some do not have a formally designated R&D department or facility; their design and development work may or may not be accounted and reported as R&D. The lines between R&D, and other activities, such as designing products for particular customers, problem solving on production processes, or monitoring a competitor's new products, are inherently blurry.

In LDCs (as well as many developing countries), what is an innovation for an indigenous firm may largely involve learning to produce a product or adapt technology that has been employed for some time by firms in industrialized economies. The development process in LDCs is largely about structural change, where an economy self-discovers what it can excel at by adapting or innovating based on the many products and processes that already exist, as Rodrik characterizes (Rodrik, 2007). If self-discovery externalities or coordination is at the root of stagnation, the solution is to internalize them through government programs or private sector coordination.

The important interactions, the networks, are not the same in all industries or technologies. There are differences between system technologies and product technologies with respect to inter-industry interactions. In some technologies, universities play a key role (i.e. pharmaceuticals and computers). In others, industrial facilities play a more significant role (i.e. aircraft and steel). Government funding is important in some industries, such as aircraft and agriculture, and unimportant in others. While the shape and character differ, virtually all fields require an understanding of technical advance as proceeding through the work of a community of actors. Moreover, R&D usually is only a small part of the resources and problem solving that go into innovation. The capital that must be invested in new equipment and facilities to produce a new product, or embody a new process, generally exceed the R&D costs in magnitude. New organizations may be born, or a different division of labor, or new skills on the part of the work force, as well as new approaches in marketing (Ashford and Hall, 2011).

2.3.2.1. China and India

In China, the significance of state-owned enterprises and the township and village enterprises (TVEs) in total production freed the state's dependence on fiscal policy to influence aggregate demand in terms of purely budgetary measures, since many "off-budget" expenditures could be increased or reduced (Ghosh, 2010).

Private businesses were banned during the Mao Era for being "capitalist exploiters," but were reinstated in the Deng Era and underwent a period of liberalization and privatization. Citizens could opt to become self-employed households and set up businesses instead of taking on state jobs. They would often quickly become extremely wealthy. In the 1990s, many state-owned enterprises (SOEs) were also privatized, fueled by then Premier Zhu Rongji in an effort to prevent them from losing money. In 1997, the Communist Party declared that state-owned companies were "people-owned companies" and private individuals were allowed to create companies who would be subject to mergers and bankruptcy. Thousands of state companies were privatized or partly floated on the stock exchange. In 1978, more than 90% of GDP was produced in state enterprises, which, up to 1992, dominated China's economy.

The Chengbao system, or contracting system, during this period, where state assets were given to private operators, provided the state with necessary funding for expenses as well as a share of the profits (China International Contractors Association). This system was rapidly adopted in other sectors. In the 1980s and 1990s, many schools, hospitals and transport vehicles passed from the state to private operators. However, the Chengbao system was also criticized because felt that the change in operation for these schools and hospitals, now for-profit, was detrimental to the poor. Some private contractors were also accused of gaining their positions solely because of nepotism.

The control over the domestic economy in China has been most significant in the financial sector. The financial system in China still remains heavily under the control of the state, despite the recent liberalization and the sale of some shares to foreign investors. Four major public sector banks handle the bulk of transactions in the economy, and over the past several decades, the Chinese authorities have used control over the consequent financial flows to regulate the volume of credit (and thus manage the economic cycle) as well as direct credit to priority sectors. In addition, fundraising from firms (or off-budget official finance) has accounted for more than half the capital formation in China even in recent years. This, along with direct budgetary appropriations, has determined nearly two thirds of aggregate investment (Ghosh, 2010).

Monetary policy had minimal affects in China where private financial activity was limited and state-owned banks overwhelmingly dominated the provision of credit. Instead, macroeconomic adjustment were mostly administrative, such as moving to slow down an overheating economy through tightened credit provisions to regional and provincial governments and public and private corporations ensured through administrative fiat, rather than the use of traditional macroeconomic measures. While the Chinese economy is currently transitioning to one where more traditional macroeconomics is applicable, the Chinese government's continuing ability to quickly ensure macroeconomic correction when required is evidence of the limitations of this transition.

India also created a large number of government institutions to meet its growth objectives. Its development involved strategies to best utilize resources. In India's case, it meant transferring savings from the private to the public sector. Investments were carried out both by the government and the private sector, with the government investing in strategic sectors (such as national defense) and sectors in which private capital would not be available because of lags or the amount of investment required (such as infrastructure). The private sector was required to contribute to India's economic growth as set by the government planners. Not only did the government determine where businesses could invest in terms of location, but it also identified what businesses could produce, sell, and prices to set (Lai and Clement, 2005). The size of the government grew substantially as it played an increasingly larger role in the economy in such areas as investment, production, retailing, and regulation of the private sector. For example, in the late 1950s and 1960s, the government established public sector enterprises in areas

such as electricity production and distribution, petroleum, steel, coal, and engineering goods. In the late 1960s, it nationalized the banking and insurance sectors. To alleviate the shortages of food and other agricultural outputs, it provided modern agricultural inputs (i.e. farm machinery, irrigation, high yielding varieties of seeds, chemical fertilizers) to farmers at highly subsidized prices (World Bank, 2001). Afterwards, India designated exports as a priority sector for active government help and many institutions including a duty drawback system, programs of assistance for market development, and 100% export-oriented entities to help producers export and to increase foreign exchange earnings (Government of India, 1984). From the late 1970s through the mid-1980s, India liberalized imports, growing those not subject to licensing as a proportion to total imports from 5% in 1980-1981 to 30% in 1987-1988 (Pursell, 1992). However, this partial removal of quantitative restrictions was accompanied by a steep rise in tariff rates.

This active and dominant participation by the government in economic activities resulted in the creation of a protected, highly-regulated, public sector-dominated economic environment. India soon faced not only some major problems in its overall approach to development, particularly in the area of industrialization, but also a dramatic increase in corruption in its economy (Ahluwalia, 1985). Finally, like any other developing economy, the Indian economy faced a number of serious sectoral imbalances, with shortages in some sectors and surpluses in others.

2.3.3. Policy

The policies and programs of national governments, the laws of a nation, legal institutions and the existence of a common language and a shared culture contribute to a system that broadly affects how technical advance proceeds. In other words, national societies, cultures, differences and boundaries tend to define innovation systems. The concept of innovation systems encompasses the *determinants* of innovation and hence provides an enticing framework for policy analysis and design (Nelson and Rosenberg, 1993).

Technological communities have become transnational more than ever. For example, there has been a strong trend for manufacturing business firms to span national boundaries. The globalization of business and technology erodes the extent to which national borders, and citizenship, define boundaries that are meaningful in analyzing technological capabilities and technical advance.

There is a tension caused by the attempts of national governments to form and implement national technology policies, in a world where business and technology are increasingly transnational. Thus, the innovation process is embedded within an innovation system involving both institutional actors and individuals within and outside firms and even countries themselves. Johnson et al. observed that there are three common themes with innovation systems (Johnson, 2003):

1. National systems differ in terms of specialization in production, trade and knowledge (Archibugi and Pianta). The focus is here upon the co-evolution between what countries do and what people and firms in these countries know how to do well. Both the production structure and the knowledge structure will change gradually through a co-evolution between what countries do and what people and firms in these countries know, and that such change involves learning as well as structural change.
2. Elements of knowledge important for economic performance are localized and not easily moved from one place to another. Important elements of knowledge, called tacit knowledge, are

embodied in the minds and bodies of agents, in routines of firms and not least in relationships between people and organizations (Dosi, 1999).

3. Relationships may be seen as carriers of knowledge and interaction as processes where new knowledge is acquired and produced. Neither firms and knowledge institutions nor people alone innovate.

The approach emphasizes interdependence and non-linearity. This is based on the understanding that firms normally do not innovate in isolation but interact more or less closely with other organizations, through complex relations that are often characterized by reciprocity and feedback mechanisms in several loops. This interaction occurs in the context of institutions, as mentioned in section 2.3.2, and policies (i.e. laws, rules, regulations, norms and cultural habits) in an ecosystem of players such as government, regulators, education and training institutions, customers, technology transfer and diffusion agencies, firms, and financial services. This is useful to understand the ecosystem of mobile telephony technology, which will be expanded upon in Chapter 4 in the context of SSA. There are mobile network operators, handset equipment manufacturers, application developers, and end users.

2.3.3.1. China and India

Since 1979, China embarked on comprehensive land reforms that dramatically altered asset distribution in the country and changed the political economic landscape that determined subsequent policies. While land relations have undergone numerous changes since then, from collectivization to more reliance on independent small holder peasants, the dominance of landlordism was eliminated and greater equality of access to land and other assets also affected the conditions of access to other forms of wealth and avenues for economic and social mobility. The economic policies of China had very different results than they would have had in a more economically unequal context.

In terms of economic diversification and structural change, China focused more on manufacturing activities over the past 25 years. The manufacturing sector doubled its share of the workforce and tripled its share of output, which, given the size of the Chinese economy and population, has increasingly made China “the workshop of the world” (Ghosh, 2010).

For trade policies, Chinese export growth was much more rapid, involving aggressive increases in world market shares. This export growth was largely based on relocative capital which was attracted not only by cheap labor, but also by heavily subsidized infrastructure, resulting from a high rate of infrastructure investment. In addition, the Chinese state provision of basic goods (housing, food, and cheap transport facilities) for registered urban dwellers played an important role in reducing labor costs for employers. Until the late 1990s, this rapid export growth generated employment which constituted a net addition to domestic employment. Until its WTO accession, China had undertaken much less trade liberalization than most other developing countries. Thus, manufacturing employment grew rapidly in China until the mid-1990s, because it was not counterbalanced by major losses of employment due to the effects of displacement of domestic industry because of import competition.

Ultimately, China’s growth performance is primarily a reflection of the high investment rates that have characterized the economy over this period. During the period of liberalization, Deng established a series of economic zones in which foreigners could invest in the country and take advantage of lower labor costs. This investment helped the Chinese economy boom. In addition, the Chinese government established a series of joint ventures with foreign capital to establish companies in industries unfamiliar in China at the time. By 2001, China became a member of the WTO, which boosted its overall trade in exports/imports-estimated at USD \$851 billion in 2003 by an additional USD \$170 billion a year (Donald

and Benewick, 2005). In 2006, an estimated USD \$699.5 billion of foreign investment was present in China (*International Herald Tribune*). A great deal of this investment came from Chinese-speaking regions such as Hong Kong and Taiwan, followed by Japanese and Western investments. China is now the world's biggest producer of concrete, steel, ships, textiles as well as the world's biggest auto market. For example, from 2000 to 2006, China's steel production rose from 140 million tons to 416 million tons (China Statistics, 2005). From 1975 to 1992, China's auto production rose from 139,800 to 1.1 million automobiles before jumping to 9.35 million in 2008 (*MSNBC*, 2009). Capital formation as a share of GDP was very high by international standards, varying between 32-44% of GDP. The most recent data indicate that the investment rate in China is above 45% (Ghosh, 2010). This implies rates of domestic savings which are exceptional by international standards, particularly for an economy at China's level of per capita income.

Despite high GDP growth rates, Chinese growth has been relatively volatile, reflecting stop-go cycles of state response to inflation through aggregate credit management. The higher growth in China essentially occurred because of its much higher rate of investment. The investment rate (investment as a share of GDP) fluctuated between 35-45% over the past 25 years, compared to 20-26% in India (very recently increasing to 35%).

In contrast to China, India developed in a "mixed" economy in the sense that it had significant private sector participation, including a large private corporate sector, since its independence. The emphasis was predominantly on the regulation of private capital. But the neo-liberal reforms undertaken during the recent globalization have further expanded the scope for private activity and reduced regulation. Essentially, macroeconomic policies occurred in contexts similar to those in other capitalist economies, where involuntary unemployment was rampant and fiscal and monetary measures were used to stimulate demand. The inability to undertake land reforms or other strategies that would have involved substantial redistribution of assets not only meant that wealth and income inequalities were high, but also affected the ability of the Indian state to undertake economic policies that would be perceived as going against the interests of the land owners and other elites. Thus, the strategy of economic development in India meant direct participation of the government in economic activities such as production, selling, and the regulation of private sector economic activities through a complex system of controls.

India's economic transitions were mainly from agriculture to services in terms of share of output, with no substantial increase in manufacturing, while the structure of employment was resistant to change. The share of the raw materials sector in national income fell from 60% in the early 1950s to 25% in 2001. But the share of this sector in employment continues to be more than 60%, indicating a persistence of low productivity employment for most of the labor force (Ghosh, 2010). The higher rates of investment in India over the past two decades have not generated more expansion of industry in terms of share of GDP, but have instead been associated with an apparent explosion in services. The recent expansion of some services employment in India has been at both the high and low value-added ends of services sub-sectors, reflecting both some dynamism and some increase in "refugee" low productivity employment. And unlike China, India's increases in export employment were outweighed by employment losses especially in small enterprises because of import competition.

For trade policies, the Indian economy was sheltered from foreign competition due to its relatively infant economy and a binding foreign exchange constraint. Imports were limited to goods considered essential either to the development of the economy (such as raw materials and machines) or to the maintenance of minimal living standards (such as crude oil and food). Exports also played a limited role

in economic development, thereby minimizing the need to compete in the global marketplace. Thus, it was not an attractive location for export-oriented investment; its rate of export growth was much lower, and exports were not an engine of growth until relatively recently. As a result, India became a relatively closed economy, permitting only limited economic transactions with other countries. Domestic producers were sheltered from foreign competition not only from abroad but also from within India itself.

2.4. Implications for LDCs

Development policy has always been subject to trends. The 1950s and 1960s was all about “big push,” planning, and import-substitution. The 1970s, shifts to more market-oriented views that emphasized the role of the price system and an outward orientation. By the late 1980s, there was a convergence of views developed around a set of policy principles that John Williamson termed the “Washington Consensus” (Rodrik, 2007). Toward the end of the 1990s, this list was augmented with a series of second-generation reforms that were more institutional in nature and targeted at problems of “good governance.” Stabilize, privatize, and liberalize captured the mainstream thinking at the time for growth strategies.

There has been a shift away from the Washington Consensus belief that there is a one-size-fits-all prescription to reform for LDCs toward an understanding that each country has its own set of unique characteristics and challenges and subsequently requires customized solutions. The prior thinking of the Washington Consensus represented a trickle-down approach to poverty that did not incorporate local experiences and local knowledge. More importantly, it did not leverage the capabilities and talents of the people that these strategies aimed to help.

In both China and India, economic policies ran counter to the Washington Consensus’ main recommendations. There were high levels of protectionism, no privatization, extensive industrial policy planning, and lax fiscal and financial policies. Their diverse experiences with growth have happened in an era of rapid globalization where countries have become increasingly open to forces outside of their borders. The differing development and poverty reduction stories of China and India provide some important lessons. First, the differing experiences are evidence that national institutions and policies are an important determinant of economic growth. Second, economic growth may not necessarily deliver either income poverty reduction or improvements in social conditions, which emphasizes the importance of sustainable development. Third, what matters most is the nature of the growth: the extent to which the growth is associated with growing inequalities that do not allow the benefits of growth to reach the poor; the extent to which the structural change (institutions and policies) involved in the growth process generates sufficient opportunities for meaningful and productive employment and includes environmental considerations; the extent to which markets and states function in ways that ensure the provision of basic needs and universal access to essential social services. This also means that government mediation of the process of global economic integration matters in affecting the processes that will ultimately determine the extent to which economic growth delivers better conditions for the poor. This is the framework for this research and analysis and will be expanded in Chapter 3.

China and India are likely to be in the top three biggest economies in the next couple decades. Before globalization gave huge opportunities to China and India, they were poorer than many of the countries that have been caught in development traps. The development and growth experiences of China and India and their increasing global participation provide important lessons and implications for LDCs.

2.4.1. Determinants for Success and Failure

For China, the poverty reduction that the Chinese revolution ensured and the control the state could continue to exercise because of substantial state ownership of and investment in capital assets, as well as the continuance of the earlier financial structure and system, meant that the process of growth and global integration developed under fundamentally different conditions than that of India.

First, a baseline for development, including ensuring adequate food supplies and universal primary education, was already significantly established in China. The domestic market for consumption goods in China was significantly larger than in India. The control retained by the Chinese state over financial institutions and the activities of SOEs allowed it to sustain high levels of investment, deal with volatility, and prevent undesired levels of inflation from persisting beyond relatively short periods. The Chinese state ensured that cyclical fluctuations occurred around a high overall trend rate of income growth (Ghosh, 2010).

Second, the early phase of economic reforms in China, which essentially involved increasing remuneration to the agrarian sector, operated substantially to reduce poverty and deprivation. Subsequently, the emphasis on infrastructure development, combined with some controlled trade and investment liberalization, generated income and employment opportunities and export-oriented industrialization, becoming the next engine of growth. This occurred in a context of heavily regulated and monitored imports and ensured that export employment provided a net increase to aggregate manufacturing, rather than balancing for losses in employment in other domestic sectors since these sectors did not face import competition to the same degree with other countries that underwent trade liberalization during that period. Entry into the WTO required more sweeping import liberalization, but to some extent, that impact was counterbalanced by access to other markets that enabled the continuous expansion of exports with a cheap currency policy (Ghosh, 2010). In contrast, the inadequacies of the recent growth process in India were related to the reduced public expenditure by the state in the period of reform, most significantly the substantial reduction in central capital expenditure as a share of GDP (for infrastructure), but also public spending directed towards rural areas generally. In addition, central government policies created resource problems for the state governments in various ways, forcing them to reduce crucial developmental expenditure. This meant that rates of aggregate income growth were well below those which could have been achieved and that employment growth was well below the rate of GDP growth. These problems were compounded by the effects that trade liberalization had on small scale production in some manufacturing sectors. Agrarian distress and inadequate income and employment generation have thus emerged as the most significant macroeconomic problems for India.

Third, while delivering growth, China's transition to a market-driven system seemed to create more disparity, not only in terms of income, but also for basic services. It is estimated that 42% of the aggregate income inequality in China in 2002 was because of the rural-urban gap. This could be a conservative estimate because urban registered enjoy expanded subsidies, such as free medical care, subsidized schooling, pensions and insurance (Ghosh, 2010). But recent measures by the Chinese state aimed at countering such tendencies and the migration-mediated process of trickle-down have helped to check these undesirable outcomes. However, as much as the current pattern of economic expansion is based on high rates of saving and investment, as well as loosening the earlier credit planning system, the dangers of volatile growth and inadequate reductions in unemployment and poverty still persist. India, with its market-driven and demand-constrained system, hasn't delivered the same growth pattern and has been even less successful with poverty reduction. Macroeconomic flexibility in a market-driven environment was not effective for growth and stability or poverty reduction. While India's experience

allowed for greater financial and macroeconomic stability than experienced by many other developing and underdeveloped economies over this period, this was primarily because liberalization of their capital account was limited and India was not an attractive destination for investment until recently. They could not deliver the desired structural change in terms of the composition of output and employment like China did.

Development strategies include a mastery over a broad range of activities, instead of concentrating on one activity that one does best. The most significant instances of productive diversification are indeed the result of concerted government action and institutional collaboration. Entrepreneurs and operators must experiment with innovation (products, services, processes, etc.). They must experiment with technologies from established producers abroad and adapt them to local conditions. The type of discovery that matters in these contexts differ from innovation and R&D as traditionally understood (Rodrik, 2007). The development process in LDCs is largely about structural change through a process of self-discovery.

Technology experimentation requires complementary access to public infrastructure, such as reliable electricity and appropriate policies that will not hinder widespread adoption, especially by the poorest. For Africans living in extreme poverty, cell phones still remain inaccessible and unaffordable. The lack of adequate transportation infrastructure is still a major obstacle. Globalization can also undercut the ability of LDCs to develop healthy regulatory and redistributive institutions. LDCs have weaker institutions to begin with. Social safety nets become more difficult to finance and the need for social insurance becomes greater; financial intermediaries increase their ability to evade national regulation just as prudential supervision becomes more important; macroeconomic management becomes more challenging as the costs of policy mistakes are amplified. While markets and channels are becoming more global, institutions still remain largely national (Rodrik, 2007). Participation by LDCs in global trade and development is indeed growing, but the growing concentration of global buying power remains an imminent threat to these still infant states. China's deepening presence in the global economy and India's growing global presence suggest that this world of intense competition is unlikely to change, and only to get worse (Kaplinsky, 2005). BRIC countries, specifically India and China, can play an important role in the development stories of LDCs, serving as a role model for lesser developed countries. But India's and China's growing presence may also deprive the latter nations from global integration. For SSA, globalization will only bring the competitive pressures of production, labor, and market opportunities induced by the BRIC countries even closer. The forms that these institutions take play a significant role in their innovation system. A description of the SSA region, its mobile industry, and potential gains and losses from globalization is in Chapter 4.

3. Sustainability

3.1 Overview of Sustainability

Mobile phones are transforming Africa through a variety of uses and applications. For example, productivity gains from mobile telephony operations can be substantial. This can be evaluated through a range of factors, from the number of workers relying on mobile phones to revenue and time savings due to mobile phones, with benefits including business expansion, employment search, entrepreneurship, money transfer, and transaction costs (Deloitte and Touche, 2007). Academic research and industry reports have also demonstrated GDP per capita increases with the addition of mobile phones into a community, given a certain baseline, and opportunities have increased due to access to employment and market information (ITU, 2009a). With examples of mobile phones enabling people to check market prices of crops, transfer money, diagnose medical conditions in remote areas, or simply increase communication, the growth of mobile phone subscribers in Africa has the opportunity to address their development challenges (Perkins, 2010).

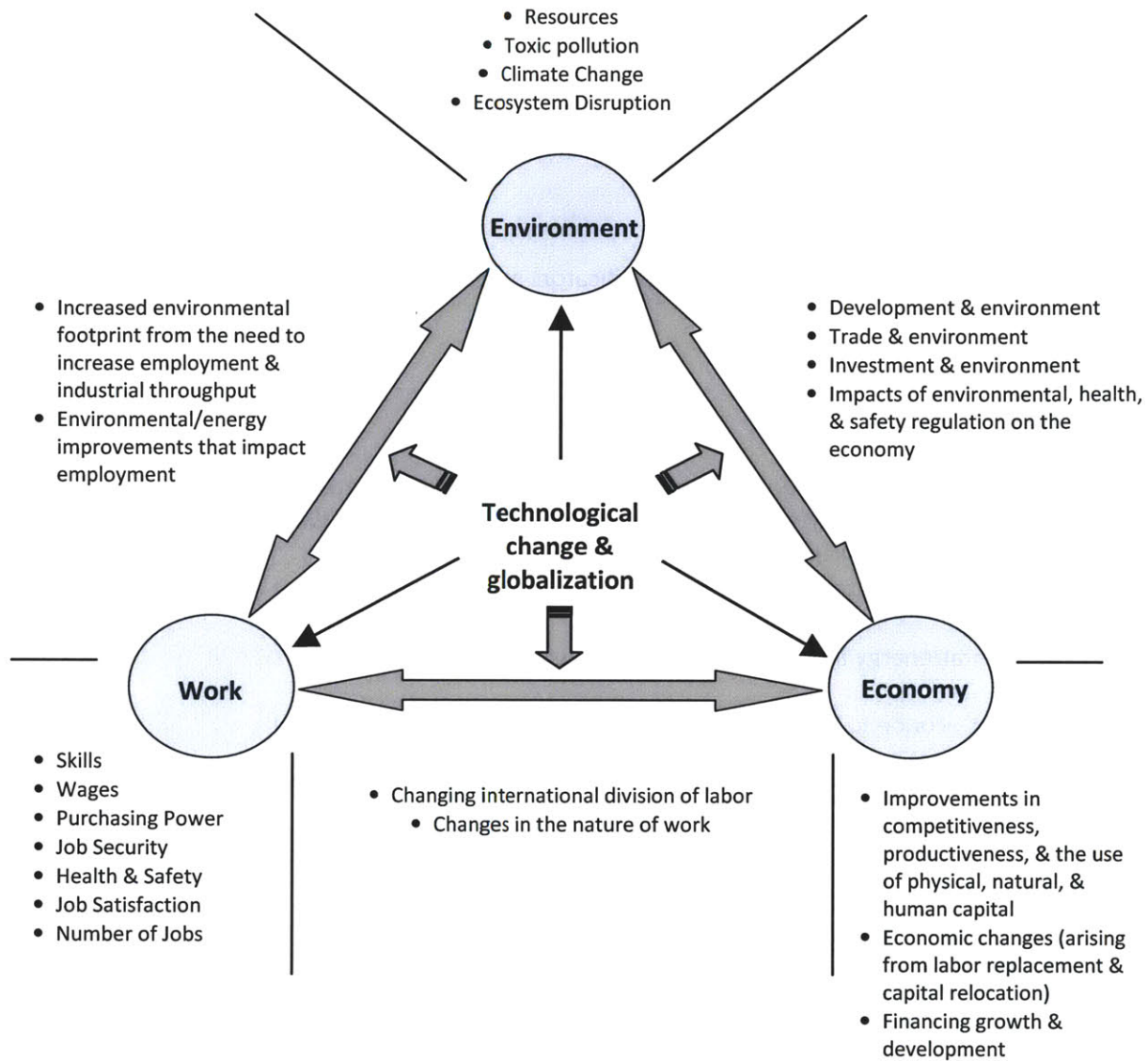
However, many ignore that this may only address economic development. Technology and national policies have all too often addressed narrow dimensions of poverty and development. A lack in development contains multiple dimensions, not only economic. Sustainable development, on the other hand, better assesses the health of a country in its entirety, taking into account the multi-dimensional and integrated nature of its overall development. The elements of sustainable solutions that enable economic and social development that Todaro and Smith describe (see Chapter 2) include increased distributional benefits, improved quality of life, and economic expansion. Whereas narrow development strategies and incomplete indicators can reveal parts of a country's development, they can also dangerously mask differences in progress across and within dimensions. Strategies for sustainable development must incorporate economic and social development and centers on the interdependence and interaction of three key dimensions:

- Employment Growth: *increasing rewarded and rewarding opportunities*
- Economic Development: *increasing access to capital*
- Environmental Protection: *increasing quality of life*

An approach to technology, institutions, and national policy that addresses sustainable development must encompass a systemic view of the structure and processes that occur in the local, national, and global level. In order to be effective, development strategies must adopt a holistic framework that captures the technological, economic, political, and social interdependencies in order to deliver comprehensive solutions.

3.2. Sustainable Development Framework

Professor Nicholas Ashford of the Massachusetts Institute of Technology presents a holistic framework that addresses the key factors to achieving sustainable development and will be the framework used for the analysis of this thesis. Ashford's Sustainable Development framework, illustrated in Figure 3.1 below, is focused on three core pillars that must all be met to ensure sustainable development (Ashford and Hall, 2011).



Source: Ashford and Hall, 2011.

Figure 3.1: Sustainable Development Framework.

This framework addresses the economic, employment, and environmental dimensions of development. Technological change and globalization have direct implications on employment in both developed and developing nations, and labor market policies share importance with government policies focusing on improving economic competitiveness and environmental quality. If the basic human needs for food, clothing, shelter, etc. are to be met, the only practical way to do this is to satisfy the basic need for a sustainable livelihood by creating employment opportunities with adequate purchasing power. For the economic dimension, the relevant activities are:

- Improvements in competitiveness, productiveness, & the use of physical, natural, human capital
- Economic changes arising from labor replacement & capital relocation
- Financing growth & development

For the work/employment dimension, the important indicators are:

- Skills
- Wages
- Purchasing Power
- Job Security
- Health & Safety
- Job Satisfaction
- Number of Jobs

For the environmental dimension, the important indicators are:

- Resources
- Toxic pollution
- Climate Change
- Ecosystem Disruption

Poverty and the challenges of development cover a broad range of interrelated issues. Thus, Ashford's framework also stresses the importance of interdependencies between each dimension. For the environmental-employment linkage, the indicators are:

- Increased environmental footprint from the need to increase employment & industrial throughput
- Environmental/energy improvements that impact employment

For the employment-economic linkage, the indicators are:

- Changing international division of labor
- Changes in the nature of work

For the economic-environment linkage, the indicators are:

- Development & environment
- Trade & environment
- Investment & environment
- Impacts of environmental, health, & safety regulation on the economy

In order to move towards these goals on a worldwide basis, sustainability policy must be made to operate in a dynamic environment in which the linkages among the economy, employment and environment are increasingly deep and pervasive, and changes in technology and these economic linkages are becoming more rapid and interconnected, respectively. When existing development strategies are matched with these three dimensions, it is evident that they are only focused on one or two and do not completely address development. This framework for sustainable development asserts that factor endowments, as described in Section 2.2, will influence a country's overall competitiveness, which ultimately can ignite and sustain development.

3.3. Other Perspectives

Dani Rodrik originally supported the Washington Consensus' prescriptive approach to economic development for the developing world, but now advocates for the context-specific process that countries must undergo to achieve sustainable development. He emphasizes that the focus should be on a higher level of generality and an examination of the broader design principles of successful growth-

promoting policies and strategies. This entails zooming away from the individual building blocks and concentrating on how they are put together.

Professorial Fellow Raphael Kaplinsky’s, of the Institute of Development Studies, theory of rent leverages the relative scarcity of different resources to create a comparative advantage in the market and maintain a sustainable income. He categorizes rents as either *endogenous*, or Schumpeterian, which consist of technology, human resource, organizational, marketing and design, and relational, or *exogenous*, which reflect, resource, policy, infrastructure, and finance (Kaplinsky, 2005). However, this framework is grounded in purely economic issues, and also ignores the multi-dimensional nature of sustainability.

The UN Center for Sustainable Development (CSD) also designed a framework, revised in 2007, that further supports the multi-dimensional nature of development challenges and the multi-disciplinary approach to development strategies (UN CSD, 2007). The division of indicators along four pillars (social, economic, environmental and institutional) is no longer explicit in the revised framework due to their attempt to emphasize the multi-dimensional nature of sustainable development and reflect the importance of integrating its pillars. This further supports the interdependencies emphasized in Ashford’s framework. The CSD framework contains a core set of 50 indicators, shown in Figure 3.2, which are part of a broader (and more complicated) set of indicators.

CSD indicator themes

<ul style="list-style-type: none"> • Poverty • Governance • Health • Education • Demographics 	<ul style="list-style-type: none"> • Natural hazards • Atmosphere • Land • Oceans, seas and coasts • Freshwater • Biodiversity 	<ul style="list-style-type: none"> • Economic development • Global economic partnership • Consumption and production patterns
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Source: UN CSD, 2007.

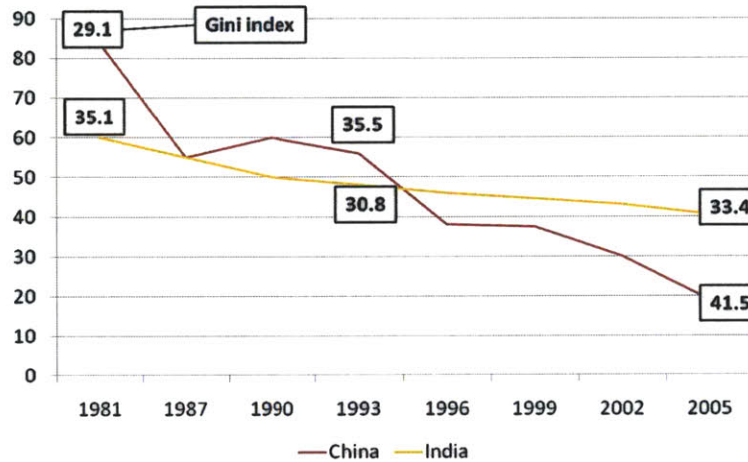
Figure 3.2: UN CSD Sustainability Framework Indicators.

The CSD’s similar framework and set of indicators remain consistent with the practice of most countries applying national sustainable development indicator sets and it is directly relevant to the monitoring of national sustainable development strategies. Note, however, that there is an absence of attention on employment. Another advantage is that the indicators can be determined by most countries with data that is either readily available or could be made available within reasonable time and costs.

Research suggests that some of the most valuable factor endowments that can be provided through activities in developing countries are innovation systems and ICT. This is consistent with Schumpeter’s theory that business cycles tend to reach equilibrium and stagnate, limiting or halting technological innovation. Thus, technological innovation is the engine of growth. Globalization through economic participation by LDCs is adding another element to this innovation-focused view, adding trade to innovation as another driving force of economic growth. This warrants the necessity of institutional and political infrastructure to not only complement technological innovation, but also protect countries from global, competitive forces.

3.4. Experiences of Sustainability in China and India

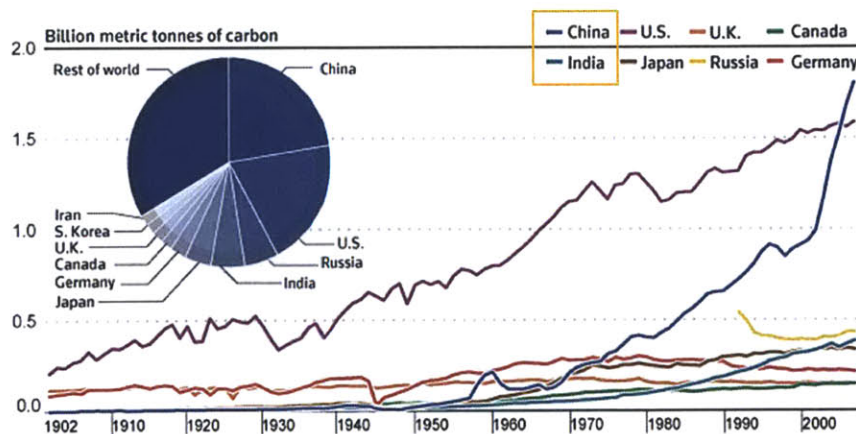
There is no question that China and India have demonstrated stellar economic growth over the last few decades, despite doubts about their sustained growth in the future (see Chapter 2). Additionally, China and India have largely shown improvements in the quality of life. Figure 3.3 illustrates the declining percentage of both China's and India's population living in absolute poverty (under USD \$1.25 per day) over the past few decades.



Source: Ravallion, 2009; World Bank working paper 5080.

Figure 3.3: Population living in absolute poverty⁵ (%).
0 = absolute equality, 100 = absolute inequality

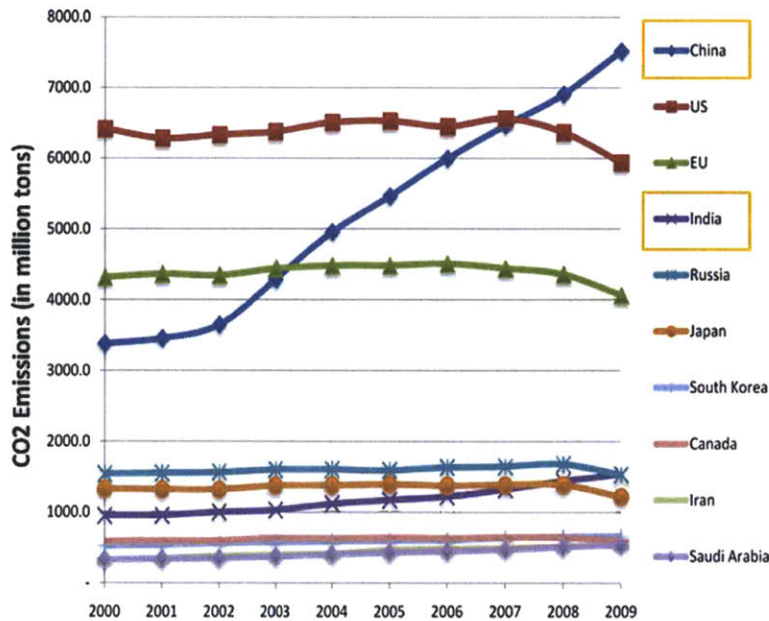
While the recent attention on China and India have been focused on economic growth, their performances along the other dimensions of sustainability, namely environmental, have not been so great. China's economic growth is not without its negative side-effects. It has been accompanied with drastic increases in greenhouse gas (GHG) emissions. The following figures (3.4 and 3.5) illustrate China surpassing the U.S. in terms of carbon emissions from fossil fuels over the past century and decade, respectively, and increases from India as well, with accelerated rates coinciding with the same periods of economic growth.



Source: US DOE, 2009.

Figure 3.4: World carbon emissions (1902-2000).

⁵ At 2005 PPP (purchasing power parity)

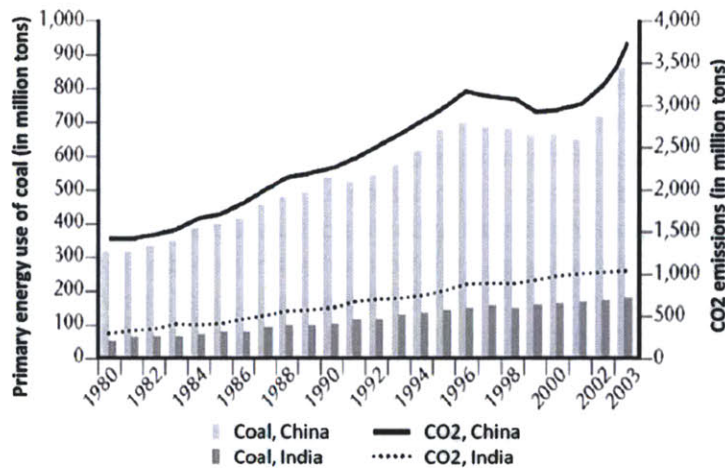


Source: BP, 2010.

Figure 3.5: World carbon emissions (2000-2009).

The increasing GHG emissions from the developing countries praised as “success stories” underscores the importance of total sustainability as a requirement for national development strategies. The following sections detail both China’s and India’s recognition of this as a priority to ensure their future growth.

The increasing use of fossil fuels, particularly coal and oil, in both China and India is generating severe air pollution due to harmful emissions. The pollution takes the form of particulates, with primarily local effects on health in urban areas, sulfur and nitrogen, with primarily regional effects via ozone and acid rain on agriculture and ecosystems, and CO₂, with primarily global effects in the form of global warming. Figure 3.6 below shows the dramatic increase of the use of coal in both countries, particularly China, from 1980 to 2003.



Sources: International Energy Agency; OECD, 2005.

Figure 3.6: Primary Energy Use of Coal and Total CO₂ Emissions from Fossil Fuel Consumption.

Demand for oil also is growing rapidly in response to the growing demand for transportation. This growing fossil fuel use is generating harmful emissions of GHG and increasing public health costs from the increasing air pollution (Ahn, 2007).

3.4.1. Sustainability in China

With China becoming the world's largest CO₂ emitter, China faces increasing pressure to reduce its negative impacts on environmental sustainability. As the largest developing country, they face both opportunities and challenges to develop low carbon economy. When developing its mitigation target to strive for sustainable environmental development, China is considering factors such as level of development, technology know-how, social impact, international image and a new international climate regime underpinned by fairness and effectiveness.

In the long term, China plans to embark on a low-carbon development pathway in line with the global trend towards low-carbon energy. This plan is to complement China's efforts to transform the way its economy grows, restructure the economy, achieve the targets of energy saving and pollutants reduction, as well as achieve sustainable development (Yi, 2009). The opportunity exists for China to develop low carbon economy so that some key sectors can gain more competitive advantage in energy saving and pollution reduction technologies. As a result, China can reach a turning point of energy consumption and carbon emissions.

But from the short- to mid-term, China is stuck in its current stage of development. The goal of transitioning to a low-carbon economy is challenged by rapid economic growth, being at the very end of the value chain in international trade, increasing employment pressure, energy structure that is dominated by coal, relatively lagging behind in technology development, and inadequacies in its current institutions and policies (Yi, 2009). China is situated in the middle of an important strategic opportunity when it could surpass the heavy-chemical industrialization stage quickly by taking advantage of all kinds of favorable conditions both domestically and internationally. The comparatively low price of fossil fuels in the one to two decades may offer China the last opportunity to complete the main tasks of industrialization. However, the failure to achieve the transition to low carbon economy would potentially put China in face of a risk of being unsustainable and maybe a border carbon adjustment tax in exporting. China is stuck in between a choice of an uninterrupted economic growth opportunity and low-carbon economic transition.

While ambitious, new environmental initiatives, as listed above, are pioneered due to the effects of industrialization, the quality of air in Chinese cities is still increasingly polluted by coal-burning power plants, grit from construction sites and exhaust from millions of new cars squeezing onto crowded roads. There has been a reported increase in inhalable particulates in cities like Beijing, where officials have struggled to improve air quality by shutting down noxious factories and tightening auto emission standards. Despite such efforts, including an ambitious program aimed at reducing the use of coal for home heating, the average concentration of particulates in the capital's air violated the World Health Organization's (WHO) standards by more than 80% of the time during the latter part of 2008.

The Ministry of Environmental Protection reports that the number of accidents polluting the air and water doubled during the first half of 2010, with an average of ten per month. They also found that more than a quarter of the country's rivers, lakes and streams were too contaminated to be used for drinking water. Acid rain had become a problem in nearly 200 of the 440 cities they monitored. (Jacobs, 2010).

With limited funds, the Chinese Government is also trying to redress the economic disparities between its eastern and western regions. However, current national economic restructuring coupled with effects of the global economic crisis is throwing millions of people out of work all over the country, thus increasing the gap between the rich and poor. Without a PAYE (pay-as-you-earn) tax system, China may not be able to afford a national social security system, and so its social sustainability will face difficulties over the foreseeable future (Diesendorf, 2003).

China is seeking a low-carbon development pathway that would better coordinate the long-term and short-term interests and also balance various policy targets. While coal is a major energy source in China, it is gradually being replaced by less-polluting natural gas for domestic heating and hot water in some cities. Recently a contract was signed to sell a huge quantity of natural gas from Australia's North-West Shelf to China (Diesendorf, 2003). Subsidies to the production and use of fossil fuels have also been largely removed. When developing its mitigation target to strive for sustainable environmental development, China is considering factors such as level of development, technology know-how, social impact, international image and a new international climate regime underscored by fairness and effectiveness.

3.4.2. Sustainability in India

Sustainable development in India encompasses a variety of development schemes in pollution reduction, social, clean technology (clean energy, clean water and sustainable agriculture) and human resources, having caught the attention of both central and state governments and also public and private sectors. In fact, India is expected to begin the greening of its national income accounting, making natural resource depletion a key component in its measurement of GDP (IBEF, 2010).

One of the biggest causes of air pollution in India is from its transport system. Indian cities are polluted by vehicles and industry emissions. Road dust due to vehicles also contributes up to 33% of air pollution (Reddy, 2007). In cities like Bangalore, around 50% of children suffer from asthma (Kumar, 2007). This is most prevalent in the bigger cities due to the huge concentrations of vehicles. On the positive side, the government appears to have noticed this massive problem and the associated health risks for its people and is gradually taking steps. The first of which was in 2001 when it ruled that its entire public transport system, excluding the trains, be converted from diesel to compressed gas (CPG). Electric rickshaws are being designed and will be subsidized by the government but the ban on the cycle rickshaws in Delhi will require a huge increase on the reliance of other methods of transport, mainly those with engines.

According to a report by the UN Environment Programme (UNEP), "Global Trends in Sustainable Energy Investment 2010," India was ranked eighth in the world in terms of investment in sustainable energy (UNEP, 2010). The report further stated that India invested around USD \$2.7 billion in sustainable energy during 2009.

There is a list of evidence demonstrating India's direction towards sustainable energy. Wind energy attracted 59% of financial investment in clean energy in India. India was placed fifth in the world for installed wind power during the year, with installed capacity of nearly 10,500 MW and a target to scale up capacity to 14,000 MW by the end of 2011. Biomass and waste was the second largest sector recipient of investment, generating USD \$0.6 billion of new financial investment or 22% of the total. India's first-ever 3 MW solar photovoltaic power plant, developed by the Karnataka Power Corporation Limited (KPCL), the state-owned power generating company, was dedicated to the nation at Yalesandra village in Kolar district in 2010. The plant, which uses modular crystalline technology to generate solar

energy, has been set up at a cost of USD \$1.29 million. Compressed natural gas-powered vehicles in India have increased 30% over 2009 to 1 million in 2010. GeoSyndicate Power Pvt Ltd, a Mumbai-based energy company, plans to set up the country's first geothermal power plant of 25 MW in the Khammam district of Andhra Pradesh (AP) at an investment of USD \$64.7 million. The Society of Manufacturers of Electric Vehicles (SMEV) expects sales of electric two-wheelers to double in the coming months, on the back of a US\$20.9 million incentive scheme announced by the Ministry of New and Renewable Energy (MNRE).

The number of carbon credits issued for emission reduction projects in India is set to triple over the next three years to 246 million by December 2012, up from 72 million in November 2009. This will solidify India's second position in the global carbon credits market (called Certified Emission Reduction units or CERs). The growth in CER issuance will be driven by capacity additions in the renewable energy sector and by the eligibility of more renewable energy projects to issue CERs. Consequently, the share of renewable energy projects in Indian CERs will increase to 31% (IBEF, 2010).

The contribution of renewable energy to the power business in India has now reached 70%, compared to 10% in 2000, in terms of project numbers and dollar value, according to Anita George, Director, Infrastructure, International Finance Corporation (IFC). India's sustained effort towards reducing GHG emissions will help lower the country's per capita emission. It is estimated that the per capita GHG emission in 2031 will be lower than per capita global emission in 2005, according to a new study (IBEF, 2010). Even in 2031, India's per capita GHG emissions would stay under 4 tons of CO₂, which is lower than the global per capita emission of 4.22 tons of CO₂ in 2005.

3.5. Setting the Path for Sub-Saharan Africa

As a region that's less developed than China and India, SSA suffers from serious environmental development challenges, including deforestation, soil erosion, desertification, wetland degradation, and insect infestation. Efforts to address these problems, however, have been handicapped by a real failure to understand their nature and possible remedies. Conventional wisdom tends to blame all of the region's environmental problems on rapid population growth and poverty. Protecting the environment of SSA is an issue that needs to be examined more carefully and incorporated into an overall strategy of sustainable economic development.

Formulating such a strategy will not be easy: at the end of the 20th century, virtually every country in this region was slipping on almost every index of development. The post-independence period of the 1960s and early 1970s, when development was considered simply a matter of following a plan formulated by the Washington Consensus, has now been succeeded by a time of fiscal crises and international marginalization. The region finds itself afflicted by the consequences of inappropriate policies, as well as by almost endemic political instability, an inability to manage its economies effectively, and an increasingly hostile external economic environment (Mabogunje, 1998). As simple survival has become more problematical, it has become increasingly difficult to avoid overexploiting natural resources and degrading the environment, compromising the prospects for sustainable development in the future.

To understand the full dimensions of SSA's development problems, it will first be necessary to examine the factors that expose this region to problems along each dimension of sustainability, as will be done in Chapter 5. This will permit a detailed investigation of the endogenous and exogenous challenges for achieving sustainable development in SSA. Then, it will be possible to look at the question of options and

pathways in terms of sustainable development in the region and to suggest the roles that mobile technology, institutions, and policies ought to play, as will be done in Chapter 5 and 6. The experiences of China and India and SSA's current situation offer an important opportunity to redirect development strategy in ways that will not only improve the social and economic well-being of SSA's people, but also enhance the quality of the environment in which they live.

As mobile telephony becomes more pervasive around the world, only with the appropriate policies and effective institutions will this technological innovation have a positive economic, social, and environmental impact on the world's least developed populations. Otherwise, those living in extreme poverty will be left out of the potential benefits from this technological boom.

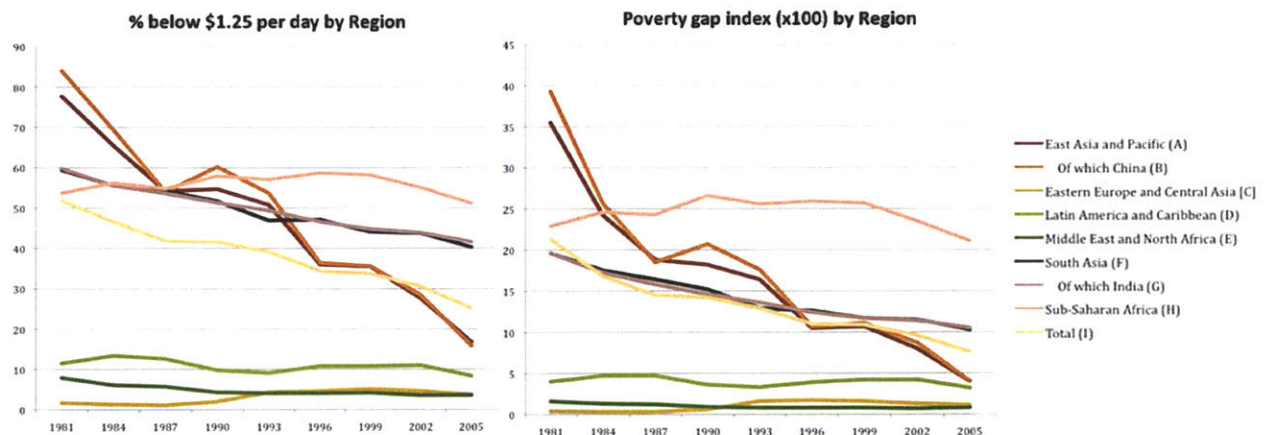
4. Regional Analysis and Mobile Industry in Sub-Saharan Africa

4.1 Current Development Experience in Sub-Saharan Africa

Poverty is multidimensional and widespread in Africa. Incomes and consumption levels are low and volatile. The available productive assets, particularly for the poor, are few and meager, increasing vulnerability to shocks. Illiteracy, malnutrition, and ill health are prevalent, with mortality and morbidity rates high. All these conditions have led to short life spans. Worsening the situation in recent years are the spread of HIV/AIDS and the resurgence of malaria and tuberculosis.

The pervasiveness of low levels of well-being is caused by, and in turn perpetuates, limited productive capacity. Undercapitalized, the production of goods and services in large parts of Africa has yet to benefit significantly from modern technological advances. Average years of schooling are inadequate, while the incidence of illness is high, contributing to low aggregate and agricultural output per worker. The low agricultural productivity is simultaneously a cause and an outcome of the degradation of an already fragile natural environment.

Despite 40-plus years of development efforts, many people in SSA are worse off today than they were in the 1960's. In many areas life expectancies have fallen, literacy rates have declined, and individual's economic prospects have remained stagnant. The per capita income remains very low, with GDP income of LDCs counted negligible (less than most rich-world cities) (Collier, 2007). Figure 4.1 illustrates that the change in percentage of people of the SSA population living under USD \$1.25 (PPP) has largely remained the same until recently. The poverty gap index reinforces the disparity of wealth in the region, but with signs of recent improvements (Chen and Ravallion, 2008).



Source: World Bank, 2008.

Figure 4.1: % below \$1.25 per day around the world and poverty gap index by region.

As Collier describes, many LDCs in Africa are stuck in “Poverty Traps” (Collier, 2007). The traps are characterized and often a combination of:

- Conflict – civil war, coups
- Natural Resource – victims of “Dutch Disease”⁶

⁶ “Dutch Disease”: resource exports cause the country's currency to rise in value against other currencies. Makes the country's other export activities uncompetitive. Yet these other activities might have been the best vehicles for technological progress.

- Neighbors and Geography – cut-off from coasts, dependency on neighboring country's infrastructure for exports/transport, dependency on marketability to neighboring countries, dependency on growth of neighboring countries (i.e. growth spill-over, for land-locked countries, growth spill-over for every 1% of neighbors is 0.7% for the country)
- Bad Governance and Policies – bad governments persist because not everyone loses from it (especially those in power and responsible for the poor governance of its citizens and resources)

However, in the most recent decade, the SSA region has seen some progress in the areas of democratic governance, economic growth and the provision of basic social services. Africa has the highest number of countries with democratic systems to date since the 1960s. SSA has succeeded in reducing by 17.4% between 2001 and 2008 the number of adults and children newly infected by HIV/AIDS, and access to Anti-Retroviral (ARV) therapy has been expanded in many countries. The region continues to show overall progress on gender equality and women's empowerment. Gender parity in primary education will be achieved in most countries in Africa in 2015. The number of seats held by women in parliament has increased in at least 31 countries (UNDP Africa).

Before the economic crisis (effects which will be discussed in Section 4.5) hit Africa in 2008, the region boasted impressive growth rates. Many countries were able to capitalize on this trend to allocate considerable sums toward basic social services, making progress toward achievement of the Millennium Development Goals (MDGs). Thus, while SSA remains the developing region with the highest number of people living in extreme poverty, poverty rates have dropped rapidly since 1990, hovering around an estimated 46% in 2008 (UNDP Africa).

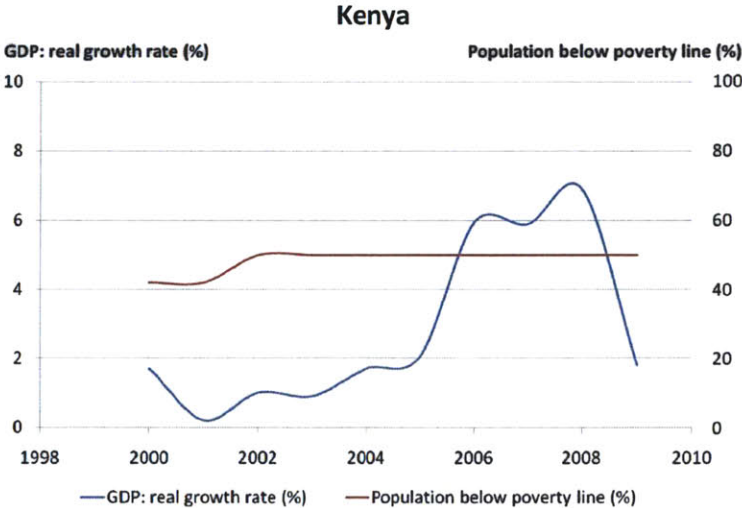
SSA may currently be the lowest emitter of carbon dioxide, but it stands to be the region most affected by climate change, which will compound the environmental and energy challenges that the region faces (UNDP Africa Fast Facts). The Intergovernmental Panel on Climate Change (IPCC) estimates that by 2020, 75-250 million people across Africa could face water shortages and reduce rain-fed agriculture by 50% in some African countries. If temperatures rise above two degrees Celsius in SSA, an additional 600 million people in the region could face hunger, new epidemics of mosquito-borne diseases as well as additional agricultural losses of up to USD \$26 billion by 2060 (IPCC).

Deforestation and pollution are also growing problems in SSA. According to the UN Food and Agriculture Organization (FAO), forested land was transformed into agricultural land at increasing rates from 1981 to 1990 (UN FAO, 2009). These changes made up 25% of the changes in forest cover during this time (Mabogunje, 1998). Given the extensive loss of forest in recent years, African governments are trying to address the problem. For example, the Nigerian government is planting trees and preserving vegetation that is natural to the area. Three million hectares have already been restored from land that was severely degraded in previous years (Niamey, 2006).

While SSA is one of the least urbanized regions in the world, the urban population in Africa is growing very rapidly (Mabogunje, 1998). With this growth comes pollution. Poverty stricken citizens in Africa, particularly in the urban population, are most negatively impacted by poor air, water, and land quality. The causes of air pollution are multiple. Because many households are using charcoal or wood for energy, the amount of carbon dioxide produced by African cities has been on the rise. The 1991 global greenhouse emissions of South Africa, Zaire, and Nigeria ranked them among the top fifty countries in terms of their contribution (Mabogunje, 1998). The people that live in Africa are exposed to indoor and outdoor air pollution that can cause many different health problems. The indoor pollution partly comes from the increased use of wood and charcoal in cooking.

For water pollution, a big cause in SSA is that they accept the solid waste from the United States, the European Union, and Japan. Africa is paid for accepting the waste, but they are not able to treat it properly to make it non-harmful to the environment and its citizens (DeBlij *et al*, 2007). Access to clean water is also a problem throughout Africa. Water is polluted mostly by human waste. Diseases like typhoid, cholera, and diarrhea come from contaminated water. Water pollution is the reason for many infant mortality rates and health problems of people of all ages (Mabogunje, 1998).

Kenya's economy relies heavily on agriculture and tourism, which in turn is dependent on natural resources. Agriculture programs target small horticulture, grain, and dairy farmers, helping them increase productivity, get credit, farm sustainably, and sell their produce. Kenya has long depended on external assistance for development financing, but the extent of that dependence has varied with domestic conditions. Whereas in the mid-1960s Kenya depended on external sources for 82% of its total development resources, by the early 1970s the proportion had fallen to only 45%. The late 1970s and 1980s brought renewed reliance on external loans, as the proportion of foreign financing needed to cover the annual government budget deficit rose from 28% in 1978-79 to 67% in 1981-82 and an estimated 89% in 1985-86. USAID supports micro-enterprises through Development Credit Authority loan guarantees to microfinance institutions. To promote conservation as well as livelihoods in wildlife-rich areas, USAID helps rural communities improve biodiversity management through nature conservatories, eco-tourism and other environmental-friendly enterprises. Figure 4.2 presents a high-level view of Kenya's GDP and poverty reduction performance, respectively, over the past decade.

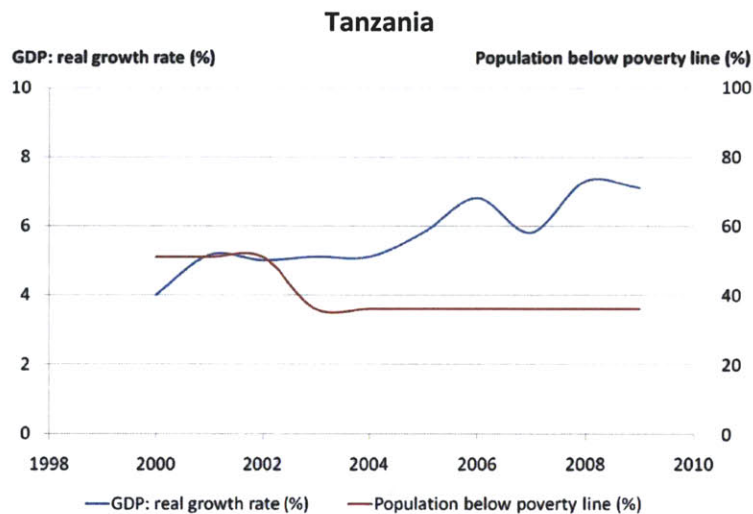


Source: CIA World Factbook.

Figure 4.2: Kenya – GDP: real growth rate (%) population below poverty line (%).

Significant measures have been taken to liberalize the Tanzanian economy along market lines and encourage both foreign and domestic private investment. Beginning in 1986, the Tanzania government embarked on an adjustment program to dismantle socialist economic controls and encourage more active participation of the private sector in the economy. The program included a comprehensive package of policies which reduced the budget deficit and improved monetary control, substantially depreciated the overvalued exchange rate, liberalized the trade regime, removed most price controls, eased restrictions on the marketing of food crops, freed interest rates, and initiated a restructuring of the financial sector.

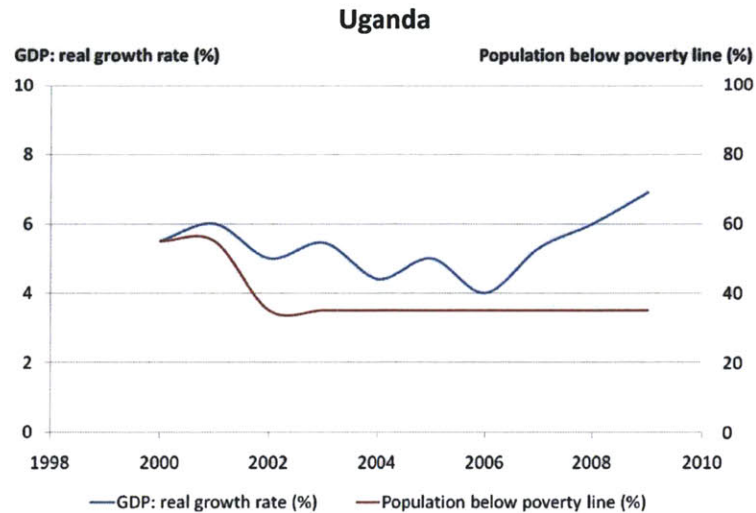
Current GDP per capita of Tanzania grew more than 40% between 1998 and 2007. In May 2009, the IMF approved an Exogenous Shock Facility (ESF) for Tanzania to help the country cope with the global economic crisis (IMF, 2009). Tanzania is also engaged in a Policy Support Instrument (PSI) with the IMF, which commenced in February 2007 after Tanzania completed its second 3-year Poverty Reduction and Growth Facility (PRGF), the first having been completed in August 2003. The PRGF was the successor program to the Enhanced Structural Adjustment Facility (ESAF), which Tanzania also participated in from 1996-1999. The IMF's PSI program provides policy support and signaling to participating low-income countries and is intended for countries that have usually achieved a reasonable growth performance, low underlying inflation, an adequate level of official international reserves, and have begun to establish external and net domestic debt sustainability. Figure 4.3 presents a high-level view of Tanzania's GDP and poverty reduction performance, respectively, over the past decade.



Source: CIA World Factbook.

Figure 4.3: Tanzania – GDP: real growth rate (%) and population below poverty line (%).

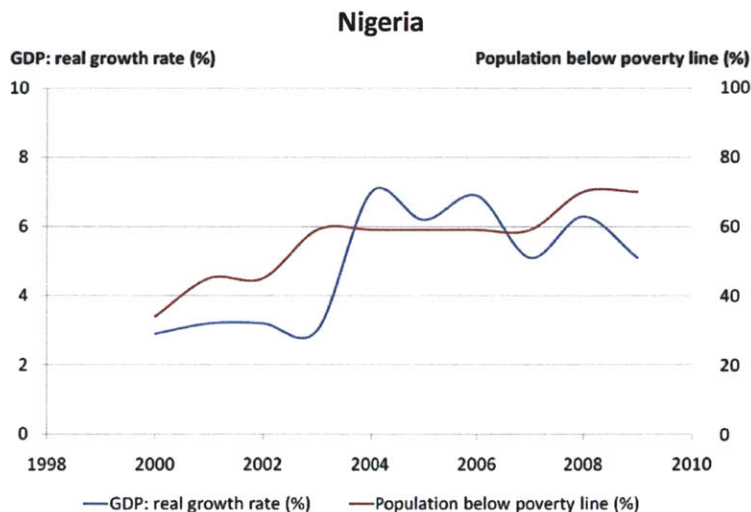
From 2007 to 2008 Uganda's economy grew by 8.9%, delivering some of the best rates of growth seen in the SSA region in recent years. With strong growth expected to continue, a key priority for Uganda is to continue to strengthen the national structures and systems that underpin its economy, ensuring that growth can be sustainable and the benefits more widely distributed amongst its citizens (MAP International, 2009). Figure 4.4 presents a high-level view of Uganda's GDP and poverty reduction performance, respectively, over the past decade.



Source: CIA World Factbook.

Figure 4.4: Uganda – GDP: real growth rate (%) and population below poverty line (%).

Previously hindered by years of mismanagement, economic reforms of the past decade have put Nigeria back on track towards achieving its full economic potential. Nigerian GDP at purchasing power parity (PPP) more than doubled from USD \$170.7 billion in 2005 to USD \$374.3 billion in 2010, although estimates of the size of the informal sector put the actual numbers closer to USD \$520 billion. Correspondingly, the GDP per capita doubled from USD \$1,200 per person in 2005 to an estimated USD \$2,500 per person in 2009 (again, with the inclusion of the informal sector, it is estimated that GDP per capita hovers around USD \$3,500 per person). It is the largest economy in the West Africa region, 3rd largest economy in Africa (behind South Africa and Egypt), and on track to becoming one of the top 30 economies in the world in 2011. Figure 4.5 presents a high-level view of Nigeria’s GDP and poverty reduction performance, respectively, over the past decade.



Source: CIA World Factbook.

Figure 4.5: Nigeria – GDP: real growth rate (%) and population below poverty line (%).

Despite recent improvements, the overall situation in SSA remains urgent and potentially unsustainable. The most pressing issues remain to be information, human development, physical infrastructure,

investment and financing for effective technologies and projects, policy and leadership, water and sanitation, nutrition and food security, rural and urban infrastructure, and complex emergencies and post-conflict issues. The regional focus of this analysis will be on Kenya, Tanzania, Uganda, and Nigeria as they are often regarded as spearheading the mobile telephony technology revolution to address some of these development challenges.

4.2. Current State of Factor Endowments

Recall that factor endowments offer a degree of indication of the level and potential for economic prosperity of a country. This is especially relevant when describing some of the shortcomings of economic development in SSA where there is a lack in building and growing “human capital” through education and income-generation.

Of the full list of factor endowments that were provided in Section 2.2, those most relevant to the mobile telephony industry are innovation systems and ICT (particularly, mobile telecommunications), in addition to a baseline level of know-how (i.e. literacy) and human capital. The following table provides an outline of the demographics and mobile assets and usage in the countries under focus.

	Kenya	Tanzania	Uganda	Nigeria
Population	40 m (41% urban/59% rural)	41 m (26% urban/74% rural)	33 m (15% urban/85% rural)	158 m (48% urban/52% rural)
Land area (sq km)	580 thousand	945 thousand	241 thousand	911 thousand
Under the age of 15 yrs	43%	45%	49%	42%
Illiteracy rate	26%	29%	25%	32%
GDP per capita, USD	777	366	396	1,100
Mobile and broadband price basket; % of GDP per capita	12; 68	28; 173	23; 555	1; 5
Mobile subscribers	18.5 m	17.3 m	11.8 m	85 m
Mobile coverage (population)	84%	48%	~100%	80%
Mobile coverage (land)	33%	N/A	65%	52%

Sources: CCK 2009; UN 2009; UN 2010; ITU 2010; CRA 2009; Uganda Bureau of Statistics 2010; World Bank 2009.

Table 4.1: Profiles of Selected Countries in Africa.

The four countries of focus for this research represent a diverse profile of countries, ranging from under 50% mobile coverage to almost nearly 100% coverage.

The following sections expand on additional factor endowments that relate to the mobile telecommunications ecosystem, such as Built Capital, Structural Capital, Social Capital and Networks and Outsiders.

4.3. The Mobile Telecommunication Industry in Sub-Saharan Africa

Africa is undergoing a revolution in mobile telephony technology that is bringing information and communication services within the reach of hundreds of millions of its citizens. The revolution is based on wireless technologies, which are bypassing the fixed-line networks on which the telecom markets of developed countries were built (Minges/AICD, 2008).

The International Telecommunication Union (ITU) estimated that there were 4.6 billion mobile phone subscriptions globally by the end of 2009, two-thirds of them in the developing world. A quarter of a billion mobile subscribers can be found on the African continent and the number is constantly increasing as it is the region with the highest annual growth rate in mobile subscribers (ITU, 2009).

Mobile telephony technology for development is a broad concept and the term covers many different technologies and sectors. Even though long-term impact studies are scarce, the potential and perceived benefits regarding innovative mobile phone usage for social and economic development are enormous. The basic mobile phone is seen as a tool that supports bottom-up economic development. It is also seen as a way of empowering individuals by encouraging entrepreneurship and innovation as well as giving the poor a voice. Through mobile phones, farmers get access to market prices, young urban citizens can transfer money back to their home villages, health workers can give diagnoses and collect data, family and friends can easily connect and communicate, news can be spread and read in crisis situations, citizens can build opinion and mobilize. As seen in data from ITU and UN in Table 4.2 below, computing technologies are unfamiliar and unaffordable – computer-based internet users are few as computers in households are rare.

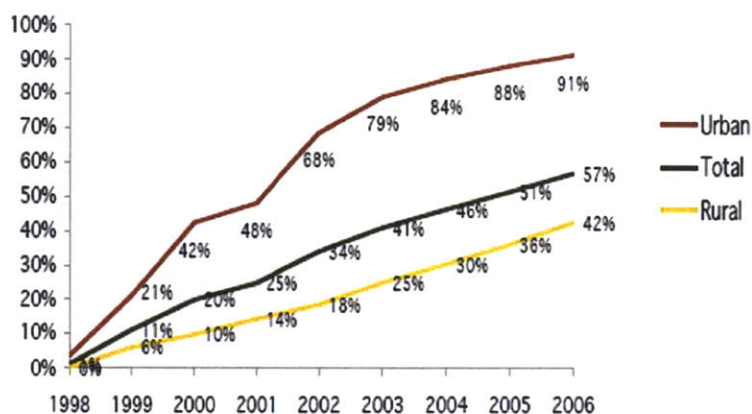
	Kenya	Tanzania	Uganda	Nigeria	Africa
Internet users per 100 inhabitants	9%	1%	8%	7%	4%
Households with computer	5%	2%	5%	5%	5%
Fixed telephone lines per 100 inhabitants	0.7%	0.3%	0.5%	0.9%	2%

Sources: ITU 2009, UN 2009.

Table 4.2: Internet users, computer ownership and fixed lines.

The fixed line sector has remained stagnant since many SSA countries decided to abandon government-run telecommunication systems and instead offer mobile network licenses to the highest-bidding private investors. In a World Bank Africa Infrastructure Country Diagnostic (AICD) study of the ICT sector, 24 countries in SSA were surveyed. Fixed-line subscribers only grew from 8.1 million lines in 2000 to 9.5 million in 2005. While an improvement, but it pales against the growth in mobile networks, which added 72 million subscribers over the same time period. The number of mobile subscribers in the 24 countries jumped more than 10 times – from 10 million in 2000 to more than 110 million in 2006. By 2006, 57% of Africans were living under the footprint of the mobile networks (Figure 4.6) (Minges/AICD, 2008)⁷.

⁷ However, these averages mask wide variations among countries. Of the 24 countries studied, the small middle-income group had seven times more fixed lines per 100 inhabitants than the low-income countries. The range in mobile penetration rates is equally great. The average rate for the region is 16.8 mobile lines per 100 inhabitants, but this ranges from around 1 in Ethiopia to 80 in South Africa. Similarly, wide variations in access can be found within countries, between rich and poor households, and between rural and urban areas. Less than 3% of rural African households have access to a fixed telephone lines, whereas 20% of urban households have them. Rural-urban differentials in access to mobile telephony services are less marked, as networks have extended into remote areas, with 42% of rural dwellers versus 91% of urbanites living under the mobile footprint (Minges/AICD, 2008).



Sources: Winrock International, Pyramid Research.

Figure 4.6: Growth in mobile telephone coverage in AICD study countries.

The region's mobile sector, on the other hand, has achieved remarkable growth and expansion in the past decade, indicated by the annual growth rate in Table 4.3.

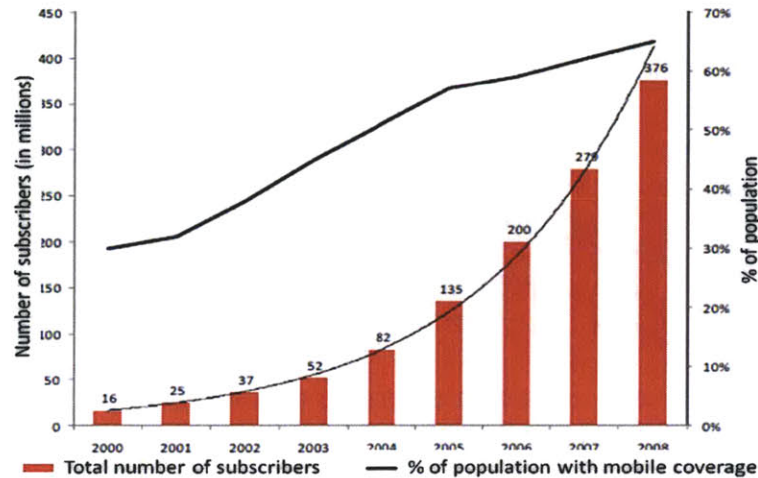
	Kenya	Tanzania	Uganda	Nigeria	Africa
Mobile cellular penetration*, 2003	5%	2%	3%	3%	5%
Mobile cellular penetration*, 2008	42%	31%	27%	42%	33%
Compound Annual Growth Rate (CAGR), 2003-2008	54%	68%	56%	70%	44%

Source: ITU 2009. *Mobile penetration is defined as the number of active SIM cards/population so can exceed 100%

Table 4.3: Mobile penetration and growth rate, 2003-08.

The mobile telephony market in SSA has grown three times faster than the world's average over the majority of the past decade. SSA currently has 280 million mobile subscribers, an estimate of 35% of the entire population⁸.

⁸ At the same time, there are only 215 M people with access to electricity (International Energy Agency, 2010).



Sources: Wireless Intelligence; GSMA.

Figure 4.7: Number of mobile phone subscribers and coverage in Africa.⁹

Because of this trend, mobile telephony services, mainly in the form of GSM (Global System for Mobile), are becoming highly available, even in rural areas. Many countries have virtually full GSM coverage of rural settlements (ITU, 2007).

While Africa's telecommunication market the fastest growing in the world, there still lacks a robust infrastructure to fully support this growth. According to the International Energy Agency and their WEO report, SSA is the only market with less than 50% electrification (International Energy Agency, 2010).

Cell Phone Users without access to grid	Size	Needs
Sub-Saharan Africa	65M	Ability to keep phone charged for use
East Africa	29M	Ability to keep phone charged for use

Sources: Wolfram; World Bank; IDRC-funded Univ. of Dar es Salaam study; UN; Tanzania Statistics Bureau.

Table 4.4: Cell Phone Users without access to grid.

There are existing options to provide electricity, but there are still gaps in allowing users to benefit. Alternatives such as solar chargers have difficulties of charging during rainy seasons. The National Power Grid, while convenient, is unreliable, expensive to obtain a connection, leaving electricity inaccessible to most mobile phone users. There are electricity hubs, such as solar power, generators, and batteries in town centers, which are the default solutions. But they are expensive, difficult to reach, far away, full of corruption and dishonesty, and time-intensive. Additional barriers and mitigations will be discussed in Chapter 7.

While the mobile communications market in SSA is still relatively young, the level of competition has increased dramatic over the past few years. Improving regulatory structure and technology advancement has led to an unprecedented growth. However, according to the ITU statistics, overall penetration rates remain low even though mobile network coverage reaches areas far beyond that covered by fixed line infrastructure.

⁹ "Mobile phone subscribers" are active SIM cards rather than individual subscribers. One individual could have multiple SIM cards for different service providers, thereby potentially inflating the total number of individual users within a particular country (Minges/AICD, 2008).

4.4. Regional Systems of Innovation

4.4.1. Technology Options

SSA is a region for innovation and a variety of interesting mobile phone related projects and pilots are taking place throughout the region. The region is a test-bed for new technology implementations, especially in banking, health and agriculture sectors. In this context, it might be useful to distinguish between different aspects of innovation in terms of who is the innovator.

There are a number of “traditional” laboratory research and development units in this region. Computer science, IT and engineering students at the major universities in East Africa (namely University of Nairobi, Strathmore University, Moi University, Jomo Kenyatta University, Kigali Institute of Science and Technology, National University of Rwanda, Makerere University and University of Dar es Salaam) are actively researching and developing applications for the mobile phone (Hellström, 2010).

In 2006, MIT and Nokia launched a trial initiative called EPROM (Entrepreneurial Programming and Research on Mobiles) in East Africa to develop a mobile phone programming curriculum within Computer Science departments in SSA countries. The University of Nairobi, Kigali Institute of Science and Technology and University of Dar es Salaam were involved¹⁰.

A number of international non-for profit and for profit organizations have also found their way to the region. Google has offices in Nairobi since September 2007 and presence in Kampala since 2008. Google does not only bring existing products into the SSA market, but also expands into completely new areas and come up with local solutions. For example, Google SMS gave financial support, access to technology and user experience support to Applab, a joint venture in Uganda, to offer quick and easy access to health and agricultural information (Yorke, 2009).

Mobile operators have also developed different services to meet the unique circumstances of the region and boost mobile uptake and usage. The most widespread of these services is prepaid; an estimated 95% of mobile subscriptions in the region were using prepaid services in 2008. Providers have searched for ways to enhance the ease of use of prepaid services and to make it more convenient for low-income users. This includes offering features such as low denomination airtime recharges and per second billing. In Nigeria, for example, recharges are available for as little as N50 (USD \$0.40) (Hellström, 2010).

Local and grass-root innovations are also spreading. These innovations are when people create new uses for technology out of local necessity. Recall that innovation is not always something new; it could also mean enhancements of existing products to better meet the needs.

Short Message Service (SMS) or text messages have become a common means of communication in Africa, and the region has pioneered the uptake of new innovative services based on SMS. Some mobile operators allow free text messages to be sent from their web sites.

Mobile cellular phones are also increasingly being used for local m-commerce applications, such as pricing information for rural farmers and to pay for goods and services. In a region where a significant part of its inhabitants have a mobile cellular telephone but do not have a bank account, there is a huge opportunity to bring financial services to a largely untapped consumer base. Mobile operators have

¹⁰ MIT Entrepreneurial Programming and Research on Mobiles website:
<http://www.media.mit.edu/ventures/EPROM>

acknowledged this opportunity and have launched several m-banking services. Some international initiatives to support ICT for development projects have been launched, such as the Mobile Money for the Unbanked (MMU) program.

The following section features examples of these technologies and innovation. Their impact on sustainability will be discussed in Chapters 5 with analysis discussed in Chapter 6.

4.4.1.1. Kenya

East Africa's most prosperous economy is not surprisingly the region's mobile technology cluster. Kenya has a vibrant ICT community with a number of top-class, innovative technology firms and R&D facilities. Nokia opened a research unit in Nairobi, Kenya in July 2008 that was officially launched in September 2008. The objective is to carry out research on its products and services closer to the local market and understand the African telecommunications sector in general and the needs of its African customers in particular. Focus is on the handset and total cost of ownership, with the most profound challenges identified as language issues and poverty itself. They work together with East African universities and NGOs to develop prototypes of devices and applications designed for the African market (Corbett, 2008).

Swedish telecom OEM Ericsson opened up one of its three African application development hubs in Nairobi, Kenya in 2008. The other two centers are based in Nigeria and South Africa. The aim of the Ericsson Innovation Centre is to better meet the needs of poor and rural populations and to focus on developing affordable, sustainable applications and solutions in health, education, agriculture and small business development. The centers will further develop business cases that enable network operators to introduce and expand mobile broadband services and provide tools for local developers and entrepreneurs, and in that way foster a good environment for the creation of new small businesses throughout Africa (Ericsson, 2008).

iHub is an innovation hub located in Nairobi serving the regions technology community. Opened in March 2010, they offer a free open space for technologists, investors, companies and hackers with a focus on young entrepreneurs, web and mobile phone programmers and designers¹¹. According to one of its founders, technology blogger and founder of AfriGadget and co-Founder of Ushahidi, Erik Hersman, iHub is part open community workspace, part investor and venture capital (VC) hub and part incubator (Hersman, 2010). There are a number of private training institutes too, like eMobilis Mobile Technology Academy in Kenya¹². Other spontaneous workshops, seminars, bar camps and conferences are constantly taking place all over East Africa.

Innovation is also taking place outside the traditional research and development units. Grass-roots and bottom-up innovations are prevalent in this region. In Kenya, a young, male-dominated, community of programmers, bloggers and ICT enthusiasts have developed and organized themselves under the name Skunkworks¹³. They organize meetings almost every week and on the vibrant mailing list, ideas are shared and discussed, service providers praised and bashed, and new businesses are created.

An example of local innovation is in the area of mobile banking (m-banking). The most successful m-banking experience up-to-date is the M-PESA system, launched by the Kenyan mobile operator

¹¹ iHub community website: <http://www.ihub.co.ke>

¹² eMobilis website: <http://www.emobilis.org>

¹³ Skunkworks blog: <http://blog.my.co.ke>

Safaricom in March 2007. It allows subscribers to use their phone as a virtual bank by depositing and withdrawing funds through the value stored on their mobile phone. The M-PESA system deposits circulated money into physical bank accounts at the Commercial Bank of Africa, which supervises the daily transactions of mobile banking system. Users make their transactions using virtual information. When they want to withdraw cash, they go to an agent, who is authorized to keep cash and can give them the cash equivalent for the electronic value they transmit to the agent. As of May 2009, M-PESA has around 6.5 million subscribers, 9,000 distribution agents around Kenya, and handles USD \$ 10 million in transactions each day (Hellström, 2010).

Safaricom also offers Flashcom 130, a service which provides an alternative to calling someone, and letting their mobile phone ring just long enough to know they should call back (so-called "flash calling"). Flashcom 130 allows users to send a free text message asking for someone to call. Operators are also offering services that allow users to transfer airtime to other users via a text message. For instance, Zain provides the Me2U service, where a user can send a text message to charge another Zain user's airtime in any amount desired, and which is subsequently deducted from the sender's account. The perception that using a mobile phone helps finding a job is also widespread in several African countries¹⁴.

4.4.1.2. Tanzania

An estimate of 97% of Tanzanians can access a mobile phone. There were more than 1.7 million new subscribers registered in the first half of 2009. This translates to almost 1,000 people buying a new SIM card each day (TCRA, 2009). The SIM card penetration level is still low, however, estimated at 32% of the population (ITU, 2009). So the market growth potential is significant.

Similar ICT communities such as those found in Kenya are also found in Tanzania. The eThinkTank is a voluntary association of individuals who have an interest in the development of ICT in Tanzania¹⁵. Their objective is to catalyze ICT development as an essential "infostructure" that enables socio-economic progress by exploiting the opportunities of globalization of knowledge sharing (Hellström, 2010). Another similar center is e-Fulusi in Dar es Salaam¹⁶.

Mobile innovations in agriculture in Tanzania have been growing. The benefits of mobile phone access for agricultural can be in aiding a farmers' and buyer's knowledge of demand, and improvements in the coordination of supply. Mobile phones also allow for more reliable and faster means of sending information (where previously a messenger or postal service was used), and greater ability to keep track of consignments in transit and on arrival at the market. Together, mobile phones mean that less time and money is spent on travel, if not just by reducing travel-related risks (Jagun *et al*, 2007), then, apparently, by even providing a substitute for unreliable alternatives such as transport (Souter *et al*, 2005; Molony, 2008).

Fishery is also another area with evidence of mobile innovation. In Zanzibar, fishing is one of the mainstays of the economy, supplying restaurants and hotels with fish for the many tourists who visit the island. Many fishermen now carry mobile phones while they are at sea, and they use them to check market prices. If there are too many fish in Zanzibar, they sail to Dar es Salaam to get better prices to make more money. Phones also serve another even more vital use, allowing fishermen in trouble to call for assistance. Call centers have sprung up all over Tanzania. Most people do not actually own phones,

¹⁴ Research ICT Africa website: <http://www.researchictafrica.net>

¹⁵ eThinkTank website: <http://groups.yahoo.com/group/eThinkTankTz>

¹⁶ E-Fulusi Africa website: <http://www.efulusi.co.tz>

so this is how many people communicate. It is a good business, and once again these phones are connected via GSM rather than landlines. Others have developed even simpler businesses based around mobiles, such as reselling their air time to others, or make a living sending and receiving text messages. Mobile phones seem to have created a new sector of the economy, and some now wonder if the emphasis on the internet when looking at the digital divide was wrong-headed (Hancock, 2005).

4.4.1.3. Uganda

Since Zain launched Uganda's first mobile network in 1995, followed by MTN in 1998, Uganda has witnessed a revolution in mobile growth. In 1999, Uganda became the first country on the African continent where the number of mobile subscribers passed the number of fixed-line users. This is because there were, and still are, a lack of fixed-lines in the country.

AppLab, short for The Application Laboratory, is an initiative of the Grameen Foundation USA in partnership with the operator MTN¹⁷. Since September 2007, they have been working with partners in Uganda to recruit, train and support local entrepreneurs who can serve as information hubs for their respective communities. AppLab has piloted a range of mobile applications and in June 2009, they launched a bundle of mobile services together with Google. With grants from the Bill and Melissa Gates Foundation, they are now developing a network of 4,000 community knowledge workers in rural Uganda. The project aims to improve information flows and knowledge dissemination through the use of mobile devices with the hope to improve productivity and livelihoods for small-holder farmers by using applications like Google Trader, Farmers Friend, CKW Search and the Input Supplier Directory. AppLab are also present in Ghana and Indonesia and there have been discussions about rolling out some applications in Rwanda. Similar to AppLab, Appfrica Labs, a for-profit incubator and software development firm based out of Kampala, Uganda, mentors and incubates local entrepreneurs in software¹⁸.

The I-Network in Uganda is a national network of individuals and organizations that acts as a platform for sharing knowledge and information on applying ICT for equitable national development, as well as influencing and supporting ICT policy development and implementation in Uganda. They were established in 2002 and now have over 800 registered members from the public, private and civil society sectors¹⁹. Mobile Monday, the global community of mobile industry professionals and innovators, launched chapters in Kampala, as well as Nairobi, in March 2010, creating platforms where various stakeholders can meet and connect to share knowledge^{20, 21}.

Text to Change (TTC) is a non-for-profit that uses mobile phones to communicate health-related issues and support health campaigns. They started their activities by running a number of pilots in rural parts of Uganda. Their first pilot in Mbarara aimed at expanding HIV prevention and uptake of HIV voluntary counseling and testing through an interactive and incentive-based SMS multiple-choice quiz. Randomly selected participant received a number of multiple-choice questions per week. A correct answer was followed by an explanation while an incorrect was followed by an automated rectifying reply. Participants who sent in answers had an opportunity to win airtime. At the end of the campaign, participants received an SMS to encourage people to go for an HIV test. People who did go as a result of

¹⁷ AppLab website: <http://www.applab.org>

¹⁸ Appfrica website: <http://appfrica.com>

¹⁹ I-Network website: <http://www.i-network.or.ug>

²⁰ Mobile Monday website: <http://www.mobilemonday.net>

²¹ Mobile Monday Kampala chapter (Momokla) website: <http://www.momokla.ug>

participating in the program received testing and counseling for free and were also rewarded with airtime (Hellström, 2010).

Regarding innovations in mobile applications, an m-banking initiative called Zap Mobile Banking, launched in February 2009 by Zain, and initially available in Kenya and Tanzania, will be expanded to Uganda and aims to bring mobile banking services to over 100 million people in SSA (ITU, 2007).

An example of grass-root innovation is Village Phone. In Uganda, when it became too expensive and insecure to send money using the bus system, people started to transfer airtime through the Village Phone operator instead. A person living in the city would simply buy airtime, call the Village Phone operator, and give the operator the airtime details. The operator then loaded the phone with the given airtime, charge a commission, and give the rest of the money in cash to the recipient. This practice is called "Sente," which means "money" in Luganda and can be seen as a forerunner to mobile transactions in Uganda. Or when individual ownership is not feasible, a shared village phone would suffice. A common phenomenon in SSA is that callers use the mobile phone as an address book but make outgoing calls on public payphones because it is cheaper and also hides their identity (Hellström, 2010). There are also cases of many unsophisticated, but highly innovative, workaround efforts to meet needs, like dual SIM card hacks (two SIM cards merged into one for better coverage and tariffs), informal roaming M-PESA services, extensions of the phone's antenna for better reception, homemade phone chargers as well as the dynamo-powered "smart charger" for bikers (Wougnnet, 2009; BBC, 2009). All these local "hacks" present compelling examples of user-centric innovation to increase the use of their mobile phones. When looking at statistics, numbers and revenue streams, it is important to remember innovation and to separate expected and intended usage from actual usage.

4.4.1.4. Nigeria

Nigeria, as the most populous country of 158 million, is also expected to be at the fore-front of the mobile telephony revolution in SSA. Nigeria is one of the fastest growing telecoms markets. With over 85 million subscribers in 2010, a pyramid research study had a projection of 128 million by 2014. Mobile devices are the most promising way to reach the masses and to attain customer loyalty among current customers, due to their ability to provide services anytime, anywhere, high rate of penetration and potential to grow. The penetration of mobile phones into communities in the country has increased the demand for services such as m-banking.

In addition to the Innovation Center in Kenya, Ericsson has also established application development hubs in Nigeria. Aiming to develop mobile applications that will benefit society as a whole with a special focus on meeting the needs of poor and rural populations, the center focuses on solutions in health, education, agriculture and small business development.

The center at first will concentrate on mobile applications, such as mobile health (m-health), with applications to enable health workers to gather, monitor and share data on things like births, deaths and epidemics, and to use smart mobile decision support tools in their daily work. Other applications will relate to education, agriculture, business development, finance, government services and the overall improvement of communication capabilities. Like the center in Kenya, the Uganda expansion aims to also develop business cases that enable network operators to introduce and expand mobile broadband services in Africa and other emerging markets, with an emphasis on developing affordable, sustainable applications and services for rural communities, as well as stimulate local entrepreneurship and business development by providing tools for local developer communities to create their own applications (Iboma, 2008).

In the areas of m-health, eHealth implements mobile solutions in Nigeria to allow health care workers to give better patient care and receive better data collection while they are working in the field. As an example of technology transfer, they focus on using m-health tools that are proven to be effective and have already been implemented in other countries. In this way, they ensure sustainability of m-health projects and the continuous improvement and advancement²² of the software that they implement.

Nigeria has also been pioneering innovations in mobile learning (m-learning). Learning and community centers using mobile phones are becoming more common to provide more mobility, flexibility and convenience rather than computer-based learning. Learners at these community centers can receive academic support for learners through SMS through communication and interaction with educational institutions, browsing course material adapted for phone interfaces, complete multiple choice assessments with immediate feedback, and receive motivational messages. Administrative support through SMS has also increased access to financial statement and registration data by way of mobile service number and access to institution portals on the web (Boyinbode and Akinyede, 2008).

Table 4.5 presents a summary of the main technology options in each of the selected countries that were discussed above and will be the focus of analysis in Chapters 5 and 6. It is important to note that these options are not meant to be comprehensive of all the available mobile telecommunication technologies, but merely as a sampling to represent current technological capabilities and potential for broader impact. It should also be noted that the systemic nature (i.e. breadth of reach and impact) varies across each technology, and that could in turn limit, or expand, a particular option's potential contribution to sustainable development.

	Kenya	Tanzania	Uganda	Nigeria
Technology Options	M-banking (M-PESA)	M-agriculture	M-health (Text to Change)	M-health
	Innovation centers	ICT communities	Grameen Village Phone	M-learning

Table 4.5: Summary of Technology Options for Selected Countries.

4.4.2. Institutional Organization and Structure

The mobile telephony ecosystem contains a myriad of players. Mobile operators, fixed line operators, ISPs, telecommunications and IT equipment providers, software suppliers and professional services firms all find opportunities in the rapid growth of in the mobile telephony industry in SSA. Innovations in the industry, from grass-roots projects and approaches to operator-supported initiatives to complementary policies, are diverse and many different stakeholders are involved. This is often referred to as the mobile telecommunications industry. Scaled-up, successful mobile applications require a functioning, dynamic and productive mobile ecosystem where the role of various stakeholders in setting up, operating, sustaining and expanding the service is understood and analyzed (Dolan, 2009).

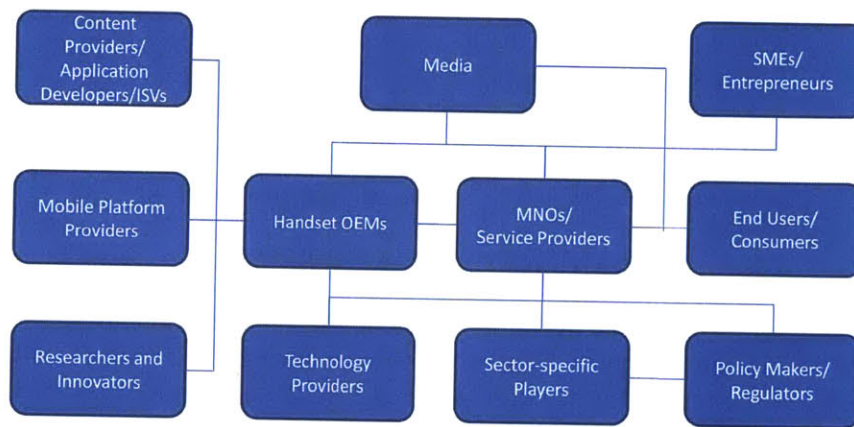
Stakeholders in the mobile ecosystem include:

- Policy makers and regulators
- Mobile network operators (MNOs) and service providers who own and/or manage the transmission as well as hosting platform

²² eHealth Nigeria website: <http://ehealthnigeria.org/what-we-do/mhealth>

- Handset/original equipment manufacturers (OEMs)
- Content providers, applications developers, independent software vendors (ISVs)
- Specific sector players (e.g. financial institutions for m-banking, agriculture associations for market information systems, schools for m-learning, clinics for m-health, etc.)
- Private sector, e.g. entrepreneurs and small and medium-sized enterprises (SMEs)
- Researchers, innovators, consultants etc.
- Civil society and users, e.g. citizens and consumers who are the intended beneficiaries of services.

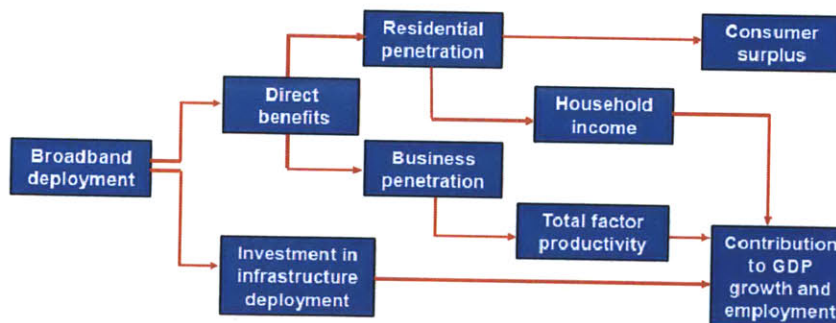
Figure 4.8 illustrates the typical interconnections.



Source: IFC.

Figure 4.8: Stakeholders in mobile telecommunication industry.

Figure 4.9 below highlights the flow of innovation through a mobile innovation system and the multiple categories of economic impact on the various beneficiaries, beginning with the deployment of mobile broadband services (Katz, 2010).

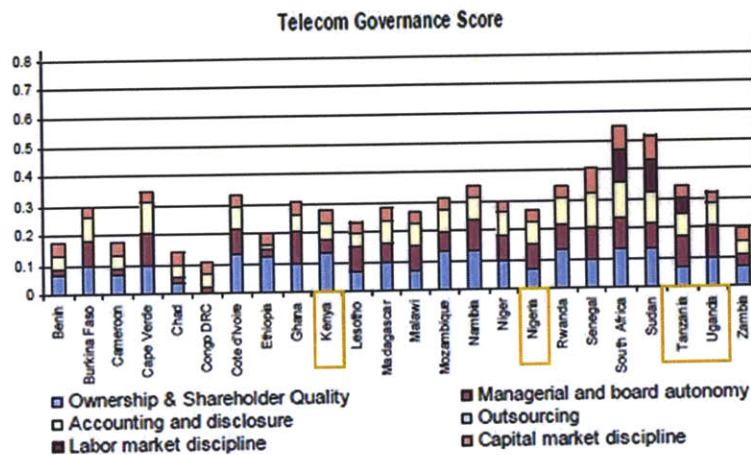


Source: Columbia Business School study

Figure 4.9: Flow chart of innovation through a mobile innovation system.

African governments began making mobile broadband licenses available about five years ago, beginning in South Africa in 2004, to stimulate better access to the Internet while gaining the substantial license fee revenues seen in Europe with third generation (3G) license auctions there (Forbes, 2010). While the private sector's has been successful in delivering ICT services, half of the fixed-line operators in Africa still remain in public control, despite low productivity and poor quality of service. Figure 4.10 presents

the AICD results regarding telecom governance in SSA (Minges/AICD, 2008). The selected countries examined in this thesis are highlighted. Only those in South Africa and Sudan put into effect even half of international best practices for governance.



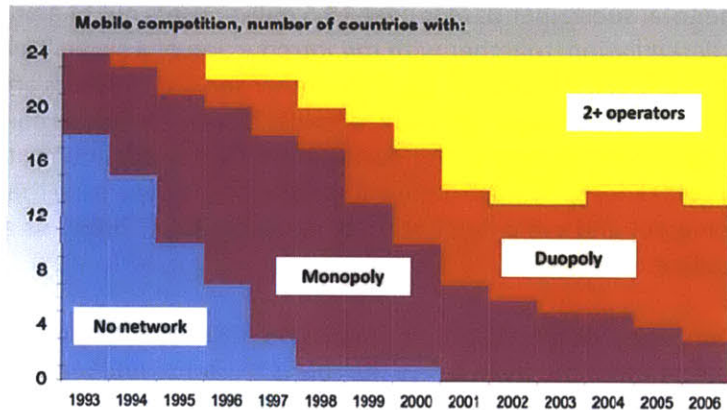
Source: AICD study

Figure 4.10: Telecom governance score.

In countries with state-owned, fixed-line incumbents, public spending on telephone service averaged 2% of GDP, an extraordinarily large amount to be spent by the public sector in a market that is becoming increasingly competitive. The reason for the high spending is because it is not uncommon for public utilities to be used as social buffers, redistributing wealth through excessive employment. However, this carries with it substantial hidden costs of redundancy and inefficiency that are as much as, for example, 0.3% of GDP in Tanzania or USD \$200 per subscriber in Chad.

As mobile network coverage increases across SSA, the primary determinant of popular access to services is price, which is high not only by international standards, but especially relative to household incomes in the region. In 2006, the average monthly prepaid package for mobile service in the countries studied was priced at USD \$12.58, marginally lower than the average price for fixed lines, which was about USD \$14.60 that same year (Minges/AICD, 2008). There is great variation across countries, with average mobile service prices ranging from a high of USD \$24.45 to a low of USD \$4.07.

Competition is the quickest route to lower prices and wider access to services. Perspectives on telecom governance have changed radically over the past few decades. The most important implication has been the shift from monopoly to competition. Greater competition has brought expanded networks, lower prices, and new efforts to reach previously underserved groups of customers. Since 1993, most of the countries studied have introduced some degree of competition in their telecommunications markets (Figure 4.11).



Source: AICD study

Figure 4.11: State of mobile competition.

The telecommunications regulatory environment can play a key role in fostering increased mobile phone adoption. In 1997, over 75% of countries in SSA had no mobile phone network, while all of the existing networks were monopolies. By 2009, a mobile phone network existed in every country, with 49% of markets fully liberalized, 24% partially deregulated and 26% as monopolies.

There seems to be a strong correlation between mobile phone coverage, the types of services offered, the price of such services, and the telecommunications market structure for a particular country. In markets with limited competition, we would expect profit-maximizing firms to offer more limited services at higher prices, and the data from the countries selected shows that increased competition has led to increased affordability and accessibility. In fact, GSMA found that, on average, prices decreased and services increased following market liberalization; average call prices fell by a minimum of 31% with partial liberalization and by up to 90% following full liberalization (GSMA, 2006). Liberalization was also associated with an increase in international traffic volumes and improved call quality. Overall, these patterns suggest that more competitive telecommunications environments can be beneficial for poor consumers.

The competitive environment has also encouraged innovation and SSA has emerged as a testing ground for new applications. For many end-users though, the environment is still *not* good enough. Handsets remain too expensive, airtime credit runs out too quickly, promised service is not delivered or reliable and applications and solutions are not experiencing wide diffusion. But this creates other types of innovations and unconventional ownership models, such as the village phone concept as seen in Uganda and shared handsets practices, but also multiple SIM card ownership. Decentralized prepaid payment plans and electricity constraints also creates another use-case differing with other parts of the world.

4.4.2.1. Kenya

The operators in Kenya have really made an effort to reach more users through creative marketing, compelling promotions, and expanded network infrastructure. The high number of subscribers is, however, a pro and con for operators. The overall revenues are high and increasing, but the average revenue per user (ARPU) has declined. Due to increased competition, operators are forced to lower their prices, which opens up for new subscribers among low-income groups.

With the deregulation of the telecommunications sector, Kenya moved beyond a duopoly consisting of Safaricom and Zain at the end of 2008 when Orange and Yu launched services as the third and fourth

operators. Combined, the total subscriber base is over 18.5 million users out of a population of about 40 million (CCK, 2009). The deregulation, together with the introduction of a single license for ICT service providers, have in many ways leveled the playing field for other service providers and led to increased competition. In this streamlined licensing framework, a holder of a single license can offer many different services without additional licenses. Also during 2009, the telecommunication regulator in Kenya established policy guidelines on infrastructure sharing in an effort to ease the investment burden of new entrants into the market and avoid duplication of resources (CCK, 2009). As a result, Zain and Yu agreed to share infrastructure.

In addition to the operators, the Communications Commission of Kenya is the independent regulatory authority for the communications industry in Kenya. Its role is to license and regulate tele- and radio-communications, and postal/courier services in Kenya. It was established in February 1999 by the Kenya Communications Act.

The Ministry of Information and Communications plays a key role in the mobile ecosystem. It was created in order to facilitate ICT development in Kenya and is a primary institution in the mobile sector. The functions of the Ministry are mainly to formulate and implement ICT policies, promote the development of ICT capacity and to disseminate and enhance public access to information²³.

The Kenya ICT Board also carries out important functions, such as marketing and promoting Kenya as an ICT destination both locally and internationally, advising the government on all relevant matters pertaining to the development ICT in the country, capacity building for government and other stakeholders and project management (i.e. coordinating, directing and implementing ICT projects in development)²⁴.

4.4.2.2. Tanzania

Tanzania now has a fully competitive telecommunication sector with six operational mobile networks. The four major dominating companies are Vodacom, Zain, Tigo and Zantel. BOL Mobile and TTCL Mobile are both still below the 200,000 subscriber mark. There are another seven additional players licensed under the converged regulatory regime but have yet to go live (TCRA, 2009).

The main ICT regulatory body in Tanzania is the Tanzania Communications Regulatory Authority (TCRA), established by the TCRA Act no. 12 of 2003, is an independent Authority for the Postal, Broadcasting and Electronic communications industries. It merged the former Tanzania Communications Commission and the Tanzania Broadcasting Commission. Its function includes licensing and regulating the Postal services, broadcasting services and electronic communications sectors in the country²⁵.

4.4.2.3. Uganda

The telecommunication sector transformed when the market opened up in Uganda. First out was Uganda Telecom in 2001 followed by Warid Telecom in 2008. Orange entered in 2009 after buying a majority stake in the country's fifth mobile license, HITS Telecom, and pledged to invest millions in USD. Two interesting low-cost operators have also recently entered the market. Smile Communication of South Africa, which is one of the first Voice over Internet Protocol (VOIP) phone and service on the African continent, and I-Tel of Uganda who are using CDMA technology. The entrance of Smile and I-Tel

²³ Ministry of Information and Communications website: <http://www.information.go.ke>

²⁴ Kenya ICT Board website: <http://www.ict.go.ke>

²⁵ TCRA website: <http://www.tcra.go.tz>

brings the number of operating companies to seven, and yet more operators are coming (Hellström, 2010).

The Ministry of Information and Communications Technology (www.ict.go.ug) that was established in 2006 has been a key institutional player. It has a mandate to provide overall coordination, support and advocacy on all matters of policy, laws, regulations and strategy for the ICT sector in Uganda. The Ministry has divided the sector into three levels: policy, regulatory and operational. The operational level is composed of telecommunications, postal and broadcasting operators. The regulatory level is composed of Uganda Communications Commission (UCC) and the National Information Technology Authority (NITA-U). NITA-U was set up in 2009 to coordinate, promote and monitor ICT development within the context of national, social and economic development.

The Uganda Communications Commission (UCC) is the regulatory body in charge of the communications sector in Uganda with the principal goal of developing of a modern communications sector and infrastructure in the country. Recently merged with the Broadcasting Council and will thereby oversee both communication and broadcasting matters²⁶.

4.4.2.4. Nigeria

Nigeria's mobile network has grown significantly since three companies, awarded the GSM license in January 2001, began operating later that year. According to the Nigerian Communications Commission (NCC) the GSM network achieved 350,000 connections within six months of their launch (www.mbendi.com). The new operators have also reduced their start-up prices (though customers still complain that their tariff is too high). Using GSM mobiles to connect with fixed lines is still hampered by the limited number of interconnectivity lines provided by Nigerian Telecommunications, which is also a GSM operator but lags behind the private firms – MTN Nigeria Communications and Econet Wireless – in expanding its mobile services.

In January 2002, the government began the overdue process of licensing a second network operator, publishing a memorandum and application instructions for prospective investors. The guideline from the NCC reports that second network operator is authorized to provide a range of telecommunication services at the national level and also receive a digital mobile license (www.mbendi.com).

Competition among various telecom operators is increasing as they are now looking for new business expansion and customer retention strategies to sustain and gain higher chunk of the market. As a result, operators are aggressively pushing the deployment of network infrastructure which is driving the investments in the country's telecom sector that is projected to grow at a CAGR of around 11% between 2009 and 2013 (www.mbendi.com).

Table 4.6 presents a summary of the main institutional players in each of the selected countries that were discussed above and will be the focus of analysis in Chapters 5 and 6. It is important to note that these lists of institutions are not meant to be comprehensive of all the available mobile telecommunication players, but a representation of the primary players. It should also be noted that the systemic nature (i.e. breadth of reach and impact) and function varies across each institution, and that could in turn limit, or expand, a particular institution's contribution to sustainable development.

²⁶ Uganda Communications Commission (UCC) website: <http://www.ucc.co.ug>

	Kenya	Tanzania	Uganda	Nigeria
Institutions	4 mobile network operators	6 mobile network operators	Innovation centers (AppLab, I-Network)	Innovation centers (Ericsson)
	Communications Commission of Kenya	Tanzania Communications Regulatory Authority	7 mobile network operators	4 mobile network operators
	Ministry of Information and Communication		Uganda Communications Commission	Nigerian Communications Commission
	Kenya ICT Board	Small and medium enterprises	Ministry of Information and Communications Technology	3 telecommunication companies (MTN Nigeria Communications, Econet Wireless, and NITEL)
	5 entities from the Kenya Post and Telecommunications Corporation		National Information Technology Authority	

Table 4.6: Summary of Institutions for Selected Countries.

4.4.3. Policies

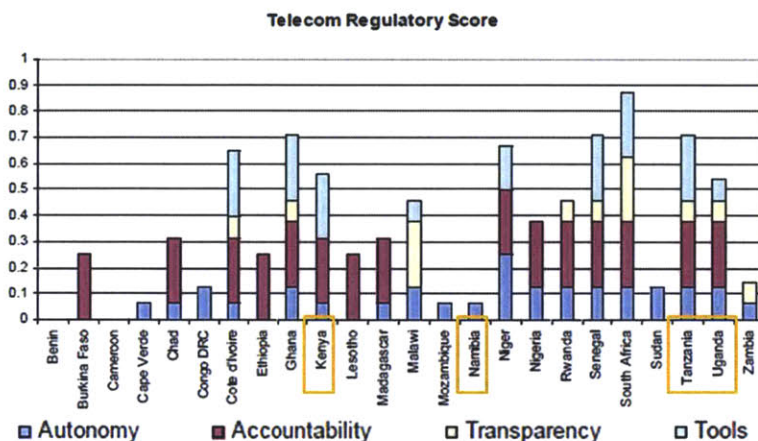
While Africa’s mobile telephony industry has shown outstanding growth, sustaining this level of growth in the future will be a significant policy challenge. Additional subscriptions and use of ICT services will come from lower-income segments of the population, typically including people in rural and remote areas. This segment is harder for operators to address, because the costs of infrastructure provision are high. These customers are also highly sensitive to pricing; small price changes can have a significant impact.

Some policy challenges to be faced in SSA to push mobile cellular development and diffusion include regulation to continue to enhance competition, develop mobile broadband, establish roaming agreements and reduce taxation. The structure and regulation of the telecommunications market affects competition – for example, by limiting entry to the market – and therefore affects access, by keeping prices higher than they otherwise would be.

All the countries in the AICD study, including the four countries under focus in this thesis, have laws and regulations covering the telecommunications sector; 11 adopted their present legislation after 2000 (Minges/AICD, 2008). A typical bill establishes a national regulatory agency (NRA) to supervise the telecommunications sector and contains general provisions governing competition, licensing, interconnection, allocation of scarce resources (such as numbering and spectrum), pricing and market entry. Wide variations are found between countries in the extent of reform. Compared with other infrastructure sectors, there has been intensive institutional reform in the mobile sector. These changes have been predominantly driven by market reforms that fostered competition and facilitated private participation. Policy oversight evolved accordingly. Most SSA countries have introduced measures to delegate decisions affecting tariffs, investment plans, technical standards, regulatory monitoring and dispute resolution outside the government (Minges/AICD, 2008).

Progress is also evident in regulations, although the results are more mixed. By 2006, 23 of 24 countries in the AICD study had NRAs in operation, but governments continue to interfere with their decisions (Minges/AICD, 2008). Effective NRAs depend on legal frameworks that make them accountable to the public, encourage them to operate transparently, give them the enforcement powers and other tools

they need to execute, and grant them autonomy and freedom from political interference. Regulatory quality differs from country to country (Figure 4.12), but autonomy is a commonly scarce commodity. The selected countries examined in this thesis are highlighted.

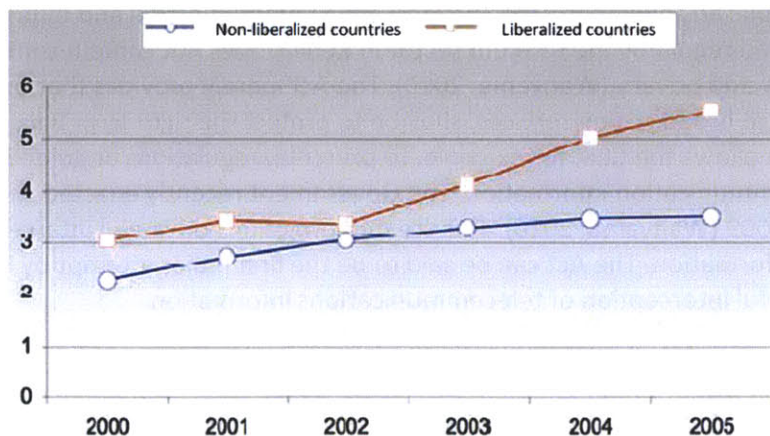


Source: AICD study

Figure 4.12: Telecom regulatory score.

On the other hand, progress on accountability has been encouraging, particularly if compared with other variables of regulation and other infrastructure sectors. Achievements in transparency have been mixed and generally incomplete, with much ground yet to be covered. Almost all the NRAs have websites. Yet availability and quality of online information vary greatly.

Failure to reform has a direct fiscal cost because competitive markets generate higher taxable revenues. Telecom revenue as a percentage of GDP in the liberalized countries is 5.6%, compared with 3.5% in the non-liberalized countries (Figure 4.13) (Minges/AICD, 2008). Note: liberalized countries are those that have established an independent regulatory agency, partly privatized government-owned operators, and mainstreamed competition for at least five years.



Source: AICD study

Figure 4.13: Telecom revenue as share of GDP.

In liberalized countries, telecom revenues increased by 2.5% of GDP between 2000 and 2005, compared with a 1.2% rise observed in the non-liberalized countries (Minges/AICD, 2008).

Other factors, notably taxes, tariffs and energy shortages, have kept prices of ICT services in Africa high. These taxes include import duties on mobile handsets, taxes on services, and, in some countries, excise charges on calls. Value-added taxes range from 5% to 23% in the countries studied (Minges/AICD, 2008). The combined effect of these taxes and duties adds significant cost to mobile ownership, putting ICTs outside the reach of many consumers who otherwise might be able to afford them. Uganda ranks second in the world in taxes as a percentage of total mobile revenues, while Kenya and Tanzania are above the world average.

Although mobile tariffs are still high by international standards, they are falling steadily and, as the networks expand, are reaching lower-income customers. One indication of the drop in prices is the steady fall in the average revenue generated by network subscribers. The monthly ARPU stood at USD \$20 in 2005, almost half the level of USD \$39 in 2000 (Minges/AICD, 2008). There is plenty of opportunity for prices to come down even further. Despite high service prices, the mobile networks have been able to provide access to low-income users through flexible retail packages. Approximately 97% of the region's consumers are on prepaid plans, which allow them to purchase services in smaller increments and control their spending more precisely (Minges/AICD, 2008). High connection charges are rare, so the minimum cost of access to mobile services is much lower than for fixed networks, which operate on a post-paid subscription basis. For the operators, prepayment dramatically reduces credit risk and the cost of revenue collection. Moreover, the absence of credit checks, proof-of-address requirements, and other "know your customer" measures has reduced the transactional cost of customer acquisition in the region and increased the flexibility of markets.

However, shortages of electricity contribute to higher costs, as service providers must rely on their own generators to power mobile base stations and other telecom equipment. Scarce and unreliable electricity also affects operators' earnings because mobile subscribers, particularly in rural areas, have difficulty recharging the batteries in their mobile phones.

4.4.3.1. Kenya

There have been many institutional arrangements to develop legislative frameworks to regulate the mobile industry. In public arrangements, the current Kenya Communication and Information Act, the statute that governs and regulates the telecom sector in Kenya, does not contain comprehensive provisions, i.e. security and privacy (Wanyama, 2010). The Act merely provides that one of the functions of the CCK, in relation to broadcasting services, shall be to protect the right to privacy of all people. There is no clause that allows the CCK, for example, to prescribe regulations or guidelines on the interception of telecommunication information. The Government recently enacted the Mutual Legal Assistance Bill Act in 2009 (Wanyama, 2010). This created provisions on lawful interception of telecommunication information. The Act can be said to be the first major attempt by Kenya to enact a specific statute on lawful interception of telecommunications information.

Kenya has also started an initiative to register all mobile phones with a mandate for subscribers to supply ID documents in order to reduce cybercrimes (BBC, 2010). Users will have to supply identity documents and proof of address before they get a number, disconnecting those who don't register. While this has received some praise for its innovative approach, many doubt that it will be a panacea (Kinyanjui, 2010). It is very simple to get counterfeit phones and documents to bypass this requirement. Additionally, in 2004, Safaricom and Zain tried to introduce a new system that would allow the operators to trace stolen or misused phones. Reportedly, the initiative failed because the police were not held accountable. The expensive equipment used to implement the system, the Equipment Identity

Register (EIR) which allows networks to keep their own records of blacklisted, lost, or stolen phones, often sits idle at both mobile providers' headquarters (Kinyanjui, 2010).

4.4.3.2. Tanzania

In September 2005, the Government of Tanzania and TCRA introduced a converged licensing framework and the concept of technology neutrality, which was meant to enhance the provision of communication services in the country. It has worked and the mobile market in Tanzania has been growing at more than 60% per year in the last five years and passed the 17 million subscriber mark in December 2009 (TCRA, 2009).

In 2005, mainland Tanzania (i.e. not Zanzibar) modified its licensing system for electronic communications, modeling it on the approach in Malaysia during the late 1990s where traditional "vertical" licenses (right to operate a telecom or broadcasting network, and right to provide services on that network) are replaced by "horizontal" licenses (right to operate a telecom and broadcasting network, but a separate license required to provide services on that network) (Hellström, 2010). This reform was the first of its kind on the African continent actually put into practice, and allowed investors to concentrate on their area of expertise (i.e. network operation or service provision) across a maximum number of previously separate sectors (i.e. telecommunications, broadcasting, Internet). This reform should, amongst other things, facilitate the arrival of telephony services over cable television networks, television services over telecommunications networks, and Internet services over all types of networks. In short, Tanzania is the first African country to adapt its regulatory environment for convergence.

4.4.3.3. Uganda

Despite the fact that the market is consistently growing, penetration rate is still below the African average of 33% (ITU, 2009). This indicates that SIM cards and handsets remain beyond the reach of the masses in terms of affordability. In order to address this and other access related problems, Uganda, as one of the first countries in Africa, developed a policy on universal access and set up a Rural Communications Development Fund (RCDF) in 2001. Operators in Uganda pay a 1% levy on revenues to this fund, money that is later used to implement internet points of presence, internet cafés and public pay phones in rural areas (Hellström, 2010).

Most key policies, laws and regulations are in place. The Uganda Communications Act of 1997, National ICT Policy of 2003, and various supporting regulations were established in 2005. Also, a simplified licensing regime has significantly reduced barriers to market entry and increased competition, which has led to lowered tariff rates across the sector. In 2008, as the trio of Zain, MTN and Uganda Telecom prepared to take on new entrants like Warid and Orange, they lowered the tariff rates by 10% (Hellström, 2010).

4.4.3.4. Nigeria

The Nigerian government is also realizing the importance of ICT as a viable platform to transform the country's economy into knowledge-based economy. The telecom sector is presently undergoing speedy transformation on account of explosive growth and rapid infrastructure development. The liberalization of the telecom sector along with increased competition among players have brought substantial benefits to consumers in terms of lower subscription rates and enhanced choice.

The process of deregulating the telecommunications industry in Nigeria began in 1992 with establishment of the Nigerian Communications Commission by Decree 75 of 1992 (www.mbandi.com). The objective of the regulators have been to create an environment which would facilitate the supply of

telecommunications services and facilities, allowing private entrepreneurs to enter the market while promoting fair competition and enhancing the level of service for all concerned.

Recent deregulation of the mobile phone market introduced GSM network providers operating on the 900/1800 MHz spectrum, namely MTN, Zain, Globacom and MTel. This contributed to the rapid growth of cell phones, and has mostly replaced the unreliable services of the Nigerian Telecommunications Limited (NITEL) (www.mbendi.com). Nigeria's telecom regulator, Nigerian Communications Commission (NCC), introduced the Unified Licensing Regime with the expiration of the exclusivity period of the main GSM network providers (www.mbendi.com). The goal is that the operators with the unified license will provide fixed and mobile services, Internet access, as well as any other communications service they choose to offer.

Table 4.7 presents a summary of the main mobile telecommunication policies in each of the selected countries discussed above and will be the focus of analysis in Chapters 5 and 6. It is important to note that these policies are not meant to be comprehensive of all policies affecting or governing the mobile telecommunication industry, but merely as a sampling of the major, pioneering policies that have a direct impact to the development of the industry. It should also be noted the systemic nature (i.e. breadth of reach and impact) varies across each policy, and that could in turn limit, or expand, a particular policy's contribution to sustainable development.

	Kenya	Tanzania	Uganda	Nigeria
Policies	Kenya Communications and Information Act	Converged licensing framework for communications	Uganda Communications Act of 1997	Nigerian Communications Commission of 1992
	Mutual Legal Assistance Bill of 2009		National ICT Policy of 2003	Unified Licensing Regime

Table 4.7: Summary of Policies for Selected Countries.

4.5. Effects of Globalization

Even though globalization is a positive or powerful force for the improved material well-being of humankind that would aid developing countries to create better economic environments, to accelerate into the information age, improve their access to technology, speed development and enhance global harmony, its effects on the political, economic, social and cultural aspects of the weaker member states can have severe consequences. Globalization creates the danger of further marginalizing the African continent. Its universalization of communication, mass production, market exchanges and redistribution, rather than nurturing new ideas and developmental orientation locally in Africa, subverts its autonomy and powers of self-determination. Nation-states in Africa today rarely define the rules and regulations of their economy, production, credits and exchanges of goods and services due to the rampaging menace of globalization (Akindele, 2002). They are hardly capable of managing their political, economic and socio-cultural development. LDCs are vulnerable to external shocks and have low capacities to take or manage associated risks. Such vulnerability stems mainly from their structure of production and income, the consequent low level of development and industrialization, and fiscal and balance of payments constraints of development and industrialization, and fiscal and balance of payments constraints.

The recent global economic crisis has been unprecedented since the Great Depression of 1929-32 (South Centre, 2010). SSA has been severely affected. Although they are not a homogeneous group (in terms of

the size of population, structure of production and exports, the degree of integration into the world economy, the degree of indebtedness, etc.), they share some common characteristics that make them susceptible to external shocks. They are marginalized in international trade, particularly in manufactured goods. The combined population of LDCs was 800 million people, over 12% of world population, in 2007. Yet, they account for less than 1% of total world trade, and about 0.1% and 0.3% of the international trade and global output of manufactured goods in 2007, respectively (UNCTAD, 2009). Their low weight in international trade, their structural weakness and heavy dependence on foreign trade and finance make them extremely vulnerable to external shocks. Their manufacturing sector is particularly vulnerable not only because of its infancy, but also because of its reliance on the primary sector (raw materials) for the provision of foreign exchange and sources of income.

Growth in LDCs as a whole is expected to have declined from 7.6% in 2007 to under 3.5% in 2009 (South Centre, 2010). African and Island countries and petroleum and mineral exporters are particularly affected, with negative growth in some cases. The demand for manufactures, in general, suffers not only from the fall in exports but also from changes in domestic demand as a result of the decline in the rate of growth of private consumption, which is projected to fall by 3% in SSA (South Centre, 2010). The decline in workers' remittances is another important cause of the fall in domestic demand for manufactured goods in many LDCs. For example, for six African countries, remittances were equivalent to more than 100% of their total exports. In 2008 workers' remittances as a percentage of GDP reached over 27% in the case of Lesotho, and 18%, 17.8% and 11% in the cases of Haiti, Nepal and Bangladesh, respectively (South Centre, 2010). The decline in remittances is projected to reach over 3% of GDP in some cases.

4.5.1. Balance of Payments

The combination of a low level of development and rigid production structure imposes both fiscal and balance of payments constraints on many countries in SSA; in other words, non-oil commodities provide low and unstable sources of income and foreign exchange necessary for investment and industrialization. The average per capita income of LDCs in 2006 was USD \$462. But when oil exporting countries and Island countries are excluded the average reduces to USD \$398 for African LDCs. Furthermore, in the same year, 23 countries (22 African) out of 35 (excluding oil exporting countries and Islands) show per capita income of less than USD \$266 a year (UNCTAD, 2009).

Such a low level of sources of finance available for public administration, investment and debt repayments is due to the low level of per capita income which is, in turn, a reflection of the low productive capacity of LDCs. The low and inflexible productive capacity also causes the balance of payments constraint, with high current account deficits in relation to GDP because of the need to import investment goods, intermediate goods, fuels and such consumer items as foods. Furthermore, the more integrated the country is in the international economy, in terms of the exports/GDP and imports/GDP ratios, particularly the latter, the higher the current account deficit. In other words, there is a direct relation between the degree of LDCs' integration into the world economy, influenced by premature trade liberalization and balance of payments constraints.

The deterioration in their balance of payments has resulted in tighter fiscal constraints and a reduction in financial resources available for long-term investment, leading to the cancellation of projects and a significant drop in investment in development plans. This has detrimental effects on the growth of production capacities. For example, the rate of growth of investment is projected to decline by over 12% in SSA (South Centre, 2010).

4.5.2. Trade

Some countries in SSA may be highly integrated into the world trading system, but they are marginalized in international trade, particularly for manufactured products. They suffer from structural weaknesses, balance-of payments and fiscal constraints, and they are mostly highly-indebted and dependent on the production and export of primary (raw materials) commodities and external sources of finance. The commodity boom of 2003-08 allowed most of them to increase their national savings and investment and to accelerate the growth of their GDP and Manufacturing Value Add (MVA). Nevertheless, the subsequent “bust” due to the economic crisis has had serious detrimental impact not only on their current levels of economic activity and employment, but also on their longer-term prospects for industrialization and development.

The combination of a fall in external and domestic demand together with the increased exposure of the manufacturing sector of LDCs to competitive pressures in internal and international markets has led to the closure of a number of factories in the manufacturing sector of LDCs in Africa, resulting in unemployment. The increased competitive pressure is the result of changes in the rules of the game regarding competition in international markets and premature trade liberalization in pursuit of “market oriented” development strategies imposed by IFIs and bilateral donors (South Centre, 2010). Rapid technological change, emergence of global production networks, new methods of production, continued high agricultural subsidies in developed countries and the emergence of new players such as China as exporters of labor-intensive manufactures have increased the competitive pressure on the manufacturing sector in LDCs, particularly textiles and clothing which account for over two-thirds of their manufactured exports. Such changes have increased the need to restructure and nurture the manufacturing sector. Yet, their policy space has diminished. As a result, despite acceleration of growth of their MVA during the boom years, most LDCs have seen de-industrialization.

4.5.3. Foreign Assistance

The global economic crisis was a wake-up call for LDCs to reconsider their long-term industrialization and development strategies. International assistance and reforms of policies of international organizations and donors are a necessity. In the short term, the space available to LDCs for counter-cyclical policies in response to the crisis is highly limited. Some selective import restrictions under the “balance of payments clause” of the World Trade Organization (WTO) and capital controls would be helpful, but not sufficient (WTO, 2009). International measures should be taken to assist the LDCs to address the crisis. These include provision of external liquidity, debt moratorium, debt relief and cancellation. But what is essential for the long-term development of LDCs is to increase their capacity to absorb external shocks and instability in export earnings without suffering a significant loss of growth. To do so, they need to diversify and upgrade their production and trade on the basis of a development and industrialization strategy than has so far been pursued.

For this, LDCs need considerable policy space. But this may be further constrained significantly by the Economic Partnership Agreements (EPAs) between many LDCs and the EU because the model proposed would eliminate most of their tariffs and introduce new obligations on investment and procurement that would also affect their domestic industries while restricting their ability to regulate the inflow and outflow of funds.

4.6. Need for Unique Solutions

Today, the global economic and financial crisis is threatening to reverse much of the progress that has been made in SSA in recent years. The crisis is likely to add between 7 million and 16 million people

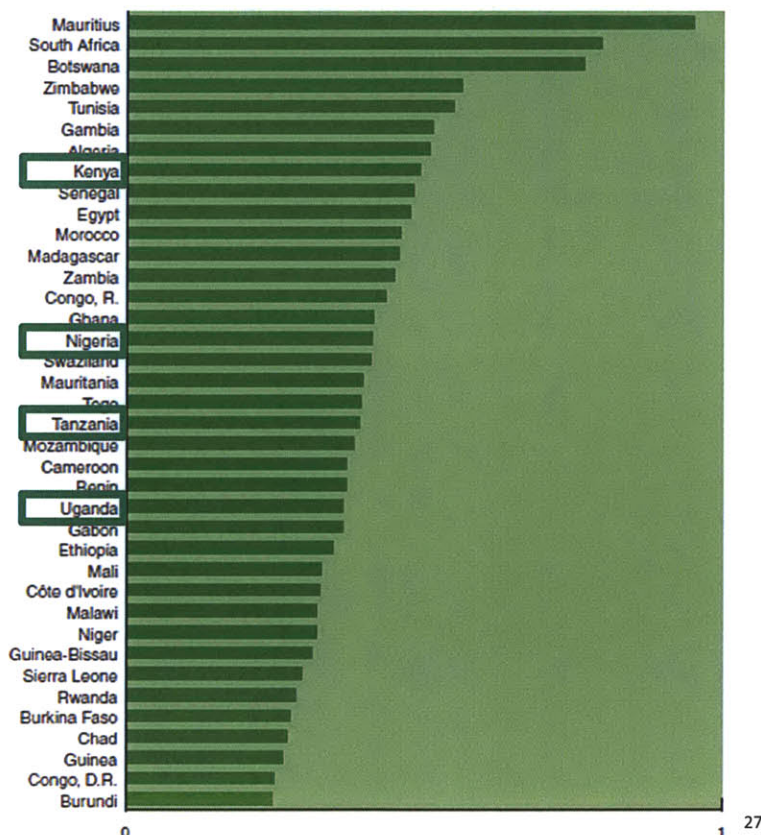
living below USD \$1.25 a day in SSA (World Bank , 2009/ UN DESA, 2009). The IMF estimates that the poverty rate of SSA is expected to be 38% by 2015, rather than the 36% it would have been without the crisis, lifting 20 million fewer people out of poverty (IMF, 2009).

There is no “one-size-fit-for-all” development strategy for LDCs in Africa as they include diverse economies despite some common problems (i.e. poverty traps, vulnerabilities to shocks). While the recent global economic crisis has affected the market with European and Middle East telecom companies slowing down their investment, Asian (mainly Indian) are companies stepping in. The SSA market, especially for the mobile industry, will most likely become even more competitive in the few years to come, and due to the launch of several key projects and products, mobile services other than voice are expected to boom. Chapters 5 and 6 will detail the mobile industry’s influence on sustainable development in SSA as well as its potential to counteract harmful consequences of globalization.

5. Mobile Industry Influence on Sustainability in Sub-Saharan Africa

5.1. Overview

Overall, sustainability has been worsening in Africa over the past three decades. Low productivity (and in some cases, declining productivity), deterioration of natural resources, coupled with rapid population growth means that development is unsustainable in most SSA countries. This is illustrated by the Economic Commission for Africa's (ECA) index of overall sustainability, which combines economic, environmental, and institutional dimensions in Figure 5.1 (UNECA, 2002). The examined countries are highlighted.



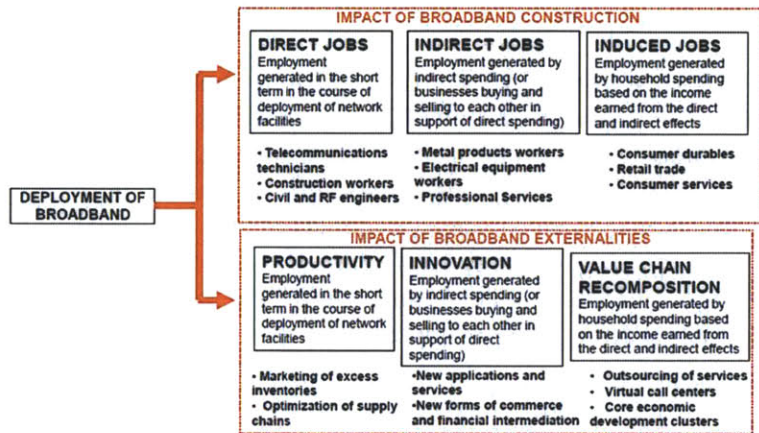
Source: Calculations by Economic Commission for Africa.

Figure 5.1: Overall Sustainability Index Scores by Country, 1975-2000.

The ECA's index shows that Kenya ranks 8th, Nigeria as 16th, Tanzania as 20th, and Uganda as 24th, a diverse spread across the African nations reviewed. The continent urgently needs a rapid, sustained, and broad-based economic transformation that is equitable within and across generations. In other words, SSA needs development that is sustainable. The key to achieving the transition to sustainability is realizing and enhancing the capabilities of individuals and their communities. Citizens who are ill, poorly fed, and living in a fragile environment can neither function effectively nor improve their capabilities. Moreover, in part because of rapid population growth, the severity of ill health, food insecurity, and environmental stress is likely to increase in the coming decades. Africa must therefore explore new and radical solutions to these problems.

²⁷ The index scores are averages of scores for 1975-2000. The scores are standardized to range from 0-1.

Broadband impact on job creation comprises of two effects: broadband construction and broadband externalities. Figure 5.2 decomposes the direct, indirect, and induced jobs that are the outcome of mobile broadband deployment.



Source: Columbia Business School study

Figure 5.2: Two effects of mobile broadband deployment.

The telecommunications regulatory environment can play a key role in fostering increased mobile phone adoption. In 1997, over 75% of countries in SSA had no mobile phone network, while all of the existing networks were monopolies. By 2009, a mobile phone network existed in every country, with 49% of markets fully liberalized, 24% partially deregulated and 26% as monopolies.

There seems to be a strong correlation between mobile phone coverage, the types of services offered, the price of such services, and the telecommunications market structure for a particular country. In markets with limited competition, we would expect profit-maximizing firms to offer more limited services at higher prices, and the data from the countries selected shows that increased competition has led to increased affordability and accessibility. In fact, GSMA found that, on average, prices decreased and services increased following market liberalization; average call prices fell by a minimum of 31% with partial liberalization and by up to 90% following full liberalization (GSMA, 2006). Liberalization was also associated with an increase in international traffic volumes and improved call quality. Overall, these patterns suggest that more competitive telecommunications environments can be beneficial for poor consumers.

The development challenge facing Africa is enormous, but it can be overcome. The recent development of Asian economies (i.e. China and India) as highlighted in Chapter 2 corroborates this. Given the right circumstances, advances in and diffusion of technology can pull Africa out of its current state of low development. African countries can emulate the processes and policies that have promoted transitions to sustainability in other regions.

Recognizing that modern technology is indispensable to such transitions, this chapter outlines the effects and results, taken from existing literature and case study research, of mobile telephony technology along economic, employment and environmental dimensions. Using Ashford's Sustainability Framework (Ashford and Hall 2011), data and information on the performance of mobile telephony technology across the indicators in all three dimensions will be provided. Note, however, that

comprehensive data for each indicator may not be available. Instead, proxy information will be provided to indicate progress in that particular area.

5.2 Kenya

5.2.1 Economy

The impressive growth of mobile telephony in Africa is indeed impacting Kenya as one of the most advanced countries in the SSA region. At the end of 2007, Kenyan mobile operators offered services to more than ten million people so that nowadays one in three adults carry a mobile phone in Kenya and about the 80% of Kenyans are covered by mobile network signals (Safaricom, 2008; Mason, 2007). The network is still growing and mobile operators are extending their coverage reaching even more remote areas of the country. In one year, from 2006 to 2007, the cellular mobile services recorded an increase in the number of channels installed in GSM base station transmitters, from about 15,000 to about 20,000. This increase could be attributed to the increased demand from the growing subscriber base, requiring mobile operators to increase investment in network expansion (Mason, 2007).

While mobile subscriptions are around 45%, there is plenty of opportunity for business to come; there are still about 20 million Kenyans as a potential market for mobile phones. This fact, coupled with the current volume of the business (i.e. mobile industry contributed to more than 5% of GDP of Kenya in 2006) (GSMA, 2006) explains the notable rush around new services, technologies licenses, plans, pervasive and impacting advertisement in which Kenyan mobile operators are going into (Manica and Vescovi).

Due to the adverse effects from post-election violence which spilled into early 2008, high fuel and food prices; unseasonal weather patterns, deteriorating exports and capital flows and the global financial crisis coupled with the global economic decline, the transport and communications sector slowed down to 3.1% growth compared to 15.1% in 2007, accounting for 10.2% of total GDP in 2008 compared to the 10.6% recorded in 2007. This performance was mainly driven by the postal and telecommunications sectors which, however, grew marginally by 7.9% compared to 30.3% recorded in 2007, detailed in Table 5.1 (CCK, 2009).

Indicator	2004	2005	2006	2007	2008*
Population (Millions)	34.2	35.1	36.1	37.2	38.3
GDP at market prices (in KES .Min.)	1,274,328	1,415,724	1,622,434	1,825,960	2,099,798
Growth of GDP at Constant (2001) Prices (%)	5.1	5.9	6.3	7.1	1.7
GDP per Capita (in 2001 Prices) (Kshs.)	32,463	33,441	34,570	36,000	35,611
Transport and Communications contribution to GDP at Current Prices (Kshs. million)	125,727	145,523	171,991	194,011	214,983
Postal and telecommunications contribution to GDP (in Kshs. million)	30,167	36,242	43,251	54,947	58,574
Transport and Communications as % of GDP	9.9	10.3	10.6	10.6	10.2
Postal and telecommunications as % of GDP	2.4	2.6	2.7	3.0	2.8
Growth of Transport and Communications at Constant (2001) Prices (%)	7.0	9.0	11.4	15.1	3.1
Growth of Postal and telecommunications at Constant (2001) Prices (%)	8.5	17.7	16.5	30.3	7.9
Private sector wage employment in transport and communications ('000s)	60.7	75.1	90.9	117.8	120.3
Public sector wage employment in transport and communications ('000s)	37.9	38.9	40.2	36.1	37.4
Consumer Prices, Annual Average [Index numbers October 1997=100]	163.72	180.61	206.71	226.88	286.41
CPI Annual Inflation Rate (Overall) %	11.6	10.3	14.5	9.8	26.2
* Provisional					
+ Revised					

Source: Adapted from Economic Survey, 2009.

Table 5.1: Selected economic indicators.

Further, the postal and telecommunications sector accounted for 2.8% of the total GDP in 2008 compared to 3.0% in 2007, with slow-down also due to the domestic and global turmoil mentioned above. Mobile telephony dominated the telecommunications market by posting a rise of 53% in the subscriber base to stand at 17.4 million by June 2009 up from 11.4 million in 2007. The communications industry continued to act as a stimulant for growth in other sectors of the economy. During the period under review, the industry witnessed increased investment due to the roll-out of mobile telecommunications services by Telkom Kenya (Orange Mobile) and Essar Telecom in September 2008 and November 2008, respectively; and expansion of existing networks by Celtel Kenya and Safaricom Limited. As a result, the mobile telephony market experienced increased competition which led to significant decline in tariffs; increased access and affordability to communications services and increased mobile penetration from 30.5% to 46.8%.

The mobile telephony subsector is the most vibrant of all ICT activities in Kenya. Of the industry's contribution of USD \$1.56 billion to Kenya's GNI, mobile phone activities constitute USD \$1.09 billion, which equals 70%. Besides this subsector, the other contributing subsectors in the ICT industry are (Ministry of Foreign Affairs of Denmark and Growth Africa, 2006):

- Fixed line telephony
- Broadcasting sub-sector (radio and TV)
- IT hardware (reselling and servicing) and software (configuration and development)
- Internet (infrastructure and services)
- IT training

According to Zain in Kenya, mobile penetration enhances economic growth to substantial percentage points, resulting in the creation of employment opportunities. Kenya's Information and Communications Permanent Secretary Bitange Ndemo asserts:

"Greater penetration of mobile technology has been found to greatly contribute to economic growth. Like everything else, it comes with some negatives when it gets used by criminals to extort money from innocent people. However, it has by far greater benefits than the negative aspects (Ochieng, 2010)."

Mickael Ghossein, CEO, Orange, says mobile technology has made doing business easier:

"Today, I am able to read my email and transact other business while stuck in the Nairobi traffic jam. The mobile has become a great commodity for doing business. Now you can easily be reached whether you are out of office. You can be in touch with your colleagues whether you are on holiday. It also increases business value. Without the mobile phone, you can lose a lot of business (Ochieng, 2010)."

Economists are trying to calculate the macroeconomic effect of this communications explosion, but there is consensus that it is significant. Leonard Waverman, chairman of the economics faculty at London Business School, figures that a 10% increase in a developing country's mobile phone penetration adds 0.6% to the economic growth rate (Waverman, 2005). Indeed, the advent of mobile communications in Africa has coincided with a surge in growth. SSA's economy will expand as much as 7% this year, a 25-year high, according to the IMF. Many other factors are contributing, including high commodity prices, fewer armed conflicts, and, Kenya's case, better government. Markets need information to function efficiently, and mobile phones are providing information to people who did not readily have access to it before.

Several studies have been conducted to assess the correlation between GDP growth and mobile networks. One of the models developed by Waverman, Menschi and Fuss, the Aggregate Production Function model, estimated that, with all else equal, during 2002 in a country with a mobile penetration of 7.84 phones per 100 population, doubling the mobile penetration would lead to a 10% rise in output (Waverman, 2005). Another result indicates that the impact of mobile telecoms in developing countries is almost twice as large as the one in developed countries, mainly because there is no substitution effect of the fixed line communications (Chee, 2006).

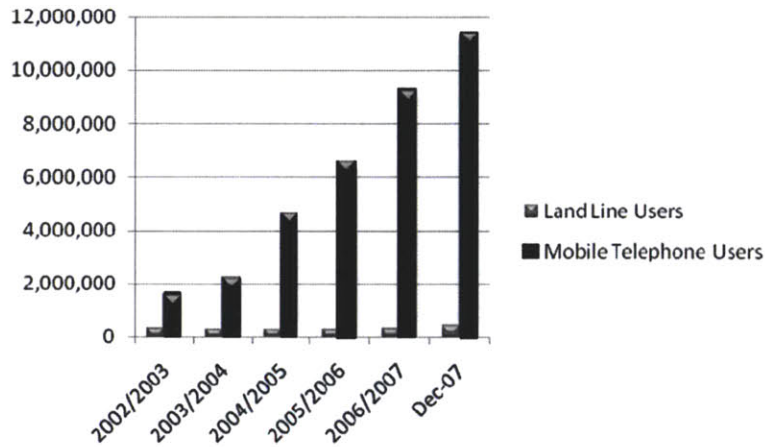
The mobile telecommunications industry itself is enjoying a new level of entrepreneurship and job creation in the developing world. For example, Nahashon M. Macharia, a Nairobi-based businessman, opens new stores selling cell phones and airtime in step with the expansion of Safaricom's network. Whenever a new cellular mast is put up, another player will provide coverage (Bloomberg Businessweek, 2007).

Indicator: Improvements in competitiveness, productiveness, and use of capital

Until 1998, the Kenya Posts and Telecommunications Corporation (KPTC) was a monopoly providing all telecommunication services; it was established after the East African Community broke up in 1977. As detailed in Section 4.4.2.1, in 1998, Kenya's Parliament enacted the Kenya Communications Act (KCA) to regulate the communications sector (www.cck.go.ke/policy_and_legislation). Based on the KCA, five entities were created from the KPTC:

- The Postal Corporation of Kenya (PCK), established under the Postal Corporation Act of 1998
- Telkom Kenya Ltd (Telkom), incorporated in April 1999 under the Companies Act of 1948
- The Communications Commission of Kenya (CCK), an independent regulator of all communications services in the country
- The National Communications Secretariat (NCS), a communications policy advisory think-tank within the Ministry of Information and Communications responsible for communications services
- The Appeals Tribunal set up to resolve disputes between operators or between CCK and the operators. It has three members: a chair, who should be an experienced advocate at the High Court of Kenya, and two technical experts, one from telecommunications and the other in postal services.

The original intention of the KCA, to liberalize telecommunications in Kenya, has largely been met. Growth has been tremendous: from 17,000 mobile subscribers in 1999 to 11.3 million by December 2007 to almost 20 million by 2010 (Omwansa, 2009). Figure 5.3 illustrates how the number of both mobile phone and land-line users has grown in Kenya over five years, largely as a result of increased competition and a healthy competitive landscape.



Sources: CCK website; Safaricom prospectus.

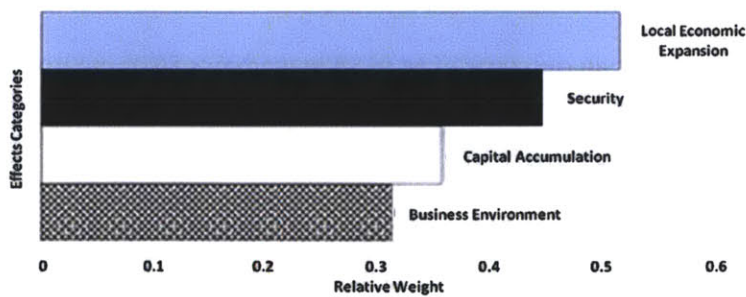
Figure 5.3: Growth of mobile phone and land line users in Kenya.

The deregulation leveled the playing field for other service providers and led to increased competition. Due to increased competition, operators have lowered their prices, which opens up for new subscribers among low-income groups and led to a current subscriber base that is about half the country's population and growing (CCK, 2009).

Indicator: Economic changes from labor replacement and capital relocation

In April 2008, Safaricom reported that the initiative M-PESA had well over 2 million active subscribers, transmitting over 100 million KShs (USD \$1.4 million) a day. This was just over a year after M-PESA was launched. At the end of July 2008, M-PESA had 3.6 million users, and was adding 10,000 new registrations daily. In just the month of July 2008, people transferred 21 billion KShs (USD \$300 million). In November 2008, the initiative had 4 million users. Meanwhile, in April 2008, over 80% of Kenyans were aware of M-PESA and 66% had actually used it. But these M-PESA users represented only 40% of all Safaricom subscribers (Omwansa, 2009).

In a study by the Strathmore University in Nairobi, M-PESA's economic effects at the community level were observed for both users and non-users of M-PESA, through direct effects and externalities, respectively. The four overarching economic effects at the community level that were found were in the areas of local economic expansion, security, capital accumulation and business environment, with ranking of each category of M-PESA's effects shown in Figure 5.4.



Source: Strathmore University study.

Figure 5.4: Ranking of the category effects of M-PESA on communities.

These four effects are composed of 11 community-level sub-effects, by order of importance, that illuminate M-PESA's potential role in supporting economic activities in the communities. These include the following (overarching effect category in parentheses):

1. Money circulation—(local economic expansion)
2. Transactions ease—(business environment)
3. Money security—(security)
4. Food security—(security)
5. Human capital accumulation—(capital accumulation)
6. Expansion of businesses—(local economic expansion)
7. Social capital accumulation—(capital accumulation)
8. Employment opportunities—(local economic expansion)
9. Financial capital accumulation—(capital accumulation)
10. Physical security—(security)
11. Quality control—(business environment)

Not all 11 sub-effects were visible in all of the studied communities and among all of the population segments. As with most development, the effects were not always perceived as mutually exclusive, but as interwoven to produce overall community effects. Overall, the highest-ranked effect by the focus group participants was increased money circulation, due to a greater volume of money flowing into and out of the communities and a faster flow of money within the community to boost local consumption. However, its importance varied by gender, with men considering it No. 1 and women ranking it No. 3.

Participants in Focus Group Discussions (FGDs) noted an increase in local economic activity in their communities. They identified money circulation, expansion of businesses, and greater employment opportunities as the central effects of local economic expansion.

In terms of the economic changes in the communities, money circulation was the most highly ranked of all the effects. It was consistently identified as having the most important outcome on communities due to a faster flow of money within the community to boost local consumption and a greater volume of money flow. Transaction ease was ranked as the second most notable effect of M-PESA. Business expansion was recorded in terms of growth of existing businesses rather than new business startups. Existing businesses were able to expand to meet growing local demand for goods and services, which was in part driven by increased money circulation through M-PESA and lower transactions costs for vendors using M-PESA to obtain their stock. This business expansion also tended to be related to food security elements identified in the communities in terms of increased volume, variety of food available and timely availability of agricultural inputs in local markets.

Quality control was mentioned as an outcome of M-PESA in women's FGDs in Kitui District. Women business owners said that while M-PESA saved them money by allowing them to send payments directly to their suppliers instead of traveling to Nairobi or another city, it also reduced their control of the quality of goods delivered (Plyler, 2010).

On an interesting side note, in addition to the 11 community sub-effects identified above, there was also a pilot project that sought to expand M-PESA's utility. Shortly before the study began in September 2009, M-PESA partnered with a private company to provide clean water in one of our study districts. While the Katitika Water Project (KWP) in Kitui District is not located within the communities selected for the study, it was a notable breakthrough in enhancing the functionality of M-PESA in directly addressing the basic human need for water in arid areas, and also community-level governance and

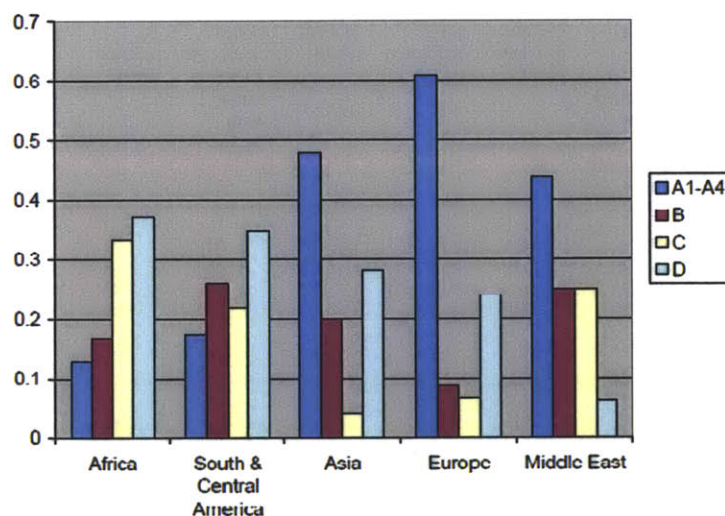
project sustainability issues. The project used a variation on M-PESA’s “bill pay” function to allow rural communities to access safe water from an automated water system. Over time, the project intended to become community-owned, providing residents with a valuable asset and skill building. The initial feedback identified three primary community effects of the KWP. The first was higher agricultural productivity in terms of new gardens and tree nurseries. Second, local business expansion was seen in new water-based businesses such as brick making and in existing businesses such as dairy cattle farming. Third, community members spoke of improved health in terms of fewer waterborne diseases and increased ability to practice good hygiene (Plyler, 2010).

To understand some of these positive economic benefits, several factors help explain M-PESA’s success in Kenya. These include the widespread diffusion of mobile phones and the low cost of mobile transactions. As discussed earlier, the diffusion of mobile phones is largely a result of the deregulation of the telecom industry leading to increased competition among the mobile phone operators. Currently, only Safaricom subscribers can operate an M-PESA account, though other network subscribers can receive an SMS from an M-PESA subscriber. The fact that Safaricom controls such a large percentage of the subscription base has given M-PESA the advantage it needed to penetrate very quickly.

In terms of the inexpensive nature of mobile transactions, M-PESA offers competitive services with attractive transaction costs. For example, to send KShs 35,000 (USD \$500) using a money transfer company such as Western Union would cost KShs 1,200 (USD \$17) within the country. But using M-PESA to send the same amount would cost only one third as much. And M-PESA is much cheaper than using a bank account. Given their setup and operational costs, banks and money transfer companies cannot offer such low rates (Plyler, 2010).

Indicator: Financing growth and development

Africa is a risky region for investors. Figure 5.5 summarizes one aspect of uncertainty, namely the risk of corporate payment default as rated by Coface²⁸.



Source: Coface.

Figure 5.5: Country ratings of the corporate payment default risk, by region.

²⁸ Coface is France’s export credit underwriter. For details on the country rating methodology, see <http://www.trading-safely.com>.

The graph shows the percentage of countries falling into each rating grade across five regions. Grade C is equal to a very unsteady political and economic environment and could deteriorate an already bad payment record, while D corresponds to the high risk profile of a country's economic and political environment that will worsen an already bad payment record. Seventy percent of the 54 African countries rated in the survey fall into any of these two categories, by far the highest proportion among the five regions considered. Data on the Institutional Investor (II) index of the risk of default tell a similar story: during 1979-96, Africa has continuously been the world's riskiest region according to this criterion (Collier and Pattillo, 2000).

African firms typically operate in environments with weak regulatory systems and poor infrastructure, with typically very small domestic markets in their business environment. This makes it necessary for African firms to export if they are to grow and generate more jobs. These are the main factors that lead to investment in fixed capital among African manufacturing firms.

Infrastructure includes a whole range of services important for business, such as transportation, telecommunications, waste disposal, and the supply of electricity and water (Fafchamps and Söderbom, 2004). Despite a high share of public expenditure to GDP in most African countries, Africa's infrastructure is poor (Collier and Gunning, 1999). Transport costs are considerably higher in Africa than in other regions, electricity costs are higher than elsewhere and water supplies are unreliable. Table 5.2 provides summary statistics on the state of infrastructure in twelve African countries with the selected countries highlighted, and, for reference, average values for SSA and OECD. Columns 1-6 show data on economic losses due to power failures, telephone, roads and rail networks and water access. These figures were calculated from the World Development Indicators and we refer to these as objective measures of infrastructure. Column 7 shows data on firms' perceptions about how serious a problem is deficient infrastructure. These figures derive originally from the World Business Environment Survey (WBES) and are referred to as subjective measures of infrastructure (Batra *et al*, 2003).

	(1) Electric power transmission and distribution losses (% of output)	(2) Telephone mainlines (per 1,000 people)	(3) Paved roads, km per million people	(4) Roads, paved (% of total roads)	(5) Improved water source (% of population with access)	(6) Rail lines, km per million people	(7) Percentage of firms ranking infrastructure as a moderate or major obstacle
Botswana		66	3119	54	95		29
Cameroon	20	6	301	13	58	67	91
Ghana	23	7	556	27	73	49	58
Kenya	20	10	270	12	57	88	94
Madagascar		3	403	12	47		85
Mauritius		205	1578	96	100		
Mozambique	24	5	339	19	57		
Nigeria	37	4	452	28	62	28	98
South Africa	8	116	1709	20	86	515	14
Tanzania	15	4	117	4	68	81	88
Uganda		3	80	7	52	11	70
Zambia	2	8	3139	62	64	129	76
OECD	6	569	12279	88		375	22
SSA	11	13	369	14	58		66

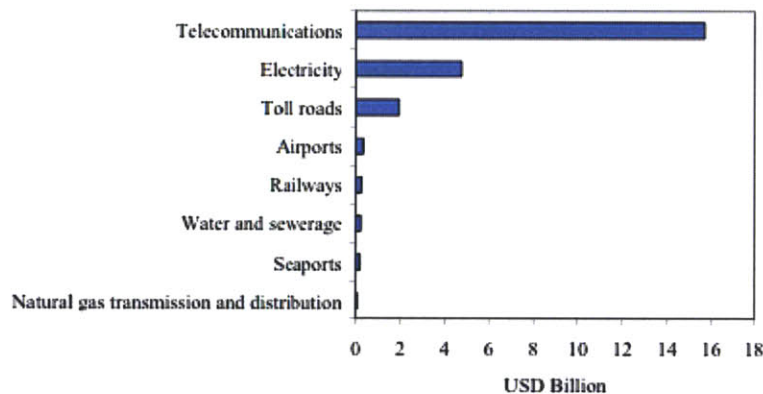
Source: Batra *et al*, 2003.

Table 5.2: Indicators of Africa's Infrastructure.

Looking at the size of paved roads network, five of the seven low income countries have worse infrastructure than Nigeria, and Uganda ranks last. Similarly, based on the telephone mainlines, Kenya is better than all the low income countries. Yet according to the subjective data on infrastructure, Kenya is only ranked higher than Nigeria. Thus, different measures convey different stories, and it is not obvious which measure to use.

Poor infrastructure is likely to be a major factor in explaining the poor economic performance of most African countries over the last decades²⁹. Industrial firms are particularly intensive users of infrastructure services, and so this sector may have been particularly hampered by this problem. Transport infrastructure, for instance, affects production in several ways. Good roads result in lower decision costs of firms when they undertake investments, and to lower costs of their day-to-day operations such as the purchasing of input and the sale of output.

Figure 5.6 below shows a breakdown of cumulative investment during the 1990-2001. It is clear that private infrastructure investment has been concentrated in telecommunications, a sector where incumbent state-owned operators have been divested and mobile licenses have been issued to private operators who now supply a rapidly growing market.



Source: University of Oxford study.

Figure 5.6: Total investment in infrastructure with private participation in SSA, 1990-2001.

In a cross-country analysis, Aizenman and Marion use World Bank data on 43 developing countries to test for the correlation between volatility and investment, and found that public and private investment are determined by different factors (Aizenman and Marion, 1999). The authors propose two reasons why public investment may increase in periods of heightened volatility: to compensate for the reluctance of the private sector to invest or, in a rent-seeking society, to distribute political rents.

The issue of financial imperfections has a major influence on private investment. African financial markets are the least developed in the world, and it has long been a widespread view among development economists that the malfunctioning of the financial markets hampers growth. For investment, the main problem is that firms with profitable investment projects often cannot rely on external funds to finance such projects. Commonly cited reasons for financial imperfections are imperfect information, cumbersome contract enforcement and lack of competition among lenders

²⁹ Cross-country macro regressions demonstrate a strong correlation between the availability of certain infrastructure – telecommunications power, paved roads, and access to safe water – and per capita income.

(Fafchamps and Söderbom, 2004). Table 5.3 shows the investment rate and average return on investment (ROI) for the countries in the study.

	Investment rate	Average return on fixed capital
Cameroon	0.11	1.36
Ghana	0.13	3.63
Kenya	0.11	1.82
Uganda	0.12	0.75
Zimbabwe	0.12	0.85
Belgium	0.13	0.18
France	0.11	0.12
Germany	0.12	0.16
UK	0.12	0.13

Source: The data on all countries except Uganda were reported in Bigsten *et al*, 1999. The Ugandan data were reported in Reinikka and Svensson, 2001.

Table 5.3: Investment rates and returns on fixed capital in eight countries.

While the idea that investment is low in Africa because of financial imperfections may have some intuitive appeal, it is important to realize that financial imperfections will not translate into binding credit constraints unless firms have a desire to invest. Thus, if there are few profitable investment opportunities, one would not expect lack of credit to be a real constraint on investment (Fafchamps and Söderbom, 2004).

5.2.2. Employment

Indicator: Skills

It is estimated that 10-15% of the Kenyan population has operated a computer in the recent past. The challenge in the training industry is the apparent lack of certification of the courses and schools, which makes it difficult for the industry to measure the level of the students and to validate whatever proof of education or training is presented. The availability of trainable employees for most ICT disciplines is relatively good, though companies must expect to invest a fair deal in introductory, on-the-job training. On average, companies should calculate 3-6 months of training for a graduate to reach a level where they are a contributor to the company. The number of graduates from tertiary institutions majoring in IT and ICT-related disciplines have increased significantly over the past 10 years, from less than 2,000 in 1995 to almost 10,000 in 2005. Nevertheless, this only account for 10% of the 100,000 graduating from Kenya's public and private universities, and polytechnics and technical institutions (Ministry of Foreign Affairs of Denmark and Growth Africa, 2006).

The Nokia Research Center (NRC) in Nairobi focuses on understanding the needs of the African mobile phone user and creates concepts to fulfill these needs. The concepts are built into prototypes and pilots and then field tested. The focus of the center is to build on the following skills:

- Entrepreneurship
- Energy management
- Health care
- Education
- Transportation
- Social media
- Arts and culture: music, storytelling, oral culture

Mobile communication has a great role in social and economical development in Africa. NRC Nairobi is co-operating with NGOs and UN organizations to develop such devices and services which could support this progress.

Similarly, the objective of the Ericsson Innovation Centre that opened up in Nairobi is to address needs of poor and rural populations and to focus on developing affordable, sustainable applications and solutions in health, education, agriculture and small business development. In its aim to develop business cases that enable network operators to introduce and expand mobile broadband services provide tools for local developers and entrepreneurs, it will foster an environment for the creation of new small businesses throughout Africa and nurturing of marketable skills.

iHub also serves as an innovation hub and the Skunkworks Blog is an information portal to provide IT content and events, both of which are based in Nairobi serving the region's technology community. iHub advertises job listings and competition to catalyze innovation and skill building.

Indicator: Wages

In the M-PESA study, human capital accumulation ranked highly overall as a community outcome as a result of the system. Focus group participants frequently cited M-PESA as a means for helping them to pay school fees and get money for medical procedures (Plyler, 2010). Financial capital accumulation ranked highly among the urban Kibera participants, who tended to focus on M-PESA's outcome on business and the business environment and its use in managing and accumulating small amounts of money (Plyler, 2010).

The cost of labor in Kenya is, as in most of Africa, higher than Asian countries. Comparatively, the wage difference between Kenya and, for example, India or China, is narrowing, mainly due to increases in salaries in these countries and introduction of improved employee conditions with its associated cost.

Indicator: Purchasing power

As of early 2007, 38% of Kenyans had no access to any form of financial services, according to a national survey, and only 19% had access to formally regulated financial institutions such as banks. In the entire country there were only 400 bank branches and slightly over 600 ATMs – and over 10 million mobile subscribers (www.fsdkenya.org).

M-PESA took off so rapidly because of the low penetration of banking services and the public need for them. Though few studies have been done to establish whether the service mostly benefits the un-banked, we have several indications that it has gone both ways. Features such as convenience, speed, and low transaction fees attract significant numbers of those who already use banks. Small businesses are among the greatest beneficiaries; using M-PESA lets them go to the bank less often, and spend more time running their businesses. Many un-banked Kenyans can now receive and send money via their mobile phones, wherever they are in the country.

In September 2008, Safaricom signed an agreement with PesaPoint Ltd. to allow M-PESA subscribers to withdraw money through PesaPoint ATMs. Registered in 2005, PesaPoint has a vision: to provide all banked Kenyans with easy access to funds in their bank accounts wherever they are in the country. So far it has installed over 110 ATMs across the country. This agreement helps overcome the problem that agents sometimes do not have enough cash to issue to M-PESA customers who want to withdraw it. This partnership was a major milestone in linking M-PESA to the formal banking system, a confirmation that more financial players are willing to collaborate to improve access to financial services (Omwansa,

2009).

In December 2008, M-PESA signed another agreement with Western Union for international cash transactions. Vodafone, Safaricom and Western Union announced that they would partner to pilot a cross-border mobile money transfer service between the U.K. and Kenya. Ultimately, this enabled M-PESA subscribers to receive international remittances just like local ones. According to the World Bank, Kenyans received approximately USD \$1.3 billion in international remittances in 2007; for some Kenyans, these remittances are a considerable part of their total income. These innovations will certainly improve many Kenyan lives (Omwansa, 2009).

Indicator: Health and safety

Plan International, a global organization dedicated to improving the lives of children around the world, is integrating FrontlineSMS, software for SMS reporting and communication, into some of its key program areas. Since 2008, when staff gathered in Kenya to discuss the use of social media and new technology in their program work, Plan has begun using FrontlineSMS in birth registration in Kenya and violence reporting in West Africa.

The team decided to combine FrontlineSMS and Ushahidi, a digital mapping platform that crowdsources information via SMS, to reach their goal. Since Ushahidi does not have an SMS interface, it needed to be set up with another tool to collect the messages sent from a mobile phone; FrontlineSMS provided the tool to do so.

ICT tools, including FrontlineSMS, can be invaluable but they must rest on an existing information and communications flow, and be part of a comprehensive approach that recognizes the true capacity of stakeholders. In the Benin case study, staff members are concerned that the expected increase in messages would overwhelm the low capacity to respond to reports in the local and national authorities. Plan Benin is working closely with the Ministry of the Family and the CPS with the aim of eventually handing over management to the authorities entirely. The information collected during the pilot phase will be used to advocate for more resources for prevention and response (FrontlineSMS Case Study).

Involving the users was critical. Concern about state capacity had lead Plan staff to assume that the system couldn't get involved in managing cases but would need to be restricted to reporting. However, the excitement of the CPS, children, and Plan staff working at the district level changed the team's thinking, and during the workshop the system was adapted towards supplying information for future decisions as well as for immediate response. Local authorities did have concerns about their own capacity to respond, but embraced the system and its potential to help them do their jobs. They suggested many ways to improve it, and fleshed out the original ideas on how the information should flow to those responsible for responding and supporting victims, including local actors that hadn't been thought of during the initial design phase. A significant difficulty was finding appropriate modems to work with FrontlineSMS. Ultimately, a conference call with the FrontlineSMS team and involved Plan staff allowed for procurement of modems which worked as soon as they were plugged in. The team has also reported that people are calling the phone number rather than texting. They concluded that more outreach and promotion of the system and how it works are needed (FrontlineSMS Case Study).

In the M-PESA study, a common theme was improved safety because thieves learned that few people carried large amounts of cash. Men and women saw money security as an important outcome of M-PESA in communities, but women saw it as a more central effect than men.

Since the KWP began, community members also reported that the health of community members had improved. Waterborne diseases were a constant concern for Kitui residents. According to Kitui District's October Drought Monitoring Bulletin, 254 people were diagnosed with cholera, and three of them died in 2009 (Office of the Prime Minister of Kenya, 2009). Residents of Katitika also indicated that overall nutrition, especially among children, had improved, and this meant more time in the fields or at school. With people using the M-PESA-aided water service and seeing the benefits, the KWP committee received more than 100 new applications for key bobs. This led not only to the project becoming a communitywide service, but also to cheaper costs of service if the water table supported increased demand.

Social capital accumulation was also frequently mentioned in focus groups, but participants were split over whether the outcomes of M-PESA were primarily positive or negative for their communities. For example, some participants said it strengthened social bonds by enabling people to be able to send money to each other when in need. Others commented that it weakened social bonds because now people had less need to return to the rural areas – they just send money to relatives there (Plyler, 2010).

Men identified physical security, in terms of reduced mugging and thefts, as an effect of M-PESA. Women viewed improved money security – in terms of ability to accumulate cash and keep it secure from theft – as the most important type of security effect associated with M-PESA.

People in agrarian areas identified food security as a more important effect than those who live in urban areas. This was mentioned in terms of increased agricultural productivity, improved access to nutritious food and a variety of foods and better access to agricultural inputs on time. Interestingly, rural women placed more importance on food security than rural men, while urban men placed more importance on it compared to urban women. As mentioned above, increased money circulation and expansion of local markets are also related to the food security effect identified in the communities.

Men and women consider human capital accumulation – in terms of education and health – an important positive community-level effect associated with M-PESA. However, aggregate data from all three study districts showed no clear consensus on the direction of M-PESA's association in creating or nurturing social and financial capital in the community. Nonetheless, respondents in Kibera, a slum in Nairobi, identified M-PESA positively with financial capital accumulation since residents linked it to business expansion and a better business environment.

Indicator: Number of jobs

In the M-PESA case study, increased employment opportunities were mostly referenced in direct relationship to M-PESA's shops. Although the increase was relatively small, given the high level of unemployment in the areas, it was very noticeable to the community members. Also, in some cases, existing businesses expanded employment with the addition of M-PESA windows within their shops. Employment opportunities were mostly referenced in direct relationship to the M-PESA kiosks, not with expansion of local businesses above (Plyler, 2010).

As M-PESA expanded its services, many more agents signed on. Agents had three primary responsibilities: 1) accept deposits and load them onto a customer's mobile account, 2) transfer funds on behalf of non-registered users, and 3) serve as points for withdrawing cash. Ngummo, a middle-class suburb of Nairobi, saw the number of its agents rise from four in June 2008 to its current ten. This indicated how popular the service has become among Safaricom subscribers, as well as being a lucrative business proposition for the agents (Omwansa, 2009).

5.2.3. Environment

Indicators: Resources, Toxic pollution

E-waste has become one of the topical environmental issues of the 21st century. The United Nations Environment Programme (UNEP) estimates that up to 50 million tons of waste from discarded electronic goods is generated annually worldwide, while its generation is estimated at three times the rate of municipal solid waste (Kinver, 2006). The increased usage of electronic goods has led to dangerous disposal of obsolete or defective items, a move that has been exacerbated by lack of recycling plants and a regulatory policy framework. According to the UNEP, the annual generation of e-waste in Kenya stands at 11,400 tons from refrigerators, 2,800 tons from TVs, 2,500 tons from personal computers, 500 tons from printers and 150 tons from mobile phones. The useful life of consumer electronic products is relatively short, and decreasing as a result of rapid changes in equipment features and capabilities thereby causing unprecedented generation of large volumes of electronic waste (UNEP, 2009). With the rise of mobile telephony technology in Africa, there has been an increase in risks associated with e-waste. Policies are currently being constructed to address issues around environmental protection. The examples below highlight the risks around environmental damage, and efforts to mitigate the potential harms.

Manufacturers, dealers, assemblers, distributors and importers of electronic equipment in the country have been encouraged to establish standards and procedures which include collection centers and storage facilities, for the voluntary take back of their equipment. Producers of electrical and electronic equipment are encouraged to maximize the reuse potential of their goods through stricter standards for product design and consumer education about the environmental benefits of reuse and recycling.

There have been a variety of institutional arrangements to address environmental issues and mitigate such risks. Kenya is set to become the first East African nation to develop regulations on the management of e-waste, following a major conference held at the UN headquarters in Nairobi (*Daily Nation*, 2010). The National Environment Management Authority (NEMA) has been tasked with undertaking a comprehensive national assessment of e-waste in the country within a year to determine the extent of the problem, develop legal framework by March 31, 2011. The meeting was attended by delegates drawn from the Environment Ministry, NEMA, and UNEP, among others. It had been convened to plot the way forward in dealing with e-waste management in line with the Basel Convention and other international frameworks.

E-waste management has also presented an entrepreneurial opportunity in the private sector through the recycling and refurbishing of discarded electronic goods and the harvesting of the precious metals they contain. There is a growing market for refurbished and used mobile phones, which, if done so in sustainably, could address e-waste problems from disposed mobile phones.

Examples of collaborations between NGOs and public institutions can be demonstrated by Camara and Computers for School Kenya (CFSK). Camara Education, a non-profit organization, announced plans to open an electronic waste recycling plant in Mombasa by the end of this year with Hewlett-Packard (Juma, V., 2010). The plant is expected to handle 500 tons of e-waste in a year. The leadership team is also visiting companies in the U.S. to learn how they handle the recycling of motherboards and monitors in order to replicate the processes in the Embakasi plant. CFSK is developing sustainable models for e-waste management (Wanjiku, 2008). CFSK has been promoting local innovation by recycling CRT computer monitors and converting them to affordable TV sets. The organization has signed a memorandum of cooperation with the NEMA to develop sustainable models for the management of

electronic waste, in parallel with NEMA's efforts to develop laws to govern e-waste management in Kenya.

These risks do represent and convey the importance of public, private, and NGO institutional arrangements and policies in minimizing the harm of rapid growth of mobile telephony. This has been an exciting period of experimentation with institutional arrangements and their evolution to address these risks. A consistent theme in Kenya, for example, has been to draw upon international frameworks, best practices and lessons learned from other national policies through global collaboration. In a way, Kenya is experiencing a *policy* transfer in conjunction with the technology transfer of mobile telephony.

Indicators: Climate change, Ecosystem disruption

Agricultural sustainability is also a major concern for Kenya. Recent food shortages in developing countries have highlighted the urgent need to develop sustainable solutions to ensure food security. An estimated 3.8 million Kenyans are highly or extremely food-insecure (USAID, 2009). According to the latest Global Hunger Index (GHI), more Kenyans are in need of emergency food aid today than 20 years ago, and Kenya has moved from a "serious" to "alarming" ranking on the GHI (von Grebmer *et al*, 2009). Most Kenyans facing food shortages are based in rural areas and in slums (Gachiri, 2009)³⁰. Additionally, of Kenya's 576,000 square kilometers of land mass, only about 16 percent has medium or high agricultural potential (Kinyua, 2004). Typical causes of Kenya's food insecurity are low agricultural productivity (often attributed to low/sporadic rains), inadequate access to capital and land, inadequate infrastructure and high population pressure, along with the current global economic crisis (Ngumbi *et al*, 2008).

Food security is often defined "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life" (UN FAO, 2003). This definition is particularly useful, given its implicit emphasis on access and consumption and production of food.

In the M-PESA study, participants said they were seeing a noticeable increase in agricultural productivity in their communities and often had experienced this increase themselves. Unlike money circulation, transaction ease and security of money, the link between agricultural productivity and food security is not straightforward. But it is highly likely that those three top effects produce an environment that can facilitate improved food security.

By increasing volume and velocity of money in communities, M-PESA appeared to increase the likelihood of a farmer being able to pay for casual labor at the time it is most needed and plant more of their fields. FGD participants repeatedly mentioned the ability to get money fast to use for farm-related expenses. Many also expressed that M-PESA had increased money circulation in the village (Plyler, 2010).

5.3. Tanzania

5.3.1. Economy

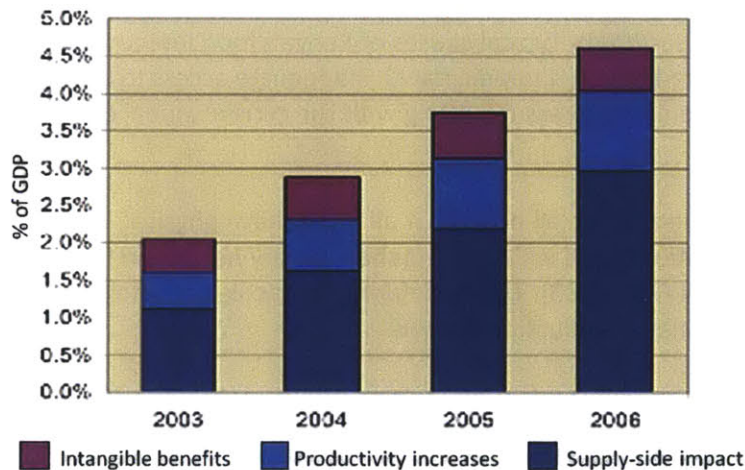
Indicator: Improvements in competitiveness, productiveness, and the use of capital

³⁰ The Global Hunger Index is based on a 100-point scale. The closer to zero, the more food secure a country is seen to be.

Tanzania now has a fully competitive telecommunication sector with six operational mobile networks. The four major dominating companies are Vodacom, Zain, Tigo and Zantel. BOL Mobile and TTCL Mobile are both still below the 200,000 subscriber mark. There are another seven additional players licensed under the converged regulatory regime but have yet to go live (TCRA, 2009). The main ICT regulatory body in Tanzania is the TCRA and an independent authority to license and regulate the postal, broadcasting and electronic communications industries. It merged the former Tanzania Communications Commission and the Tanzania Broadcasting Commission³¹.

Indicator: Economic changes from labor replacement and capital relocation

The mobile telephony industry accounted for 4.6% of the total Tanzanian GDP at the end of 2006 (Mura *et al*, 2008). With a specific tax of 7%, reducing taxes allowed more Tanzanians to connect and use mobile services and thereby raise the GDP. The mobile industry also saw increases in employment numbers (direct and support industries) and increases in productivity due to reductions in travel costs, improvements in information flows (circulation of information on price, quality, quantities), and improvements in the efficiency of mobile workers. Figure 5.7 shows the economic impact of the mobile industry as a percentage of GDP in Tanzania between 2003 and 2006 (TCRA, 2007).



Source: Deloitte analysis.

Figure 5.7: Economic impact of mobile communications industry as a percentage of GDP.

Small- and medium-sized enterprises (SMEs) play a key role in the economic growth of any country and this especially seen in Tanzania. The application of modern ICTs can improve the performance of SME by reducing communication costs. Mobile phones have become the mainstream delivery mode due to the widespread reach to a majority of the African population. Mobile telephony technology is considered to have transformative effect on SMEs, with an opportunity to grow through the simplified business information exchange.

Since in early 1990s, there has been a tremendous increase in ICTs usage and especially mobile phones usage by individuals and in businesses in Tanzania. The rapid technological advancement that the world has witnessed in the recent years especially in the electronic industry has also changed the means of production around the world. This can be evidenced in the telecommunications sector where, since the introduction and evolution of the mobile phones, the ways and means of business information transfer

³¹ TCRA website: <http://www.tcra.go.tz>

have changed leading to more efficiency and productivity in both service and manufacturing sectors (ITU, 2006).

For SMEs to adopt e-business and e-commerce strategies and tools, benefits must outweigh investment and maintenance costs of the ICTs both in terms of knowledge and infrastructure. Business environment, commercial considerations and potential returns drive the ICTs adoption by the SMEs. Primarily, the mobile phone technology and especially SMS are catching up quickly in Africa and the potential of the technology has been shown by many SMEs.

Morogoro is one of the administrative regions in mainland Tanzania. Morogoro lies at the base of the Uluguru Mountains, and is an agricultural center in the region, with the Sokoine University of Agriculture based in the city. Many NGOs and missions are also based there, which provide schools and hospital services. The city is believed to be the commercial and transportation center of the region, specializing in sugar, coffee, livestock, and tobacco.

Key economic impacts of the spread and use of mobile phones in business operations in SMEs is indirect, but can be realized through the transformed way in which individuals, businesses and the society in general operate, interact and communicate. For example, simpler ways of placing orders through mobile phones has been a reason behind the success of SMEs, where investment capital is still very low.

The mobile phone can act as the “gatherer” and “disseminator” of information for micro-entrepreneurs. Data shows that most SMEs in the region are using the mobile phones for communicating with suppliers, and the nature of use depended much on the economic capability of the individual SME (Donaghue, 2004).

During the study by Melchioly and Saebo, it was found that mobile phones were used in small businesses to obtain better prices for products. Mobile phones were utilized in improving coordination of transportation of the goods from the suppliers and in finding new markets for their products. For example, the SMEs in the wood carving sector found markets in the capital city Dar es Salaam through the use of mobile phones and could send the products to Bagamoyo, where there were more tourists. Respondents from the SMEs that were explored in three different categories, metal fabrication, carpentry, wood carvings, showed that many of the SMEs reported reduced operations costs as a result of using mobile phones in business communications.

As the findings indicated, the use of mobile phones helped SMEs to obtain better prices of their products. Moreover, timely delivery of information on current market prices was critical for high value, perishable agricultural products such as fresh fish, fruit and flowers. As for the case of SMEs in Morogoro, the sales revenue of most SMEs increased as the result of mobile phones usage. This indicated one of many positive impacts from the use of mobile phones by SMEs in business transactions.

Based on this study’s findings, improvements in the information flows through the use of mobile phones between buyers and sellers in Tanzania allow for the efficient trading of information without the travelling. This is particularly significant and extremely crucial in rural areas where business men and women would have needed to travel to urban areas to check for demand and negotiate on price, all these business issues are now conducted on the mobile phone. Moreover, in certain circumstances, mobile phones can allow the “middle man” to be cut out (Jenson, 2001).

Economic activities in the research area depend heavily upon agriculture and the extraction and processing of natural resources for development. Therefore, distance from markets where the goods are sold has traditionally been an obstacle for entrepreneurs to access business information. Poor transportation links between urban and rural areas prevent SMEs operators from accessing information that is becoming increasingly important in the production and marketing of products. The utilization of mobile phones offer promising opportunities for producers and retail sellers to track price information, both in rural as well as urban areas (Melchioly and Saebo, 2010).

Mobile phones provide an excellent opportunity for these companies to grow their markets, namely providing access for other suppliers and consumers. As an example, Vodafone interviewed taxi drivers who said that with mobile phones they were now able to communicate among them to inform their colleagues about which villages have longer queues in taxi stands. Secondly, mobile phones allow SMEs to improve their efficiency dramatically. The increased information on prices allows significant cost savings, avoiding unnecessary traveling to markets where prices are too low. As an example, BBC interviewed Tanzanian fishermen who said that mobile phones are helping them to determine in which ports they should sell their fresh fish.

In larger companies, the impact is less significant. Although mobiles still have some impact in efficiency and market growth, it will not be as significant as for SMEs since larger firms already have fixed lines and reasonable communication systems. Furthermore, direct impacts will not be very significant since networks should be built with foreign firms (i.e. Ericson, Nokia), the exception being the consumption of electricity (significant in telecom operators). Finally, knowledge spillovers may not very probable, since the FDI attracted is mostly market oriented and there isn't a proactive stance from a champion (like MTN in Nigeria), which leads to clear education benefits for local suppliers and service partners (Chee, 2006).

A study looked into the effects of mobile phones on traders of perishable foodstuffs operating between Tanzania's Southern Highlands and Dar es Salaam's wholesale market, with a particular focus on the importance of credit in the relationship between potato and tomato farmers and their wholesale buyers. Poor farmers often lack credit to purchase agricultural inputs, and rely on their buyers to provide it. Mobile phones are being integrated into Tanzania's existing agricultural trading business culture chiefly because of the crucial role they play in improving the exchange of supply and demand information between farmer and the wholesale market. This market information can be useful in freeing a farmer from sending his produce to the market without any information by allowing him to know whether to divert his crops elsewhere for minimum profit more locally instead of maximum loss farther away. While mobile phones can help forge new relationships within the market, they play little part in strengthening current relationships – in the way that the example of the popular and successful Kamwene Sanga³² shows face-to-face communication can. The overriding drawback with distance communication, however, is that farmers using mobile phones to contact their dalali³³ are largely asking for supply and demand information, and this relies on the dalali being truthful in the reply he gives. The reality for many farmers dealing with dalali's is that the mobile phone does not alter this trust relationship.

However, the reliance many farmers have on their dalali as a source of credit means that in return for credit, they have little choice but to supply their crops to him and accept that they may be cheated on

³² A trader based at Dar es Salaam's Kariakoo municipal market

³³ An auctioneer

the price they are told their crops are sold for. ICT can be used to circumvent this situation through mobile phone-based services that provide information on prices and buyers in other markets, but this runs the risk of a farmer's ties with his dalali – their traditional source of capital – being weakened. ICT may also help solve the credit dilemma if the dalali, who generally have a much better record of getting credit to the rural poor than formal credit systems, are targeted as key agents in future m-payment applications aimed at agricultural traders. It is imperative to note that uses of new ICTs emerge from a socially embedded context that fundamentally influences and alters the uptake and usage of ICT. Without a strong empirical field reflection that details the social aspects of socio-economics, initiatives of private and donor organizations remain misdirected.

This study argues that the ability to communicate using mobile phones does not significantly alter the trust relationship between the two groups. It also suggests that farmers, in effect, often have to accept the price they are told their crops are sold for – irrespective of the method of communication used to convey this message – because their buyers are also their creditors. In this situation, many farmers are unable to exploit new mobile phone-based services to seek information on market prices, and potential buyers in other markets. Doing so runs the risk of breaking a long-term relationship with a buyer who is willing to supply credit because of their established business interaction. It is suggested that, under a more open system than currently exists in Tanzania, m-payment applications should target these creditor-buyers as key agents in connecting farmers to the credit they so often require (Molony, 2008).

Indicator: Financing growth and development

Tanzania's telecommunications industry appears to have resumed growth, following more than two quarters of declining growth. This growth has largely been attributed to operators like Vodacom, Zain and Tigo. Intense competition among the operators has also led to an expansion of this sector, resulting in both Vodacom and Zain also reporting their strongest quarterly net additions in late 2009. In addition, reductions in tariff have led to large scale adoption of mobile phones and equipment. Currently, the number of mobile phone users in Tanzania is close to 20 million, with a penetration rate of more than 40%. This rate is expected to reach 77% by 2014 (www.economywatch.com).

New methods of production and trade require improved technology and infrastructure which exert new demands which may stimulate new changes in finance. Additionally, changes in the institutional structure may call for changes in the financial operations to match it. For instance, changes from public sector-led development to private sector-led development in a market economy would imply fundamental changes in the operations of financial intermediaries (Wangwe *et al*, 2004).

5.3.2. Employment

Indicator: Skills

ICT communities such as those found in Kenya are also found in Tanzania. The eThinkTank is a voluntary association of individuals who have an interest in the development of ICT in Tanzania. Their objective is to catalyze ICT development to enable socio-economic progress by exploiting the opportunities of globalization of knowledge sharing (Hellström, 2010). Another similar center is e-Fulusi in Dar es Salaam³⁴. Centers such as these are effective in building the skills of their citizens.

Indicator: Health and safety

³⁴ E-Fulusi Africa website: <http://www.efulusi.co.tz>

A study conducted by Vodafone suggests that the main benefits of mobile phones for the population of Tanzania were easier contact with families and improved relationships, shown in Table 5.5. Mobile phones were also reported to be very useful in the case of emergencies and for job search.

Impact (% of interviews mentioning the following)	%
Improved relationship	85.3
Call rather than travel to family and friends	91.1
Easier communication with family and friends	84.6
Useful in emergencies	27.1
Assists in job search	27

Source: Vodafone study from EMDC paper.

Table 5.4: Impact of mobile phones in Tanzania.

Indicator: Job satisfaction

The growth in mobile operators and the competitive landscape in this sector have led to companies competing for talent and for creating a healthy work environment. For example, Zain claims to be committed to attracting the best people in the industry, increasing their levels of job satisfaction and encouraging them to grow and develop. They claim to build a workplace culture that respects the vital role their employees play in society and utilizes the talents that individuals bring to the organization (www.zain.com).

Indicator: Number of jobs, Wages

The Vodafone study mentioned above revealed that in terms of direct employment, the impact is still limited. This is because from the few jobs that mobile operators will create, many of them will certainly be held by expatriates, and doing business out of renting mobiles is still not a widespread practice in Tanzania. The fact that most of the value-added services are not made in Tanzania but in foreign headquarters, and that there isn't any proprietary technology to be protected also suggests that there aren't significant wage increases (Chee, 2006).

But in the case with mobile innovations in agriculture and fishery in Tanzania, the benefits of mobile phone access for agriculture can potentially be in aiding a farmers' and buyer's knowledge of demand and improvements in the coordination of supply, thereby maximizing their return and payment. Mobile phones also allow for more reliable and faster means of sending information (where previously a messenger or postal service was used), and greater ability to keep track of consignments in transit and on arrival at the market. Together, mobile phones mean that less time and money is spent on travel, if not just by reducing travel-related risks (Jagun *et al*, 2007), then, apparently, by even providing a substitute for unreliable alternatives such as transport (Souter, 2005; Molony, 2008).

5.3.3. Environment

Indicators: Resources, Toxic pollution, Ecosystem disruption

With the increase of mobile coverage, there has also been an increase in the development of communication networks with masts placed amid settlements, on top of buildings, in conservation areas and at apparently any location deemed to be technically suitable to offer the desired communication coverage for a specific operator system. Such activities have not gone without permits (Mchallo, 2009).

Environmental concerns associated with cellular masts include, among other things, the following:

- Noise and gaseous emissions from the electricity generators
- Opening access to areas of conservation importance
- Effects on the aesthetic aspects of an area, i.e. disruption of scenic view of the locality due to mast protrusion, colors, configuration and lighting
- Potential for emission of harmful rays; this depends on the technology employed for the communication facilities installed on towers
- Potential for interference with other systems like television and radio reception
- Haphazard location and multiplication of such structures within the same locality or area, that arouses fears and concerns on the multiplicity of associated potential direct and cumulative negative impacts
- Land acquisition for and community acceptance of such structures are issues that require careful attention in the planning of these developments, so as to avoid conflicts with key stakeholders

As it turns out, the requirement for Environmental Impact Assessment (EIA) certificates which became legally binding in July 2005, when the Environmental Management Act (EMA) Cap 191 became operational, has not been complied with adequately. Thus, environmental aspects and stakeholders concerns which should be considered in deciding the locations of masts have been ignored or not satisfactorily addressed. That has led to public outcries expressing fears and disapproval of the manner in which such developments were being executed. NEMC is the entity that would intervene for those who feel they were not comfortable living with the masts.

Until recently, the TCRA has been responsible for granting licenses for installation and operating telecommunication systems. Other clearances include land and business permits from local government authorities. However, the environmental dimension became a basic necessity after putting in place the EMA and subsequent EIA and Audit Regulations. According to the EIA and Audit Regulations, installation and expansion of communication towers fall under the category of projects for which EIA is mandatory.

In the absence of a strategic environmental assessment identifying appropriate locations for communication masts in the country and specifying cases where EIA (including social impact assessment) may or may not be required, each mast should in principle be considered as an independent project, of which a separate environmental assessment would need to be conducted. Some masts will need full EIAs and for some, depending on location, only preliminary environmental assessments (PEA) may be required. A group of masts may be assessed as a single project depending on how they are geographically located. For all ongoing projects, the law and its subsequent regulations state that they should be subjected to Environmental Audits.

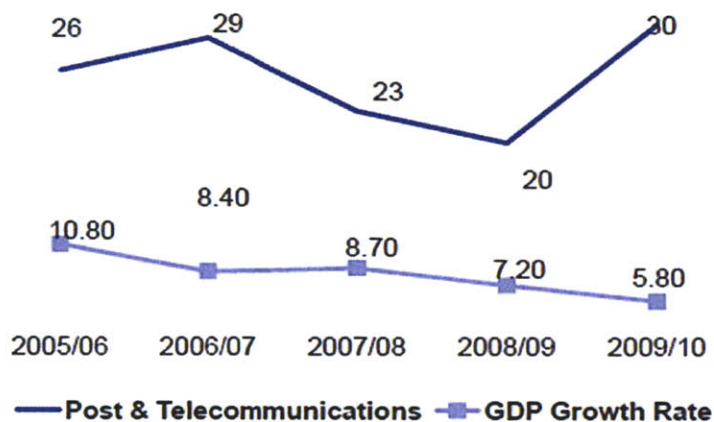
Considering the fact that all types of technologies are used in the telecommunications sector, potential for use of obsolete technology exist whereby limits for dangerous rays emissions may not be observed. Thus, the Tanzania Atomic Energy Commission (TAEC) needs to be involved to provide guidance on how safeguards against such risks can be ensured (Mchallo, 2009).

5.4. Uganda

5.4.1. Economy

In a reversal of declining growth rates in the middle of the decade, the postal and telecommunications sectors posted a 30% growth rate in 2009-2010, up from the 19.8% growth in 2008-2009. More important to note is that this growth occurred amidst declining GDP growth rates in the aftermath of

the global economic crisis (Figure 5.8). The growth rate is attributed to increased investment in the telecommunications sector and the diversification of products (data and value-added services) in the market (UCC, 2010).



Source: UCC, 2010.

Figure 5.8: GDP and communications sector % growth rates.

Indicator: Improvements in competitiveness, productiveness, and the use of capital

The telecommunication sector was transformed in Uganda when the market opened up and led to the entrance of several operators (Hellström, 2010). The Ministry of ICT provides overall coordination, support and advocacy regarding of policy, laws, regulations and strategy for the ICT sector in Uganda. The Ministry has divided the sector into three levels: policy, regulatory and operational, each with their defined functions and institutions³⁵.

The reduction of call costs and SIM cards is the result of strong competition and profitable growth in the mobile phone industry, particularly, in Uganda’s case, of three mobile phone operators. With such competition, telecom firms are addressing the market needs of their clients through product differentiation. Many of the new and improved services are attempts to meet the growing needs of the majority: the low-income customer. Mobile phone airtime services include the prepaid pay-as-you-go model which allows the user to control the amount of purchased airtime. Calls received on a handset in Uganda are free. Smaller denominations of pre-paid airtime cards have made airtime purchases easier for low-income clients who may only hold small amounts of cash at any one time. Public phone operators also advertise their rates per minute on their kiosks or shops, which allows customers to shop around for the lowest price. The three mobile phone operators attempt to have relatively competitive rates according to certain peak or non-peak hours allowing customers to choose a rate which best meet his or her usage needs. The engagement of strong competition in Uganda within mobile phone services benefit Ugandan citizens in terms of greater choice, lower costs and increased economic activity as well as new business prospects for small and medium-sized businesses (Diga, 2007).

The UCC is the independent regulatory authority for the communications industry in Uganda and the institution that will see the above universal service objectives are provided in the country. Developed under the Uganda Communication Act of 1997, the UCC’s role is to license and regulate telecommunications, radio-communication and postal/courier services in Uganda (UCC, 1997). The

³⁵ Uganda Communications Commission (UCC) website: <http://www.ucc.co.ug>

telecommunication firms must abide by the Ministry of Works, Housing and Communications' (MoWHC) National Information and Communication Technology Policy Framework regulated by UCC, and ideally, UCC would allow citizens to report or comment on service delivery by telecommunications firms (MoWHC, 2003). Regulation and law facilitate availability and affordability of mobile phone services to its citizens and several policies and regulations have been employed in Uganda to address such terms. Under the constitution, freedom of expression (Article 29) and right of access to information (Article 41) are principles derived from the United Nations Declaration of Human Rights and lay the basis of universal access of telecommunications in Uganda (MoWHC, 2003). It is also recognized that several regions in Uganda may not receive basic coverage because of the high costs and commercial impracticality of reaching isolated areas. The UCC recognizes the gaps of access and market efficiency (UCC, 2005a). In Uganda's current state, there is still a major gap of commercially viable consumers who wish to access and own a mobile phone, but have not been reached either due to marketing or long distance from shops. However, there is also the access gap for those who will not be able to afford service. The cost of connectivity for the firm is also commercially unviable. Such people and rural areas would require intervention by government to improve services for the disadvantaged. Uganda has attempted to address this gap through improved rural outreach of communication through development of their Universal Access Policy.

Ugandan regulation defines universal service as "a defined minimum set of services of specified quality which is available to all users independent of their geographical location, and in the light of specific national conditions, at an affordable price" (UCC, 2005b). In Uganda, universal access falls under the Ministry of ICT with the objectives to (UCC, 2005b).

- "ensure the availability to all persons in Uganda of good quality communication services"
- "define a set of communication services to which all users, including customers should have access at an affordable price in the context of universal service taking into account the prevailing economic and technological conditions"
- "ensure universal provision of and access to quality and affordable basic communication services"
- "promote widespread access to quality services at affordable rates and ensure that rural and high cost areas have access to communication and information services at prices reasonably comparable with those offered in urban areas"
- "secure the delivery of affordable and quality basic communication services to all persons in Uganda" and "expand and maintain the accessibility of affordable and quality communications services to all persons in Uganda"
- "provide and maintain service to those who would not normally be served including, but not limited to, people in high cost service areas in rural and remote regions or lower income groups."

Uganda's commitment to expanding telecommunications into rural areas has been progressing since initiating the 1997 Act. Uganda remains one of the few African countries to have implemented an active universal services policy, the Rural Communications Policy (RCP) by 2001. This policy recognized the weakness of rural area telecommunications coverage and set out the objective to "increase the penetration and level of telecommunication services in the country through private sector investment rather than government intervention" (UCC, 2001). One of the basic services initiatives included that, one public pay phone be available within every 5,000 persons or at least every sub-county operates two payphones (UCC, 2001). The monitoring of indicators has also been included in the policy to measure the progress of the policy. Under the RCP and the original Uganda Communication Act, a Rural

Communications Development Fund (RCDF) was developed in 2003 whereby all three mobile operators were subject to a one percent obligatory levy to the RCDF. The UCC, in consultation with the operators, has identified the rural areas where the operators do not plan to service, and the RCDF hopes to provide subsidies towards tendered contracts to roll out connectivity in these areas to meet the telecommunication needs for those underserved communities. This fund is meant to install new pay phones in all of the country's identified 156 (out of 920) sub-counties, to assist small rural internet cafes in starting up and training, to create local content for the internet and to give subsidies to rural tele-kiosks. In 2002, businesses providing public pay communication in their internet cafés, tele-centers or payphones were no longer required to pay license fees (Masambu, 2007). This RCP initiative is supported by a USD \$5 million financial seed funding assistance from the World Bank under the Energy for Rural Transformation Project (Tusubira, 2004). The National Information and Communication Technology Policy of 2003 developed as a result of one of the main objectives from the RCP. This policy delivers the framework and action points for universal access to telecommunication. Uganda has been most progressive in their universal access policy framework. Uganda is forging to deliver services to all members of their population through their progressive telecommunication policy framework (Diga, 2007).

Indicator: Economic changes from labor replacement and capital relocation

Mobile phones are used as an enabling tool for countries and individuals to develop their economic potential. Previous work on mobile phones and economic development can be divided into two distinct areas: the macro-level and micro-level studies. Under the macro-level studies, researchers have attempted to evaluate whether mobile phone penetration was improving economic development through rise in GDP or through increases in FDI (Waverman, 2005; Williams, 2005).

As for micro-level economic development, a few case studies explored the micro-level effects of the mobile phone on productivity (particularly with SMEs) and income in developing countries. The Grameen Village Phone in Bangladesh and Kerala, India fisherman studies found that the improvement of information transfer transform into increased profits for fishermen (Bayes *et al*, 1999; Jenson, 2007). Other studies report greater personal use of the mobile phone than for business or production use (Donner, 2006). Such a mix of business and personal use would make it difficult to determine the true SME productive impact of mobile phones. Several economic development studies, at both the micro and macro level, have attempted to explain the impact of mobile phones.

Indicator: Financing growth and development

The introduction of mobile telephony has revolutionized Uganda's telecommunications industry since Zain launched the first network in 1995, followed by MTN in 1998, Uganda Telecom in 2001, Warid Telecom in 2008 and HiTS Telecom, in which France Telecom's mobile unit Orange has bought a majority stake, in March 2009. The intensified competition means that hundreds of millions of USD are being invested into new infrastructure, but it has also led to an unsustainable price war. However, at a market penetration of only around 30% there is ample room for further growth. In an environment of rapidly falling ARPU, the operators are trying to find ways of generating additional revenue streams. Mobile data and third-generation broadband services as well as m-payment and m-banking services are at the forefront of this development, in a country where less than 10% of the population currently have Internet access or hold bank accounts. In view of the uncertainty as to what extent Uganda will be affected by the global economic crisis, this report contains two scenario forecasts for the country's mobile market to 2010 and 2015 (Lange, 2010).

An example of the joint ownership of mobile operators is the case of Uganda Telecom. As of January 2010, Uganda Telecom became a joint venture between a communications consortium called Ucom, which owns 69% of UTL, and the Ugandan Government, which owns the remaining 31%. Ucom is a consortium consisting of LAP Greencom of Libya and Telecel International of Switzerland.

5.4.2. Employment

Indicators: Skills, Health and safety

The I-Network in Uganda is a national network of individuals and organizations that acts as a platform to build their skills and to share knowledge and information on applying ICT for equitable national development. They have over 800 registered members from the public, private and civil society sectors. Mobile Mondays also help create platforms where various stakeholders can meet and connect to share knowledge.

In the Text to Change (TTC) initiative, HIV/AIDS awareness was provided via an SMS-based quiz to 15,000 mobile phone subscribers during three months in Uganda. TTC was founded with the goal of improving health education through the use of text messaging, which holds the advantages of anonymity and strong uptake among the population. Partnering with the mobile carrier Celtel and the local NGO AIDS Information Centre (AIC), TTC conducted a pilot program from February through April 2008 in the Mbarara region of Uganda, with the objective of increasing public knowledge of and changing behavior around AIDS. The program aimed to encourage citizens to seek voluntary testing and counseling for HIV/AIDS.

An SMS-based multiple-choice quiz was administered to 15,000 Celtel mobile phone subscribers in Mbarara. Free airtime was offered to users to encourage participation in the program; this was determined to be a powerful incentive since users can exchange the airtime with other subscribers as a type of currency. The quiz produced a 40% increase in patients who came in for testing – from 1,000 to 1,400 during a six-week period.

In terms of information gathering, a key finding of the survey was that although people were quite knowledgeable about issues such as condom use, they did not think that AIDS testing was accurate or anonymous. This was a major finding; prior to this, the population of Uganda had not been surveyed on this question before. TTC was able to pass this along to larger health agencies operating in the region, thereby contributing to the efficacy of existing health programs.

One of the goals of this next campaign is to promote the safety and effectiveness of the testing center, and therefore specifically encourage testing. Collaboration with local partners will be further strengthened, with the local HIV/AIDS organizations submitting questions. TTC intends to shorten the duration of the program to four weeks, hoping to minimize participant drop-out rates, and to include non-English speaking subscribers by enabling them to read SMS messages in their local languages.

A pilot that TTC conducted saw the sponsoring partners benefit as well: Celtel reaps benefits not only from a corporate social responsibility (CSR) perspective but also through the promotion of its texting service. The testing center increased the number of tests held, allowing TTC to receive expanded funding.

Van Beijma, TTC founder, cites several critical success factors for scaling TTC and similar mHealth projects. These include (Celtel; AIDS Information Centre (AIC); Merck; Dutch Ministry of Foreign Affairs):

- Develop surveys in the numerous local languages. This would make their message more accessible to specific ethnic and social groups. Literacy is also an issue. However, van Beijma notes, “If people do not speak or read English and they get a text message they will ask their neighbor what it means.”
- Secure ongoing funding. Though TTC is more cost effective than many other education programs, steady funding will allow for stable operations and growth.
- Collaborate with other mHealth organizations. Van Beijma notes that one of the consensus findings of the 2008 MobileActive conference in South Africa is the need to set up a consortium to promote collaboration among mHealth organizations in different developing countries. “The goal is to work with organizations that are doing similar and complementary things in different countries. This way if we move into other countries we will combine strengths, for example, by developing software together.”

Some of the lessons learned in a post-evaluation were (AIC and TTC, 2009):

- The TTC program is feasible. Many people felt recognized after receiving invitation to take an HIV test on their phones
- There is still high unmet demand for HIV counseling and testing (HCT)
- The uses of SMS/text messages help reach many at a relatively lower cost within a shorter time
- The program helps to deliver messages without distortion and makes the fight against HIV/AIDS participatory and sustainable as text messages can be stored for a long time and referred to from time to time
- The program has a long term effect of increasing knowledge about HIV, addressing myths, misconceptions and taboos surrounding HIV/AIDS and stimulating demand for HIV/AIDS services
- The program needs to be complemented with other media approaches such as radio announcements, posters, testimonies and experiences from those who have accessed services to realize its full potential. The persistent reminders of people through the text messages compel them to test.

MTN Uganda’s telecommunication services have also given Ugandans greater access to local and global markets, and have enabled some to invest in capital items such as vehicles, land and houses, and to save on time and travel expenses. Especially noteworthy is the impact that this service has made in the lives of women, as learned in a study by Mutoigo and Sejjaka³⁶. Women tended to be most vulnerable to exploitation. They had two viable avenues for enhancing their status in society: education and professional training on the one hand, and economic prosperity on the other (Abena, 1991). The combination of computers with telecommunications opens both avenues for Ugandan women, enabling many to use savings on business investments to improve their household management.

Indicator: Job satisfaction

A study was conducted on the overall improvement in employment and well-being of AppLab in Uganda. For AppLab, it became quickly apparent that information alone was not a complete solution. For example, a reference pointer or a tip about maternal health techniques may be useful to an expectant mother, but creating deep, impactful behavior change – what information-driven development initiatives seek – requires a context in which that information has a value. People certainly had a hunger for knowledge and a willingness to embrace the mobile phone to search for answers, as shown by the questions participants asked from the beginning about family planning, HIV and other sexually

³⁶ This study was carried out between April 2001 and June 2003. It involved meetings with six MTN managers, and a 2002 survey of 475 MTN service users in the major towns of Uganda.

transmitted infections, which affect them directly and for which few reliable, anonymous sources are available. But the study required several things to make this information actionable and impactful: specific information, a context in which to make it useful, and relevant services and resources.

The study found that village-based intermediaries help increase the benefits of mobile phone-based applications. This was observed in their Village Phone work, as well as other involvements in microfinance and social enterprises serving the poor (grameenfoundation.org). Community Knowledge Workers (CKWs) are farming group leaders, nominated and elected by their peers because they meet a number of important criteria, who have been rigorously trained to harness the power of mobile technology to benefit the group. She or he encourages, cajoles and reminds the group to farm better and organizes them to get to market, enhancing the information already being shared among the group and then funneled back to the NGOs, government agencies and buyers they interact with. By closing the loop and covering the last mile of delivery, intermediaries like this can ensure that information is put to best use by those who can best benefit from it. As Kentaro Toyama points out, “the human intent and competence [that mobile technology] aims to generate must already be in place for the technology to work” (Toyama, 2010). In the case of CKWs, the competence and intent are already in place in functioning agriculture extension programs and liquid markets. The addition of the technology through a trusted intermediary adds efficiency. And as farmers increase crop yields and sell more at the market, their incomes rise.

Another thing learned during the study in Uganda was how carefully messages must be communicated. With more than 800 languages spoken in Africa, and varying degrees of literacy, linguistics remains a clear challenge for mobile service practitioners. For example, though Google SMS Tips was launched in Uganda, the local vernacular, it proved difficult to parse incoming queries and match keywords using the English-language logic behind the application. Adding in one more language – let alone the remaining 45 necessary to reach all Ugandans – would have proven exponentially complex because of the overlap of words and the fact that most of those languages were not designed to be written.

The challenge in communicating in a written form reveals the potential for using voice-based information to deliver the message more effectively. Few studies exist documenting the comprehension of information delivered en masse, which is understandable given that this approach is new, and that mobile provides a more scalable way to deliver information than anything that previously existed. While users can understand messages, changing behavior based on that understanding is another step. People hear the “don’t smoke” message over and over, but they still do (Cantor, 2011).

Indicators: Number of jobs, Wages

At the onset of its operations in 1998, MTN Uganda’s workforce consisted of approximately 80 direct employees, of whom 25 were expatriates. Over time, the labor force changed. The number of expatriates declined to nine, while its local staff increased to 310. MTN Uganda is one of the most sought after employers in the country for remuneration, given that the market is afflicted with high unemployment. In Uganda, the per capita income averages USD \$215 per year; MTN Uganda pays yearly salaries which range from USD \$5,000 for support staff to more than USD \$25,000 for managers. This pay structure, coupled with the growing local significance of the company, attracted some of the best talent in Uganda.

The impact of MTN Uganda on the labor market has been felt nationally. By July 2003, the company created over 310 new jobs for direct employees in an area full of unemployment. In addition, MTN

Uganda provided employment for contractors, as it outsources work on information technology, switching systems and fiber-optic cable installation in Kampala. Finally, over 6000 people are employed indirectly through its franchise system or as providers of ancillary services such as the sale of mobile phones and accessories, phone repairs, advertising and events promotions and many other less obvious businesses. MTN Uganda has opened more than 600 service outlets in the country. Of all FDI in Uganda, the mobile communications industry has become the most conspicuous.

However, this is not the entire picture. The company's reward system for expatriates is fundamentally different from that of locals, causing considerable tensions. There was a case where one local was hired at wages of about USD \$7,000 per month, plus the benefits expatriates typically receive. Across the board, however, expatriate staff received preferential treatment. The average expatriate earns about USD \$15,000 per month. Although the number of expatriate staff has been reduced, the total wage bill for these expatriates was not reduced proportionately. The 2002 wage bill for fourteen expatriates was almost the same as that of the two hundred and forty locals. MTN Uganda managers argue that this fact misrepresents the situation. According to MTN, the figure for expatriate wages included "management fees" which were paid to the parent company in South Africa. There appear to be at least two further explanations for this seemingly stark inequality: differences in skill and the "risk factor" associated with living in Uganda. The company argued that expatriates have skills that locals do not have, and that there is a shortage of management skills in Uganda, that the expatriates are employable in any international company in the world.

The expatriate problem is generic to most multinational corporations. Expatriates serve a particular function, which Bartlett and Goshal term "socialization" in their recent study of Unilever (Bartlett, 2001). Expatriate managers serve as the vanguard for international finance capital; they are custodians of the company's assets in a country that is perceived to have high economic and political risk. Their role is to provide confidence to shareholders with respect to their investments in developing areas. Yet while socialization may represent the way of doing things for multinationals, it is a double-edged sword. First of all, it reduces rather than increases shareholder value, due to the incredible cost of maintaining expatriate managers. The cost of maintaining an expatriate manager runs two to 10 times higher than maintaining a local manager in the same position (Bartlett, 2002). Not only are expatriates paid excessively high salaries and pensions, but they also have tuition provided for their children in international schools. Second, socialization creates distributive inequity and ensures that a large amount of host-country generated income, which would be more beneficial to local consumption, is appropriated in the form of expatriate wages. Third, it reinforces and confirms the stereotype of multinational corporations as exploitative and racist rather than developmental and egalitarian in their employment practices.

Overall, MTN Uganda's human-resource achievements, in terms of job creation and professional development of local staff, fostered a better connection. However, the company lost many opportunities to improve relationships with staff due to the disparities in its hiring practices. Its in-house hiring is definitely tainted by a less than fair reward system. The gap in compensation packages between the local and expatriate employees accentuates racial tensions. If these wage disparities are creatively addressed and more genuine participation of local staff is encouraged, MTN Uganda will more effectively live up to its promise to be a better connection – a caring organizational community. Considering the context of an increasing competition from Uganda Telecom Limited (UTL) in the telecommunication industry, MTN could ensure its corporate sustainability better by addressing these issues in more creative ways (Mutoigo and Sejjaaka, 2004).

5.4.3. Environment

Indicators: Resources, Toxic pollution, Ecosystem disruption

The mobile networks to cover the 8.5 million mobile subscribers in Uganda currently use predominantly GSM technology operating in the 900MHz, 1800 and 1900 MHz frequency bands. In order for a mobile subscriber to access voice telephony services, a network or infrastructure must be put in place to enable this access. A typical GSM network consists of a base station transceiver (receives and transmits electromagnetic signals) with which a mobile station (that is the mobile phone/handset) communicates within a specific radius or area.

A base station transceiver comprises three main elements: the antennas, a supporting structure such as the mast or building to hold the antenna, and the equipment to power the radio equipment. The antennas emit electromagnetic fields (EMF) or radio frequency fields (RF), which is a form of energy technically referred to as non-ionizing radiation (NIR). NIR refers to the fact that this radiation does not carry enough energy to ionize atoms or molecules as compared to ionizing radiation.

Masts are free standing steel structures that are used to support antennas located at base stations usually for the purposes of providing geographical coverage. Antennas may also be placed on other structures such as buildings and other existing structures.

The number of subscribers that can be served by a base station depends on a number of factors such as the number of calls made within a particular time frame, the topology of an area, and mobility of the subscribers. Base stations are, therefore, strategically located to enable people to not only make calls within a certain radius, but also to allow for seamless communication while on the move. This is one reason why base stations are increasingly being located in residential areas, business centers, schools, and hospitals, among others.

While there is a lot of public concern as to the effects of EMF emitted from these base stations on people's health and the environment, much of it is due to limited awareness. In attempt to address these concerns, the UCC has offered answers to the following frequently asked questions on mobile phone base stations and EMF radiation. The health risks from telecommunications masts may include accidental risks (i.e. falling off the mast) and risks related to exposure to EMF radiation.

According to World Health Organization, extensive research has been conducted into possible health effects within the entire frequency range or spectrum. All reviews conducted so far have indicated that exposures below the limits recommended in the International Commission of Non-Ionizing Radiation Protection (ICNIRP), 1998 guidelines, covering the full frequency range from 0-300GHz do not produce any known adverse health effects. In Uganda, technologies such as GSM, Code Division Multiple Access (CDMA) and Universal Mobile Telecommunications System (UMTS) fall within this frequency range.

Since research regarding health effects from EMF radiation of mobile phones and their base station antennas is still ongoing, precautionary measures are necessary. These include simple administrative controls such as limitation of access and other protection measures like warnings or barriers around areas of strong EMF sources.

The National Environment Management Authority (NEMA) is the principal agency in charge of all environmental issues in Uganda. Specific to mobile phone base stations, NEMA is in charge of assessing impact of mobile phone base stations on the environment. These impacts include effects on human health.

As the regulator of the communications sector in Uganda, UCC issues licenses for the installation and provision of telecommunications infrastructure and services. The licenses require the operator to conform to specific technical standards and requirements as well as relevant laws of Uganda. These requirements include compliance with the National Environment Act and Regulations. Furthermore, upon request by NEMA, UCC reviews and gives technical advice on the environment impact and audit reports of base stations with focus on how the developer has assessed the environmental impact of the telecommunications equipment (i.e. equipment associated with transmission reception, switching and distribution of telecommunications signals at the proposed sites). NEMA then considers these comments for any further action.

The safety measures in place to protect the public from EMF radiation include: 1) Administrative control measures such as restriction to entry to the base stations (e.g. fencing, locking up, posting security guards) and placing appropriate signage and 2) Site placing and location aspects - the positioning and/or location of antennas at places way above head level while standing (typically considered 1.5m above ground level) and ground level (i.e. on masts and roof tops) to limit human EMF exposure (UCC FAQ, www.ucc.co.ug).

5.5. Nigeria

5.5.1. Economy

Indicator: Improvements in competitiveness, productiveness, and the use of capital

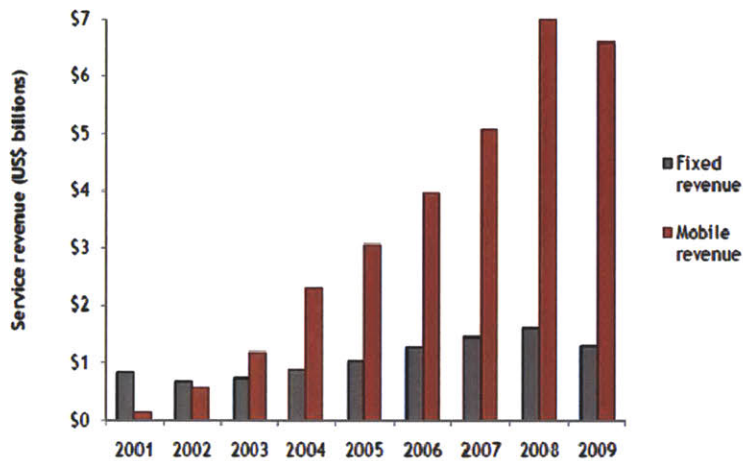
Nigeria's mobile network has grown significantly since three companies began operating in 2001, outlined in Section 4.4.2.4. The new operators reduced their start-up prices. In 2002, the government licensed a second network operator (www.mbendi.com). Competition among various telecom operators increased as they sought new business expansion and customer retention strategies to capture more of the market. Operators aggressively pushed the deployment of network infrastructure, driving the investments in the country's telecom sector that is projected to grow at a CAGR of around 11% between 2009 and 2013 (www.mbendi.com).

Indicator: Economic changes from labor replacement and capital relocation

The main economic benefits of mobile services in Nigeria include:

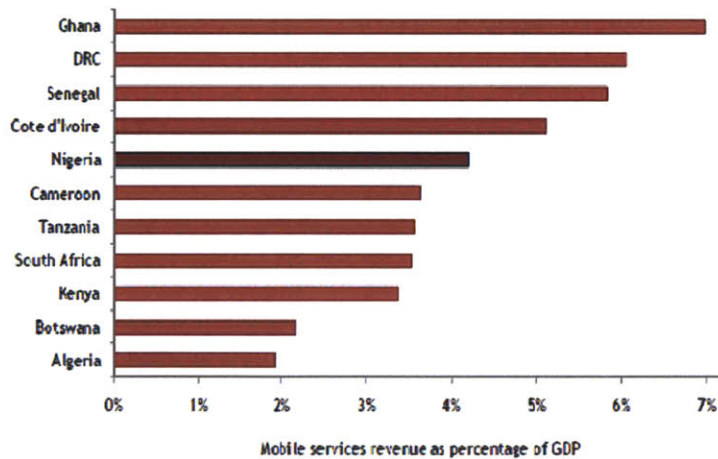
- End-users spend money on mobile telecom services.
- Telecom operators spending on marketing, distribution, maintenance, training, support and network enhancements have significant effects.
- Mobile operators create employment, both direct and indirectly, and invest in the development of the labor force.
- Mobile services have a wider economic impact, since they enable a different way of conducting business, reducing the time and cost of transactions, improving access to markets, commoditizing information and generally allowing businesses to operate more efficiently.

Across Nigeria, due to the limited fixed-line and Internet penetration, fixed telecom service revenue tends to be exceeded by its mobile counterpart. Mobile service revenue accounts for the lion's share of total telecommunications revenue in any given African market, shown in Figure 5.9. It is estimated that mobile services revenue in a set of eight African countries, including Nigeria, on average accounted for 76% of total telecommunications revenue in 2009.



Source: Pyramid Research Mobile Demand and Fixed Communications Forecasts, 2010.
Figure 5.9: Fixed and mobile service revenues in Nigeria.

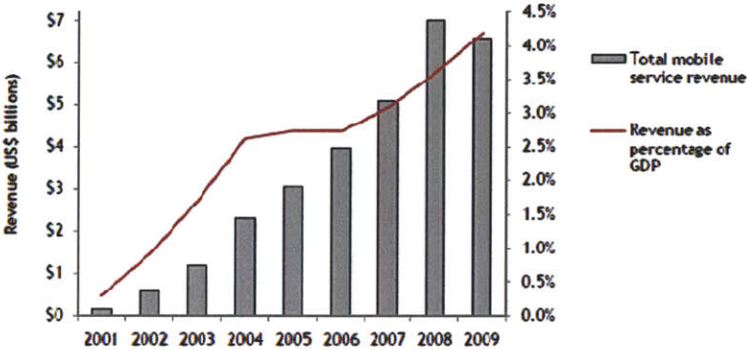
Mobile services, in particular, contribute a significant amount to the economies of countries where they operate. In an extensive analysis by Pyramid Research, it was estimated that mobile service revenue alone contributed an average of 4.2% to the gross domestic product in 10 African markets in 2009 (Figure 5.10).



Sources: Pyramid Research Mobile Data Forecast, 2010; EIU, 2010.
Figure 5.10: Mobile service revenue as a percentage of GDP in select African markets, 2009.

For the sizable Nigerian economy, the telecom services market has become a key pillar of growth. Pyramid estimated that total service revenue generated by mobile operators in Nigeria has increased significantly, from USD \$135 million in 2001 to roughly USD \$7.0 billion in 2008. The study estimates that mobile service revenue in 2009 fell 6% to USD \$6.6 billion. Mobile services have clearly been ahead of fixed since 2003, when mobile service revenue exceeded fixed revenue for the first time. The mobile market has grown to represent more than 80% of the overall telecom services market in Nigeria. We estimate mobile service revenue has grown from representing 1.2% of GDP in 2001 to roughly 4.2% of the country's economy in 2009. This puts the mobile sector at roughly the level of the manufacturing sector but above transportation, the finance sector and government services. The telecom sector's

contribution to GDP has witnessed the fastest growth during the 2000-2009 period, illustrated in Figure 5.11.



Sources: Pyramid Research Mobile Data Forecast, 2010; EIU, 2010.

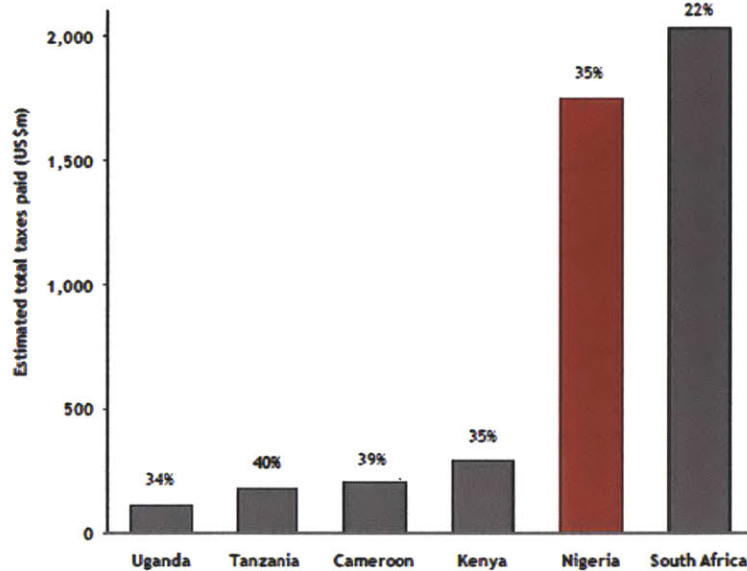
Figure 5.11: Mobile service revenue contribution to GDP in Nigeria.

In addition to the direct effect on the economy measured as a contribution to Nigeria’s GDP, mobile services have an indirect impact by enabling efficiencies in adjacent industries. Empirical studies, conducted as early as in 1970s, have shown that access to telecommunications services has a positive impact on the economy of the recipients’ countries. Waverman et al, after analyzing the impact of mobile telephony on GDP between 1980 and 2003 in 92 developed and developing countries, concluded that mobile telephony plays as vital a role as fixed telephony has played in the Western world in the 1970s and 1980s (Waverman *et al*, 2005). The economic impact of mobile telephony is twice as great in developing countries as it is in developed countries. In addition, they also believe that a 10% increase in mobile penetration of the population positively impacts GDP growth by 0.59% in emerging markets. More recent studies, such as those conducted by Deloitte in 2007 or by Kathuria, Uppal and Mam about India in 2009, estimate that a 10% increase in mobile services penetration leads to GDP growth of 1.2-1.4% (GSMA and Deloitte, 2007; Vodafone, 2009).

Licensing fees are one of the most direct ways in which mobile operators contribute toward the economy of their host countries. In Nigeria, since the introduction of GSM in 2001, the government has received more than USD \$2.5 billion from spectrum licensing fees. In 2007 alone, the Nigerian federal government received a total of more than USD \$1 billion from the sale of licenses.

Import duties and taxes from the telecommunications industry have also contributed substantial amounts of revenue to the federal government. As an example, MTN’s license stipulates that it pays 2.5% of its assessed net annual revenue. The operator also implemented a policy to spend 1% of its annual after-tax profits on CSR via its MTN Foundation, established in 2005 to finance initiatives in education, economic empowerment and health issues.

African mobile service providers pay a considerable amount of money in taxes and levies to their respective governments. For instance, in 2006, mobile operators in South Africa and Nigeria paid a total of USD \$2 billion and USD \$1.7 billion in taxes, respectively, as shown in Figure 5.12 (GSMA, 2008). This accounted for 22% and 35% of operators’ revenues. In addition to income and revenue taxes, mobile operators generally pay other forms of taxes, which can be levied on airtime, network equipment, handsets, etc.



Sources: GSMA; Frontier Economics, 2008.

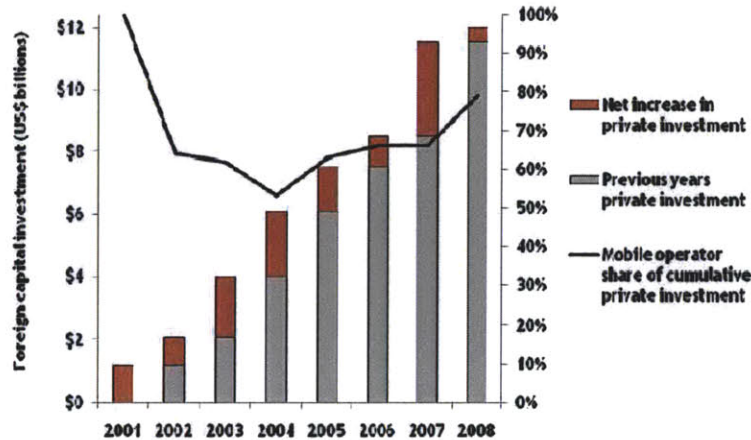
Figure 5.12: Total taxes paid by MNOs and their contribution as a % of total tax receipts in select African countries, 2006.

Indicator: Financing growth and development

With every network rollout and upgrade, GSM operators bring money and employment opportunities to the market. According to MTN, operators in Nigeria have invested in building three networks: a core telecommunication network, a transmission network and a power supply network. This effort is a result of Nigeria’s underdeveloped infrastructure. Nigerian operators have to not only budget for building the transmission backbone and infrastructure but also for power generators, bringing in skilled ICT employees and transportation.

Since the introduction of GSM services in Nigeria, mobile operators together have invested several billion dollars in infrastructure deployments, network rollouts, upgrades and expansions. To support the mobile infrastructure, operators have also embarked on building backbone networks. These consist predominantly of fiber-optic cables, base stations and satellite connections, transmitting traffic between cities and to other countries. MTN’s famous Yellow Bahn fiber-optic cable, for example, is more than 5,500 km (3,400 miles) long.

It was estimated that capital investments in mobile networks and operations have accounted for 80% of total telecommunications foreign capital investments (a total of more than USD \$12 billion by the middle of 2008) since the Nigerian government successfully liberalized the industry in 2001. As of March 2010, the NCC reported USD \$18 billion in telecom sector capex, USD \$16 billion of which is invested by mobile operators, illustrated in Figure 5.13.

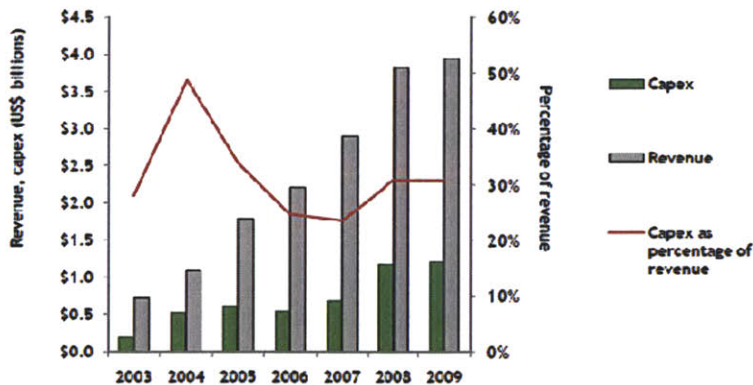


Source: NCC.

Figure 5.13: Private investment by telecom operators in Nigeria, 2001-2008.

A look at a specific operator illustrates the magnitude of telecom players' role in the overall infrastructure and operational investment in Nigeria. Of the existing mobile operators, MTN has invested the most in Nigeria.

After the initial network rollout, which took the majority share of its revenue in 2004, MTN claims to have allocated more than 30% of its revenue to capex (Figure 5.14). During this time, MTN has focused its investment on building up the transmission network to substitute for the lack of established telecom infrastructure. This, however, was not enough, and its network could not cope with the rapidly increasing number of customers, resulting in the NCC fining the operator USD \$20 million and banning advertising (Pyramid Research, 2010).



Sources: Pyramid Research; MTN annual reports.

Figure 5.14: MTN Nigeria capital expenditures, 2003-2009.

5.5.2. Employment

Indicators: Skills, Wages, Number of jobs, Job satisfaction

Ericsson has also established application development hubs in Nigeria. Like the center in Kenya, the Uganda expansion aims to also develop business cases that enable network operators to introduce and expand mobile broadband services in Africa and other emerging markets, with an emphasis on developing affordable, sustainable applications and services for rural communities, as well as stimulate

local entrepreneurship and business development by providing tools for local developer communities to create their own applications (Iboma, 2008).

Mobile health solutions allow health care workers to give better patient care and receive better data collection while they are working in the field. As an example of technology transfer, they focus on using m-health tools that are proven to be effective and have already been implemented in other countries. In this way, they ensure sustainability of m-health projects and the continuous improvement and advancement of the software that they implement³⁷.

Nigeria has also been pioneering innovations in mobile learning (m-learning). Learning and community centers using mobile phones are becoming more common to provide more mobility, flexibility and convenience rather than computer-based learning. Learners at these community centers can receive academic support for learners through SMS through communication and interaction with educational institutions, browsing course material adapted for phone interfaces, complete multiple choice assessments with immediate feedback, and receive motivational messages. Administrative support through SMS has also increased access to financial statement and registration data by way of mobile service number and access to institution portals on the web (Boyinbode, 2008).

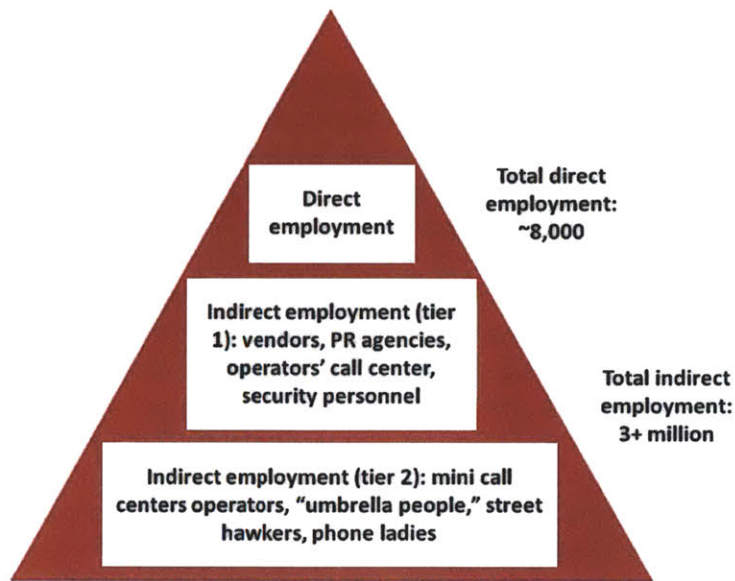
With every network rollout and upgrade, GSM operators bring money and employment opportunities to the market. According to MTN, operators in Nigeria have invested in building three networks: a core telecommunication network, a transmission network and a power supply network. This effort is a result of Nigeria's underdeveloped infrastructure. Nigerian operators have to not only budget for building the transmission backbone and infrastructure but also for power generators, bringing in skilled ICT employees and transportation.

Mobile operators contribute to the economy by creating workplaces and jobs that rely on the distribution of mobile technology and services. This contribution also takes the shape of employment beyond the telecom operator ranks, by enhancing entrepreneurship, productivity and other commercial skills. The use of mobile phones enables professional and economic agents to multitask and carry out various activities simultaneously.

In total, according to a speech titled, "Telecommunications as Catalyst for Modern Industrialized Nigeria," by Mr. Ndukwe, executive vice chairman of NCC, telecom operators employed around 8,000 people directly and around 3 million indirectly in 2008 (Ndukwe, 2008). Although direct employment is easier to quantify, indirect employment has a wider and more profound impact. Figure 5.15 shows that there are several groups, which could be divided into two broader categories, that earn their living due to mobile services:

- The top category of indirect employment encompasses equipment sales, infrastructure deployment, advertising, marketing and public relations as well as security – workers involved in the protection of base stations. Reportedly, in 2008 Zain employed as many as 8,000 security guards.
- At the base of the pyramid, there are mobile service resellers, recharge card distributors, retailers, phone booth operators as well as street vendors. The so-called mini call centers consist of simply one or a few mobile phones and airtime bought in bulk from the operator. Call center operators allow other people to use the phone for a fee and quite often will take a message, also for a fee.

³⁷ eHealth Nigeria website: <http://ehealthnigeria.org/what-we-do/mhealth>



Source: Pyramid Research, 2010.

Figure 5.15: Employment related to mobile sector in Nigeria, 2008.

MTN Nigeria is a good example of how mobile operators spur indirect employment. The operator has reorganized its distribution network, bringing down the number of appointed distributors from 202 in 2007 to 111 in 2008. On top of that, there is a second and third level to the distribution channel, amounting to around 5,700 contractors and more than 30,000 identified informal distribution points as well as probably several hundred identified points that are currently being incorporated into MTN records. Many of these people are involved in selling prepaid scratch cards. It is common in Nigeria to see people selling scratch cards among the cars trapped in a traffic jam or positioned on street corners under an operator logo-branded umbrella, selling airtime vouchers. Airtime for mobile operators, including MTN, is available via umbrella stands among other points of sale (Pyramid Research, 2010).

Nokia partnered with a social enterprise venture, Co-Creation Hub, to provide a platform for young Nigerians to come up with business ideas that also address some of Nigeria's social issues. Co-Creation Hub had sought entries from Nigerians on how they can use mobile technology to set up businesses that address issues like the quality of Education, Health, combating corruption, and deepening democracy. Already some entries have been received from willing young Nigerian and the entries have been pruned to produce three winners after a 48-hour camping at the Pan-Africa University, Lagos. Nokia, along with other organizations like TBWA/Concepts will allow the winners to use their platforms to transform the ideas into thriving businesses. Segun Fodeke, a software developer, won the first prize with her idea on how mobile devices can be used to track the performance of elected government officials against the promises they make when seeking elections. Nokia is particularly allowing any of the winners who develop a mobile application an opportunity to upload their innovations on the Ovi Store. The Ovi store is Nokia's proprietary platform from which millions of Nokia users can download applications, games, maps and music. Globally, there are at least 3 million downloads on Ovi store per day. Nokia's Head of Marketing for West Africa, Reuben Onwubiko said the Ovi Store platform provided the winners a life-time opportunity to make money from the revenue from downloads all over the world. The onus is therefore on those who have entered for the competition to ensure that they come up with solutions that would be attractive even beyond the borders of Nigeria (*Nigerian Tribune*, 2011).

Job creation and employment is one of the benefits that GSM has brought; the sector is the highest sector that has employed both skilled and unskilled manpower recently. A large number of people, especially young graduates, have been given employment in GSM companies.

Apart from this direct employment, jobs have been created, where many people are self reliant doing their own GSM businesses, one of such business is making of calls and the sale of recharge cards to GSM users. This business is popularly known as business centers or call centers. Looking around the cities, towns and even villages one will hardly walk about two poles without seeing a business center mainly characterized by the use of umbrellas, kiosks and even shops painted with the colors of the mobile service providers. It is easy to start because it requires little upfront capital (in fact, all that is needed is an umbrella as a shade, a stool, a table and a handset loaded with a credit balance). This has provided a means of livelihood for many people who would have otherwise been unemployed; some have also learned the technical aspect of the business by repairing and fixing of mobile phones in their repair shops.

Sales of GSM phones and its accessories are big business and also very profitable in Nigeria. With the statistics that over 43 million handsets have been sold and 76 million mobile lines in Nigeria, the return on investment is lucrative. All these are indicators of the health of the market where it is headed. The impact is also felt in the way businesses are conducted; it has reduced the risk and cost of traveling long distances, since one can be in his house and actually attain to the business using his mobile phone. It has made all of us ubiquitous.

Cooperate organizations, such as banks, have integrated GSM technology into banking operations known as m-banking where a customer has full access to his or her account using the mobile phone or device. Exam centers and educational institutions have also employed this technology too where candidates check their results on their mobile phones, the internet can also be accessed from the mobile phone and other value added services like picture messaging, music downloads etc.

Socially, there are many benefits through the CSR from the service providers and phone companies. Some have provided educational facilities, AIDS campaign awareness, ICT labs, Hospitals and sponsorship of several events, one of such events is the Globacom (one of the service providers in Nigeria) Premiership League where huge amount of money is set aside for the development of Nigeria football. Many individuals have also benefited from these companies by being their ambassadors.

More investors are showing interest in Nigeria because of the rapid increase and return on investments, with the recent issuing of 3G licenses to four telecom companies, more benefits are on the way for GSM users in Nigeria (Omeruo, 2007).

The National Office for Technology Acquisition and Promotion (NOTAP) promised to create at least one million jobs in the ICT sector of the Nigerian economy by 2013. NOTAP also resolved to facilitate the development of seven fully made-in-Nigeria products that will have international exposure within the next nine years. The Director General decried the attitude of many researchers in the country as most of their research outcomes stopped at the prototype level. It was reported that according to a survey carried out by his office, in NOTAP alone there are over 1,500 of such prototypes that didn't materialize into commercial products. With the recent formation of the National System of Innovation Drive (NSID) by his agency and other job creation agencies such as the National Poverty Eradication Programme (NAPEP) and National Directorate of Employment (NDE), at least one million jobs will be created in the

next two years. The occasion also announced the establishment of a NOTAP Industry Research Funds. The fund will award scholarships for PhDs to world-class science and engineering graduates (Ogoegbulem, 2011).

5.5.3. Environment

Indicators: Resources, Toxic pollution, Ecosystem disruption

Over 55 million mobile phones are in use now in Nigeria. Large quantities of mobile phones and accessories including secondhand and remanufactured products are being imported to meet the pent-up demand. This improvement in mobile telecom services resulted in the preference of mobile telecom services to fixed lines. Consequently, the contribution of fixed lines decreased from about 95% in year 2000 to less than 10% in March 2005. This phenomenal progress in information technology has resulted in the generation of large quantities of e-waste in Nigeria. Abandoned fixed line telephone sets estimated at 120,000 units are either disposed or stockpiled. Increasing quantities of waste from mobile phones estimated at 8 million units by 2007, and accessories will be generated. With no material recovery facility for e-waste and/or appropriate solid waste management infrastructure in place, these waste materials end up in open dumps and unlined landfills. These practices create the potential for the release of toxic metals and halocarbons from batteries, printed wiring boards, liquid crystal display and plastic housing units (Osibanjo and Nnorom, 2008).

Estimates indicate that an average of 3 million phones will be retired annually in Nigeria. Considering an economic phone life of 4 years, the over 32 million phones, (weight estimated at about 3200 tons) in use in 2006 would be at their end-of-life (EoL) by 2010. This volume of waste may contain up to 1800 tons of waste plastics, 15 tons of lead and 124 tons of copper. The downside of this impressive statistics is that waste generation by the telecommunications sector will also follow this trend (Osibanjo *et al*, 2008).

6. Analysis of Options and Pathways

There is a wealth of data and information illustrating that the impact of mobile telephony technology is significant. Examples of technology, institutions, and policies were presented in Chapter 4 and the sustainability of these components of a mobile telephony system of innovation was presented in Chapter 5. This chapter will analyze the impact that elements of the mobile telephony innovation system have on sustainable development in the selected countries of SSA.

In Chapter 2, the concept of a system of innovation was introduced as a something that facilitates the flow of technology and enables the innovative process through institutions. Recall that innovation is seen as a continuous process involving both radical and incremental improvements as well as the diffusion, absorption, and use of such innovation. The elements of an innovation system are technology, institutions, and policy. Thus, an innovation system is a set of institutions where in concert, enable innovation through technology development and policy. Chapter 4 presented an overview and examples of the technology, institutions, and policies that represent the mobile telephony industry in Kenya, Tanzania, Uganda, and Nigeria.

Sustainable development is a holistic assessment of the welfare of a country. Chapter 3 details the three dimensions of the sustainability framework that enable economic and social development: 1) economic development, 2) employment growth and 3) environmental protection. Chapter 5 then follows the examples of the mobile telephony innovation systems in Kenya, Tanzania, Uganda, and Nigeria and their respective impact on sustainable development in each country. It is important to note that the examples in Chapters 4 and 5 are not meant to be a complete representation of the technology, institutions, and policies in the mobile telephony industry as that would be an infeasible task, but to highlight samples of how such elements of the system can contribute to or hinder sustainable development, and to extract insights from those cases based on the available literature and data.

A color-coded rating system is used indicate the impact and relative differentiation between parts of each country's innovation system and between the countries themselves. Below is the color-coding:

	= Positive impact
	= No impact
	= Negative impact
	= No data to support

While this rating system is qualitative due to lack of a complete and comprehensive set of data, the purpose is to compare the relative impact of mobile telephony technology.

It was noted that the examples of technology, institutions, and policies used to convey the impact of mobile telephony industry on sustainable development were a sample representation. It should also be noted that the nature of the technology, institutions, and policies are varying in systemic nature themselves. These are all interdependent elements and in order to assess any part to scale, the surrounding and supporting infrastructure needs to be at some baseline level of maturity.

6.1. Impact Based on Assessment against Sustainability Indicators

6.1.1. Economic Sustainability

Table 6.1 is an overall assessment of how each of the technological options, institutions, and policies within the mobile industry that were presented in Chapters 4 and 5 perform against the economic sustainability indicators. The assessment is segmented by each of the selected countries.

Kenya		Improvements in competitiveness & use of capital	Economic changes	Financing growth & development	Tanzania		Improvements in competitiveness & use of capital	Economic changes	Financing growth & development
Technology Options	M-banking (M-PESA)	+	+	0	Technology Options	M-agriculture	+	+	0
	Innovation centers	+	+	+		ICT communities	+	+	+
Institutions	4 mobile network operators	+	+	+	Institutions	6 mobile network operators	+	+	+
	Communications Commission of Kenya	+	+	+		Tanzania Communications Regulatory Authority	+	+	+
	Ministry of Information and Communication	+	0	0		Small and medium enterprises	+	+	+
	Kenya ICT Board	+	+	+		Converged licensing framework for communications	+	0	+
	5 entities from the Kenya Post and Telecommunications Corporation	+	+	+					
Policies	Kenya Communications and Information Act	+	0	0					
	Mutual Legal Assistance Bill of 2009	+	0	0					
Uganda		Improvements in competitiveness & use of capital	Economic changes	Financing growth & development	Nigeria		Improvements in competitiveness & use of capital	Economic changes	Financing growth & development
Technology Options	M-health (Text to Change)	+	+	+	Technology Options	M-health	+	+	+
	Grameen Village Phone	0	+	0		M-learning	+	+	+
	Innovation centers (AppLab, I-Network)	+	+	+		Innovation centers (Ericsson)	+	+	+
Institutions	7 mobile network operators	+	+	+	Institutions	4 mobile network operators	+	+	+
	Uganda Communications Commission	+	0	+		Nigerian Communications Commission	+	+	+
	Ministry of Information and Communications Technology	+	+	+		3 telecommunication companies (MTN Nigeria Communications, Econet Wireless, and NITEL)	+	+	+
	National Information Technology Authority	0	+	+		Nigerian Communications Commission of 1992	+	+	+
Policies	Uganda Communications Act of 1997	+	+	+	Policies	Unified Licensing Regime	+	0	+
	National ICT Policy of 2003	+	+	+					

Table 6.1: Assessment of the selected countries on economic sustainability indicators.

Technological change and radical innovation is occurring through all the mobile phone-centric innovations addressing the needs of people in SSA. M-PESA is arguably one of the most well-known mobile applications. The case study from Strathmore University in Nairobi highlights the many major

economic benefits. Local economic expansion, capital accumulation, and improved health of the business environment were especially notable. While this study focused on a single community and reflected micro-level effects, as the technology becomes more widely diffused and adopted, the effects will likely spread as well.

We see that across each of the four countries, liberalization of mobile telecommunications led to more telecommunication companies and subsequently increased competition and productiveness.

In Kenya, the Kenya Communications Act, aimed at liberalizing telecommunication within the country, created five entities that drastically increased competition and several mobile network operators (MNOs). The lowered prices opened up new subscribers and tremendous mobile subscriber growth.

In Tanzania, the six MNOs and four primary telecom companies have also contributed to increased competition and fueled growth in the subscriber base, but have not reached as many subscribers as Kenya (recall that Tanzania's subscriber base is at ~30% with Kenya close to 50%). The use of mobile technology and applications in the SME environment seems to be the most beneficial. Communication between suppliers seems to be an area for immediate and significant economic gain for many SMEs in Tanzania. However, mobile phones used for agricultural purposes had potentially mixed results. While mobile phones can help forge new relationships within the agricultural value chain, they play little part in strengthening current relationships. The remote communication between the farmers and their dalali depend on trust as a prerequisite for there to be any benefits derived from mobile phones in agriculture.

Uganda also saw improved competition and productiveness when the telecommunications market was opened up and saw several MNOs arrive. Furthermore, the Ministry of ICT specifically coordinates and advocates for policies that support Uganda's ICT sector. The increased competitive environment has led to reduced call costs and SIM cards and product differentiation to address specific needs of their customers and to reach other markets, particularly low-income customers. The Uganda regulation and the UCC have specifically focused on addressing market gaps and inefficiencies and aims to provide universal service.

Similarly, Nigeria's mobile network grew when multiple MNOs were launched in 2001. The competition among the MNOs caused them to seek business expansion and customer retention strategies. The study by Pyramid Research demonstrates significant increases between the total service revenue generated by the MNOs between 2001 and 2008. Licensing fees from the MNOs contribute to the country's GDP and import duties and taxes contribute to the revenue of the federal government.

Uganda saw a growth in telecommunications despite a decline in GDP due to the global economic crisis. This growth was attributed to continued increase in investment because of intensified competition.

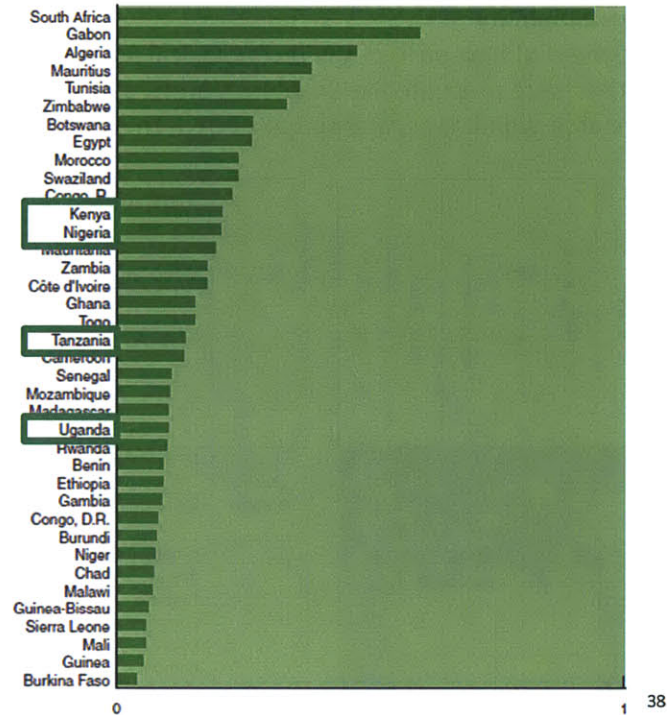
In Chapter 2, technological innovation in industrialized states is primarily brought through R&D divisions, or a functionally similar entity, or businesses, academic institutions, and government agencies. While these institutions have not commonly existed or been properly supported in developing and especially underdeveloped countries, we see that in each of the four countries, innovation and research centers have a notable presence. The multi-national companies (MNCs) are particularly engaged in technology transfer as Section 2.3.2 discusses, learning to produce products and adapt mobile technology employed elsewhere in more industrialized economies to the a more resource-constrained environment. The types of interactions and networks in mobile innovation are much more bottom-up, especially in the cases where MNCs are not involved. As ideas are born and incubated, new organizations will come about.

Each country is creating a competitive environment of MNOs that allow mobiles to be more affordable and accessible to all users. In addition, each country has a regulating body that can be granted authority, if not already given, to govern the growth and development of the mobile telephony industry. But the governing bodies vary in terms of effectiveness and authority to regulate.

Chapter 2, Section 2.3.3, also discussed the common themes around technology policies within innovation systems, with the first being national systems that co-evolve the production and knowledge structures. The second is the localization of the elements of knowledge important for economic performance. The third is that relationships are seen as the carriers of knowledge, and interactions as processes where new knowledge is acquired and produced. The approach to technology policies that each country has taken is largely been beneficial to the growth of the mobile telephony industry. We see in the case for Uganda, there is public funding that supports private firms.

Unfortunately, infrastructure (built capital) that is indirectly related to the mobile telephony system as laid out in Section 4.4.2, such as paved roads and remaining telephone land lines, affects overall economic performance and subsequently investor perception of the risk. MTN Nigeria has invested efforts in building telecommunication network, transmission network, and power supply network, focusing on a complete mobile industry system. MNOs in Nigeria have collaborated on financing the mobile telecommunication infrastructure. While the African region is still viewed as a risky environment for investors, the growth of companies and supporting policies will increase further financing of growth and development in the near future. Figure 5.6 demonstrated that all sources of finance view telecommunications as a worthy investment. Thus, the growth of MNOs and telecom businesses will further attract more financing.

In the ECA study referenced in Chapter 5, Section 5.1, created an economic sustainability index that measured the extent to which each African country had achieved lasting economic transformation, shown in Figure 6.1. The measure combined a number of indicators on foreign assets, human capital (education and health status), gender inequality, manufactured capital, and productivity. The selected countries in this study are highlighted.



Source: Calculations by Economic Commission for Africa.

Figure 6.1: Economic sustainability index scores by African countries, 1975-2000.

Overall in Africa, economic sustainability initially improved and then deteriorated in the last 25 years. Within the group of 38 countries, the share of the population living in those with low economic sustainability fell from about 85% in 1975-84 to 50% in 1985-94, due mainly to investments made in the first decade. But in 1995-2000, this share grew to 72%. This reversal reflected in part the limited effective investment in 1985-94. But it was driven mostly by the fact that Kenya and Nigeria joined the low economic sustainability cluster in the third period, pushing the population share of that cluster up by 22 percentage points. In most other countries, economic sustainability remained roughly the same.

The gains in 1985-94 are largely attributed to better health and greater education, a growing stock of manufactured capital, rising productivity, and an expanding market system. These positive trends slowed in 1995-2000. Many countries had smaller achievements in health and education. Indeed, in the countries affected by HIV/AIDS, gains in life expectancy were reversed. Moreover, output per worker declined in Algeria, Congo, Kenya, and South Africa, while capital per worker fell in Algeria, Kenya, and Nigeria.

Economic sustainability is most strongly (and positively) related to output per worker, capital per worker, and the size of the telephone network. It is also positively and strongly correlated with all indicators of health and education status and the indicator of market development (how much of a country's economic activity takes place in markets). These correlations suggest that raising productivity through technological innovation and increased human and manufactured capital is an important means of promoting sustainable economic development in Africa (UNECA, 2002).

³⁸ The index scores are averages of scores for 1975-2000. The scores are standardized to range from 0-1.

6.1.2. Employment Sustainability

Table 6.2 is an overall assessment of how each of the technological options, institutions, and policies within the mobile industry that were presented in Chapters 4 and 5 perform against the employment sustainability indicators. The assessment is segmented by each of the selected countries.

		Kenya									Tanzania						
		Skills	Wages	Purchasing power	Job security	Job satisfaction	Health & safety	Number of jobs			Skills	Wages	Purchasing power	Job security	Job satisfaction	Health & safety	Number of jobs
Tech. Options	M-banking (M-PESA)	+	+	+				+	Tech. Options	M-agriculture		+	+	+	+	0	-
	Innovation centers	+	0					+		ICT communities	+						
Insts.	4 mobile network operators	+	+					+	Insts.	6 mobile network operators	+	-	-	-			+
	Communications Commission of Kenya	+	+	0	0	0	0	+		Tanzania Communications Regulatory Authority	+	+					
	Ministry of Information and Communication	+	+	0	0	0	0	+		Small and medium enterprises	+	-		-			-
	Kenya ICT Board									Converged licensing framework for communications							
	5 entities from the Kenya Post and Telecommunications Corporation	+	+					+									
Policies	Kenya Communications and Information Act																
	Mutual Legal Assistance Bill of 2009																

Uganda		Skills	Wages	Purchasing power	Job security	Job satisfaction	Health & safety	Number of jobs
Tech Options	M-health (Text to Change)	0	0	0	0	0	+	+
	Grameen Village Phone	+	+	+				+
	Innovation centers (AppLab, I-Network)	+						
Insts.	7 mobile network operators	+	-	-	-			+
	Uganda Communications Commission	+	+					+
	Ministry of Information and Communications Technology	+	+					+
	National Information Technology Authority	+	+					+
Policies	Uganda Communications Act of 1997							
	National ICT Policy of 2003							

Nigeria		Skills	Wages	Purchasing power	Job security	Job satisfaction	Health & safety	Number of jobs
Tech. Options	M-health	0	0	0	0	0	+	0
	M-learning	+	+	0	0	+	0	0
	Innovation centers (Ericsson)	+	+	+				+
Insts.	4 mobile network operators	+	+	+				+
	Nigerian Communications Commission	+	+	+				+
	3 telecommunication companies (MTN Nigeria Communications, Econet Wireless, and NITEL)	+	+	+				+
Policies	Nigerian Communications Commission of 1992							
	Unified Licensing Regime							

Table 6.2: Assessment of the selected countries on employment sustainability indicators.

As discussed in the previous section, innovation and research centers have a significant presence in the selected four countries. Kenya and Nigeria have innovation centers or ICT communities focusing on mobile technology supported by multi-national corporations (MNCs), namely Nokia and Ericsson, and Uganda has centers supported by international NGOs, such as Grameen and the Gates Foundation. Tanzania has more locally-founded and supported innovation centers. These entities are effective at nurturing skills of participants and incubating ideas.

Mobile applications have had a significant impact on the Employment dimension of the Sustainability Framework. In Kenya, mobile banking with M-PESA in the community study increased wages and purchasing power, and number of jobs, at least on a local, community level. Phone companies have long allowed individuals to purchase “air-time” (i.e., pre-paid cell phone credit that can be used for voice or SMS communication) and to send this credit to other users. It was a small step for the recipient user to on-sell the received air-time to a local broker in return for cash, or indeed for goods and services, thus transferring purchasing power from the initial sender to the recipient (Jack and Suri, 2010). Through applications like FrontlineSMS, combined with Ushahidi, organizations were able to keep better records of birth registrations and provide updates during violent upheaval.

Vodafone’s study of Tanzania also reinforces the notion that mobile phones connect people, and that improves safety and offers quicker service during emergencies. Because of the growth of mobile phones in Tanzania and the increasing need for technical competency for mobile development, mobile telecommunication companies like Zain are some of the attractive companies to work for. However, also

in the Vodafone study, SMEs and similarly the telecom companies will look to expatriates to fill the need for top-talent.

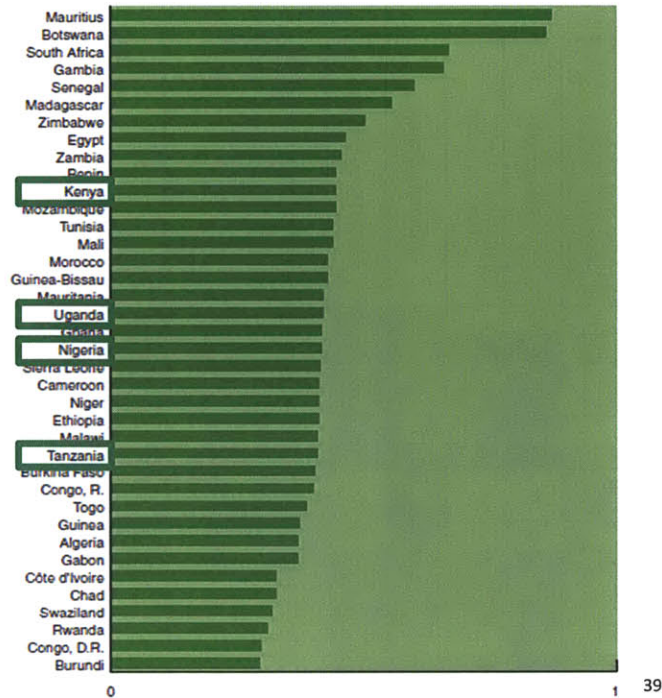
The TTC initiative in Uganda offered free airtime as an incentive for participation and saw drastic increases in AIDS testing. This mobile innovation created benefits to other stakeholders, such as partnering telecom companies like Celtel through the promotion of their SMS service. With increasing and on-going funding, programs like TTC are in a position to increase job opportunities. However, TTC only addresses a small slice in the massive pie of need to treat citizens affected by HIV/AIDS. MTN Uganda also improved the livelihood of women through education/training and improved economic prosperity. Job satisfaction and number of jobs are also increasing. However, like Tanzania. Uganda also tends to pay higher wages to foreigners and expatriates in telecom companies.

Mobile health has also been prominent in Nigeria. There, these applications have helped medical workers delivery better care and collect more data. Nigeria has also been specifically address skill-development through mobile learning. Mobile operations like MTN Nigeria are spurring on direct and indirect employment opportunities through innovative business models to reach the top and bottom of the economic pyramid. This is done through sales of equipment or integration of GSM into business operations.

In order for these often grassroots and bottom-up innovations to become more widespread and have a greater impact to employment development, they need to leverage existing information and communication flows. Involving users was a key not only for widespread diffusion and adoption, but also to maximize positive impact. When users are involved, they can often adapt these mobile innovations designed for one purpose to other urgent needs. This was illustrated by the KWP project that leveraged M-PESA (i.e. information and communication flow) to become a widespread service to improve the health of people living in Katitika.

Across each country, the variables that are most benefited are skill-building, wages, the number of jobs created, and often times health and safety. But there was a lack in data on job satisfaction, job security, and retention, perhaps reflecting the priorities the others' research. However, within each country, it is mostly the technological options and institutions that are the most effective at adding value to these indicators. Policies, at this point, are still far removed and either very upstream in the value chain or too reactive to have much a noticeable impact on direct benefits. As Aker's paper asserts and reinforces the data for each region, the mobile phone sector spawned a wide variety of business and entrepreneurship (Aker and Mbiti, 2010).

As institutions were very influential on employment indicators, the institutional sustainability index in ECA study shown in Figure 6.2, which combined indicators of rights (civil and political freedoms) and institutional development (institutional constraints on executive power, competitiveness in the transfer of executive power, and the depth of market development), gives additional insight into the employment conditions of each country. The selected countries in this study are highlighted.



Source: Calculations by Economic Commission for Africa.

Figure 6.2: Institutional sustainability index scores by African countries, 1975-2000.

Beginning in the early 1990s many African countries initiated significant economic and political reforms, including Benin, Burkina Faso, Ethiopia, Ghana, Malawi, Mali, Mozambique, Togo, and Zambia. Political competition became more open and institutionalized. Political participation and the accountability of leaders grew. But even as the socio-economic impact of these reforms continues to unfold, the need for further deepening of the reforms is becoming apparent. These reforms are perhaps the most important change that most African countries are undergoing (UNECA, 2002).

6.1.3. Environmental Sustainability

Table 6.3 is an overall assessment of how each of the technological options, institutions, and policies within the mobile industry that were presented in Chapters 4 and 5 perform against the environmental sustainability indicators. The assessment is segmented by each of the selected countries.

³⁹ The index scores are averages of scores for 1975-2000. The scores are standardized to range from 0-1.

		Kenya			
		Resources	Toxic pollution	Climate change	Ecosystem disruption
Tech. Options	M-banking (M-PESA)	0	0		+
	Innovation centers				
Institutions	4 mobile network operators	-	-		-
	Communications Commission of Kenya	+	+		+
	Ministry of Information and Communication	0	0		0
	Kenya ICT Board	0	0		0
	5 entities from the Kenya Post and Telecommunications Corporation	-	-		-
Policies	Kenya Communications and Information Act	+	+		+
	Mutual Legal Assistance Bill of 2009	+	+		+

		Tanzania			
		Resources	Toxic pollution	Climate change	Ecosystem disruption
Tech. Options	M-agriculture		0		+
	ICT communities				
Institutions	6 mobile network operators	-	-		-
	Tanzania Communications Regulatory Authority	-	-		+
	Small and medium enterprises	-	-		-
	Converged licensing framework for communications				
Policies					

		Uganda			
		Resources	Toxic pollution	Climate change	Ecosystem disruption
Technology Options	M-health (Text to Change)	0	0		0
	Grameen Village Phone	0	0		+
	Innovation centers (AppLab, I-Network)				
Institutions	7 mobile network operators	-	-		-
	Uganda Communications Commission	+	+		+
	Ministry of Information and Communications Technology	-	-		-
	National Information Technology Authority	-	-		-
Policies	Uganda Communications Act of 1997				
	National ICT Policy of 2003				

		Nigeria			
		Resources	Toxic pollution	Climate change	Ecosystem disruption
Technology Options	M-health	0	0		0
	M-learning	0	0		0
	Innovation centers (Ericsson)				
Institutions	4 mobile network operators	-	-		-
	Nigerian Communications Commission	+	+		+
	3 telecommunication companies (MTN Nigeria Communications, Econet Wireless, and NITEL)	-	-		-
Policies	Nigerian Communications Commission of 1992				
	Unified Licensing Regime				

Table 6.3: Assessment of the selected countries on environmental sustainability indicators.

In 2006 GSMA estimated that about 896 million mobile phones were sold, about 50% of these were replacement phones, and about 1 in 10 new customers used a “used” phone. We also estimated that more than 20 million phones would be collected for reuse or recycling; those that could not be repaired

composed less than 0.003% of the total annual weight of the waste electronic equipment. Typically, more than 70% of a mobile phone can be recycled and design innovations by manufacturers are eliminating the use of hazardous materials in new phones (www.gsmworld.com).

Both Kenya's and Nigeria's cases reinforce the growing threat of e-waste. In Kenya, efforts to coordinate all stakeholders and members of the value chain to establish standards and procedures, and address cradle-to-grave lifecycles. Public-private partnerships to address e-waste collection and management and regulatory body, NEMA, charged with assessing extent of problem, but no action yet. However, regarding agricultural productivity, technology options like M-PESA have proved to have an extremely positive impact through increasing volume and velocity of money flow in communities.

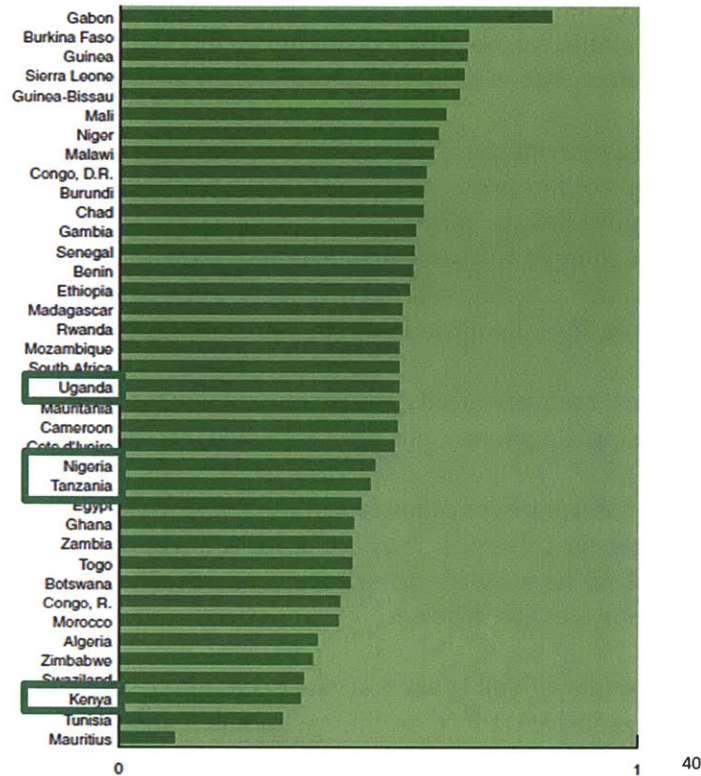
In Nigeria, there is no material recovery facility or waste management infrastructure established. Thus, with an exploding growth in mobile phones, this problem could increase dramatically.

Tanzania and Uganda show concerns over cellular masts and base stations. In Tanzania, they are involving many players to manage this issue. They are bringing in TCRA and NEMC and have created regulations to ensure that all masts subscribe to certain standards. There are still many gaps, but they are demonstrating an awareness of the problem.

In Uganda, NEMA is also charged with all environmental issues in the country. They are also charged with assess the impact of these base stations on the environment and human health. UCC is also involved with setting standards for telecommunications infrastructures and services. Measures (i.e. proxies) are in place.

It is clear that for each country, the environmental dimension has the worst performance relative to the economic and employment dimensions. As is the symptom of other developing countries, industrial development is main goal, deprioritizing environmental standards. However, it is encouraging that appropriate authorities are established to address environmental development. While they are still relatively young and inexperienced and policies are more reactive and ad hoc, there are policies addressing resource, toxic pollution, and ecosystem disruption that may be influenced by the growth of the mobile phone industry despite all that may hold them back.

The ECA study also created an environmental sustainability index to capture the change in a country's natural capital base, shown in Figure 6.3. Because of the scarcity of time-series data for environmental indicators, the measure is limited to only four indicators: forest cover, arable land, carbon dioxide emissions, and population density. The selected countries in this study are highlighted.



Source: Calculations by Economic Commission for Africa.

Figure 6.3: Environmental sustainability index scores by African countries, 1975-2000.

The environmental sustainability of African countries declined considerably between 1975-84 and 1985-94. This outcome appears to be explained largely by population growth, rapid growth in carbon dioxide emissions, the expansion of road networks, and market development. Environmental sustainability recovered slightly in 1995-2000 with slower growth (and in some cases reductions) in carbon dioxide emissions and less rapid population growth in almost all the most populous countries of Africa (UNECA, 2002).

According to Akin Mabogunje of the African Technology Forum, three factors that are more systemic strongly increase the threat of environmental degradation in SSA: 1) its demographics, 2) its heavy burden of foreign debt and 3) the absence of democracy.

During the last 25 years, annual growth rates of 2.5 to 3.5% have caused the population of SSA to double to 570 million. While this is certainly good for the economy, at its current rate of increase, the population could potentially double again in the next 25 years. An increase of this magnitude within a relatively short time span has led to mass migration to the cities (particularly by adult males) and other efforts to supplement family income through non-farm employment. As a result, there has been less time for farm work, and more labor-saving but environmentally harmful shortcuts are being taken. For instance, this is observed with the increase of mobile phone usage for more the flow of information and communication across large distances.

⁴⁰ The index scores are averages of scores for 1975-2000. The scores are standardized to range from 0-1.

Regarding the second factor, countries in SSA incurred large foreign debts in their efforts to industrialize and to provide their rapidly growing populations with modern social services. Most of these loans have been long-term ones from official sources and on concessional terms; as the need for borrowing has become more urgent, however, countries have turned increasingly to private, short-term loans at market rates. Thus, while in 1970, the region's total official debt (excluding that of South Africa and Namibia) was slightly more than USD \$5 billion, by 1990, it rose to nearly USD \$140 billion (UN CHS, 1987).

The problem, however, is not so much in the rising level of debt as in the region's diminishing ability to service it, a problem endemic to many developing and underdeveloped countries. High dependence on the export of primary products left SSA countries vulnerable to the long decline of commodity prices that began in the 1970s. The total value of the region's agricultural exports has fallen dramatically, with the decline averaging 0.8% a year from 1975 to 1980, 2.9% a year from 1980 to 1985, and 2.5% a year from 1986 to 1988 (World Bank, 1992).

Not unexpectedly, most countries in SSA had to undergo major structural adjustments. This has entailed not only a drastic compression of imports and a sharp devaluation of national currencies but also the retrenchment of a sizable portion of the wage- and salary-earning population. As living conditions deteriorated, more people turned to survival agriculture, both in urban and rural areas. At the same time, sharply rising prices for imported energy products forced many families to fall back on wood and charcoal for their domestic energy needs (Mabogunje, 1998). Clearly, these developments put acute strain on the environment everywhere in the region.

The performance of most African governments in implementing the reforms necessary to turn their economies around has also been a source of serious concern. The international community spent the years immediately following independence rationalizing (and sometimes applauding) the necessity for authoritarian one-party or military rule. Over time, these regimes have become inordinately corrupt and have managed the countries' economies without due concern for transparency and accountability. In most countries, this has led to a high level of political instability and social alienation that has impaired both development efforts and environmental protection (Mabogunje, 1998). There is a growing realization that economic reforms cannot be achieved without a much greater degree of decentralization and democratization in the political process.

6.2. Linkages

6.2.1. Economy and Employment Linkage

This section explores how the innovation in mobile telephony technological might affect development the selected African countries, and the implications of that development on employment. As we see in Section 6.1 above, technological, institutional, and policy innovations are significant drivers of change within the three important dimensions of the Sustainability Framework. Section 6.2 explores how these innovations drive change between the dimensions.

Technological change and the globalization of mobile telephony have direct implications on employment in developed, developing, and least developed nations, and labor market policies share importance with government policies focusing on improving economic competitiveness and environmental quality. In addition, if the basic human needs for food, clothing, shelter, etc. are to be met, the only practical way

to do this is to satisfy the basic need for a sustainable livelihood by creating employment opportunities with adequate purchasing power (Ashford and Hall, 2011).

It is possible to consider the impact of rapid technological change and globalization on employment through two indicators: 1) changes in the international division of labor and 2) changes in the nature of work. Technological change and globalization also influences changes in purchasing power. The diffusion of mobile telecommunication technology, as well as technology transfer from industrialized to developing nations, is a powerful mechanism to create a new working and purchasing class and reduce income inequality between these nations (Ashford and Hall, 2011). However, this data was not readily available. Table 6.4 presents an assessment of how each of the technological options, institutions, and policies within the mobile industry that were presented in Chapters 4 and 5 perform against the economy-employment sustainability indicators. The assessment is segmented by each of the selected countries.

Kenya		Change in international division of labor	Changes in the nature of work	Tanzania		Change in international division of labor	Changes in the nature of work
Technology Options	M-banking (M-PESA)	0	+	Technology Options	M-agriculture	0	+
	Innovation centers	+	+		ICT communities	0	+
Institutions	4 mobile network operators	+	+	Institutions	6 mobile network operators	+	+
	Communications Commission of Kenya	+	+		Tanzania Communications Regulatory Authority	0	0
	Ministry of Information and Communication				Small and medium enterprises	+	+
	Kenya ICT Board					+	+
5 entities from the Kenya Post and Telecommunications Corporation	+	+	Policies	Converged licensing framework for communications	0	0	
Kenya Communications and Information Act	+	+					
Policies	Mutual Legal Assistance Bill of 2009	0	0				

Uganda		Change in international division of labor	Changes in the nature of work	Nigeria		Change in international division of labor	Changes in the nature of work
Technology Options	M-health (Text to Change)	0	+	Technology Options	M-health	0	+
	Grameen Village Phone	0	+		M-learning	0	+
	Innovation centers (AppLab, I-Network)	+	+		Innovation centers (Ericsson)	+	+
Institutions	7 mobile network operators	-	+	Institutions	4 mobile network operators	+	+
	Uganda Communications Commission	+	+		Nigerian Communications Commission	+	+
	Ministry of Information and Communications Technology				3 telecommunication companies (MTN Nigeria Communications, Econet Wireless, and NITEL)	+	+
	National Information Technology Authority					+	+
Policies	Uganda Communications Act of 1997	+	+	Policies	Nigerian Communications Commission of 1992	+	+
	National ICT Policy of 2003	0	0		Unified Licensing Regime	0	0

Table 6.4: Assessment of the selected countries on economy-employment linkage indicators.

It is important to note that the composition of labor within nations varies considerably and continually evolves with development. For example, the transition of many nations from agricultural, to industrial, to service economies has been accompanied by technology-based shifts in the skills required of workers (Drucker, 1994). Furthermore, while developed countries such as the U.S. are described as having a post-industrial, service, or knowledge-based economy, it is important to recognize that the agricultural and industrial sectors have not been replaced (Bell, 1999). Rather, the size of these sectors has declined with the growth of the service economy, but they still form an important component of their economy.

The growth of the global communication network has significantly shaped the international division of labor. Particularly in this case, mobile telephony has both spurred endogenous innovation within each country as well as attracted MNCs to establish innovation (i.e. knowledge) centers there. Within Kenya and Nigeria, technological innovation in the mobile industry, multiple MNOs, regulatory institutions, and key policies have positively influenced the change in international labor with respect to these countries. In other words, these factors are shifting societies in these countries from a predominantly agrarian-based economy to more of a service- and knowledge-based economy. Uganda, on the other hand, has experienced a more negative impact on where a majority of the service- and knowledge-based employment is still filled with expatriates and foreign workers. Additionally, across all countries, innovation centers have been established to nurture endogenous skills and innovation. In Kenya, Uganda, and Nigeria, innovation centers have been established by MNCs attracted to these potential growth markets.

The fact that distance is not really a consideration for ICT-based services means that MNCs and SMEs are likely to focus more on the price and availability of labor than its location. Tanzania's example of SMEs demonstrates the benefits of mobile phone-based services for business operations. Further, unlike the agricultural and manufacturing sector which is somewhat homogenous in character, the service sector varies considerably from fast food, to banking, to dentistry, to car repair, to teaching. The portability of

mobile phones enables the creation of a service sector around multiple areas, from mobile banking to mobile health to mobile learning.

The creation and transition of these African countries towards service- or knowledge-based societies reduces the need for unskilled or semi-skilled workers in developed nations – who form the largest proportion of the working population – and increases the importance of a well-trained and educated labor force (Drucker, 1994; Levy and Murnane, 2004; Miller, 1995; WCSDG, 2004). The examples of M-PESA in Kenya and Text-to-Change in Uganda have increased the demand for workers who are able to perform jobs requiring complex thinking. This type of work requires solving new problems where there are no established, much less routine, solutions and communication of how to diffuse and adopt new solutions. Mobile phones provide an essential support function, but are unable to replace a human's ability to think creatively in difficult and unpredictable circumstances (Levy and Murnane, 2004). These skilled laborers are referred to as the technologists (Drucker, 1994).

However, the emergence of technology-enabled, service- and knowledge-based societies is also widening the educational/informational gap in these countries, extending the digital divide (Norris, 2001). In addition, the problem of high unemployment is worsened by the fact that over the next 50 years, the vast majority of population growth is predicted to occur in urban areas in developing nations (UNPD, 2003). The constant flow of new entrants into the labor force in these countries is argued to result in 'jobless growth,' meaning that the rise in unemployment is a structural phenomenon (Miller, 1995). In this situation it seems the formation of high-tech industries in developing nations will only be sustained if a reliable stream of well-educated workers can be established. Yet, the provision of basic education is a luxury for the vast majority who struggle daily against the poverty trap. Even if an adequate supply of educated workers could be provided, there is the concern that the sheer scale of technology-displaced workers is likely to overshadow any growth in high-tech industries (Rifkin, 2004). And this exemplifies the importance and potential impact of mobile learning initiatives such as those identified in Nigeria. Learning centers located in dense population clusters will be crucial in addressing the educational/informational gap.

6.2.2. Employment and Environment Linkage

The employment-environment linkage focuses on the effects of technological change on work interactions and the environment. Two different effects are discussed: 1) the increased environmental footprint from increased output that results from population-led and/or economic-driven growth, or from an effort to employ more people, and 2) the employment effects of a greener and more energy-efficient economy. Table 6.5 presents an assessment of how each of the technological options, institutions, and policies within the mobile industry that were presented in Chapters 4 and 5 perform against the employment-environment sustainability indicators. The assessment is segmented by each of the selected countries.

Kenya		Increased environmental footprint due to increased employment & industrial throughput	Environmental & energy improvements that impact employment
Technology Options	M-banking (M-PESA)	-	
	Innovation centers	-	
Institutions	4 mobile network operators	-	-
	Communications Commission of Kenya	-	-
	Ministry of Information and Communication		
	Kenya ICT Board		
	5 entities from the Kenya Post and Telecommunications Corporation	-	-
Policies	Kenya Communications and Information Act		+
	Mutual Legal Assistance Bill of 2009		+

Tanzania		Increased environmental footprint due to increased employment & industrial throughput	Environmental & energy improvements that impact employment
Technology Options	M-agriculture	-	
	ICT communities	-	
Institutions	6 mobile network operators	-	-
	Tanzania Communications Regulatory Authority	-	-
	Small and medium enterprises	+	-
Policies	Converged licensing framework for communications	+	+

Uganda		Increased environmental footprint due to increased employment & industrial throughput	Environmental & energy improvements that impact employment
Technology Options	M-health (Text to Change)		
	Grameen Village Phone	+	
	Innovation centers (AppLab, I-Network)	-	
Institutions	7 mobile network operators	-	-
	Uganda Communications Commission	-	-
	Ministry of Information and Communications Technology		
	National Information Technology Authority		
Policies	Uganda Communications Act of 1997	+	+
	National ICT Policy of 2003	+	+

Nigeria		Increased environmental footprint due to increased employment & industrial throughput	Environmental & energy improvements that impact employment
Technology Options	M-health		
	M-learning	-	
	Innovation centers (Ericsson)	-	
Institutions	4 mobile network operators	-	-
	Nigerian Communications Commission	-	-
	3 telecommunication companies (MTN Nigeria Communications, Econet Wireless, and NITEL)	-	-
Policies	Nigerian Communications Commission of 1992	+	+
	Unified Licensing Regime	+	+

Table 6.5: Assessment of the selected countries on employment-environment linkage indicators.

One outcome that is seen in economic-driven growth in the mobile telephony industry is an increase in environmental footprint. Through a combination of new searches for trade revenues, and increases in production/industrial throughput (and consumption) to accommodate the need to employ workers, the demand for resources and environmental impacts have increased.

We can see that across the four African countries, the growth of mobile phone adoption for bottom-up employment and the spread of MNOs are simply increasing the environmental footprint. This has raised

concerns for the short lifecycle of a mobile phone, handling discarded phones, improving standards for production and maintenance to prolong phone usage, and regulation for cellular base stations. Uganda's Grameen Village Phone, which implements phone-sharing, and mobile learning centers in Nigeria can be effective models for strategies that create employment while limiting industrial throughput, which in this case could be increased phones in usage.

Policies designed to keep economic activity within ecological limits raise difficult questions about how full employment is to be achieved (Lawn, 2004). Ashford and Hall point out that the current approach to creating employment is based upon the assumption that increasing GDP will ultimately lead to job creation through the reinvestment of income/profits – “a rising tide lifts all boats (Ashford and Hall, 2011).” Thus, any effort to constrain growth in GDP on the grounds of ecological sustainability is likely to have negative impacts on job creation. The solution, therefore, requires a creative design of policies that focuses on decoupling the “GDP-employment” link (Lawn, 2004). A range of strategies have been considered that seek to sever the “GDP-employment” link and promote steady-state strategies. These strategies include ecological tax reform – i.e., tax the undesirable effects, such as resource depletion and pollution, and not the desired effects, such as labor and income (Lawn, 2004); creating a “job guarantee” where government provides basic (and ecologically sensitive) employment to labor displaced from the private sector (Forstater, 2004; Harvey, 2006). Of these strategies, the ecological tax reform and job guarantee are considered to be the most effective, so long as additional quantitative throughout controls are used to keep economic activity within ecological limits (Lawn, 2005). We see in each country, there are regulatory authorities established to handle environmental issues. Kenya has created public-private and NGO partnerships around refurbishing phones, which has the potential to create more employment while minimizing ecological damage. However, a vigorous and well-guided approach to public investment in health, education, and infrastructure programs is necessary to promote job creation and environmental sustainability, which none of the countries studied has arrived at yet (Smith, 2005).

6.2.3. Economy and Environment Linkage

This final linkage represents the interactions between the economy and the environment in a globalized and rapidly changing world. The environmental consequences that underlie the concern for sustainable development incorporate what have been identified as four different environmental concerns: resource depletion, toxic pollution, ecosystem disruption, and climate change. Note that data on mobile telephony's impact on climate change was not sufficient to include in this research.

Three effects on the environment will be considered in assessing the effects of mobile technological change on the environment. These are 1) development and the environment, 2) trade and the environment, and 3) investment and the environment. A fourth effect is on how environmental regulation of the mobile industry impacts the economy. Table 6.6 presents an assessment of how each of the technological options, institutions, and policies within the mobile industry that were presented in Chapters 4 and 5 perform against the economy-environment sustainability indicators. The assessment is segmented by each of the selected countries.

Kenya		Development & environment	Trade & environment	Investment & environment	Impacts of regulation on economy
Technology Options	M-banking (M-PESA)	0	0	0	0
	Innovation centers	+	-	-	-
Institutions	4 mobile network operators	-	-	-	-
	Communications Commission of Kenya	0	0	+	+
	Ministry of Information and Communication	-	-	-	-
	Kenya ICT Board	-	-	-	-
Policies	5 entities from the Kenya Post and Telecommunications Corporation	-	-	+	+
	Kenya Communications and Information Act	-	+	+	+
	Mutual Legal Assistance Bill of 2009	-	-	-	+

Tanzania		Development & environment	Trade & environment	Investment & environment	Impacts of regulation on economy
Technology Options	M-agriculture	+	+	0	0
	ICT communities	+	-	-	-
Institutions	6 mobile network operators	-	-	-	-
	Tanzania Communications Regulatory Authority	0	0	+	+
	Small and medium enterprises	-	-	-	-
Policies	Converged licensing framework for communications	-	-	-	-

Uganda		Development & environment	Trade & environment	Investment & environment	Impacts of regulation on economy
Technology Options	M-health (Text to Change)	0	0	0	0
	Grameen Village Phone	-	-	-	-
	Innovation centers (AppLab, I-Network)	+	-	-	-
Institutions	7 mobile network operators	-	-	-	-
	Uganda Communications Commission	0	0	+	+
	Ministry of Information and Communications Technology	-	-	-	-
Policies	National Information Technology Authority	-	-	-	-
	Uganda Communications Act of 1997	-	+	-	+
	National ICT Policy of 2003	-	+	-	+

Nigeria		Development & environment	Trade & environment	Investment & environment	Impacts of regulation on economy
Technology Options	M-health	0	0	0	0
	M-learning	0	0	0	0
	Innovation centers (Ericsson)	+	-	-	-
Institutions	4 mobile network operators	-	-	-	-
	Nigerian Communications Commission	0	0	+	+
	3 telecommunication companies (MTN Nigeria Communications, Econet Wireless, and NITEL)	-	-	-	-
Policies	Nigerian Communications Commission of 1992	-	+	-	+
	Unified Licensing Regime	-	+	-	+

Table 6.6: Assessment of the selected countries on economy-environment linkage indicators.

As mentioned in Chapter 2, economic development has traditionally been measured by growth of the GNP. Typically, a country is regarded as developing as long as its GNP grows at a rate of 5% to 7% a year and outpaces the population growth of the country, which implies that per capita income increases (Todaro and Smith, 2009). While the contribution of the mobile industry has demonstrated economic development across each of the four countries, it has certainly brought with it more demand on resources and increased toxic pollution. The waste that discarded phones create as well as the spread of cellular base stations have been sufficiently threatening to motivate policies to address these problems. However, we see the efficiencies that mobile phones bring in the agricultural sector in Kenya can reduce ecosystem disruption caused by other factors through increased agricultural productivity and return.

Free trade advocates generally argue that the net effects of liberalized international exchange on the environment are positive. Their arguments are (Ashford and Hall, 2011):

- Free trade favors economic growth and the growth of income has positive effects on the environment due to the increased demands for a clean environment and the ability to pay for them
- Free trade favors the international exchange of technology and environmentally-sound products and services
- Free trade induces the removal of trade-distorting and environmentally-harming policies.

It can be argued that the MNOs and telecom companies forming the competitive landscape in each of the four countries are not concerned about increase demand for a cleaner environment or environmentally-sound products. Telecom OEMs have little concern about production standards and maintenance of phones. Thus, free trade at this current state in each country's mobile sector would cause more harmful effects. This is due to the lack of internalizing externalities (costs that arise from an activity that are not integrated in the total cost of the activity – i.e. market failures, intervention failures and distortions). Thus, regulatory authorities are gradually attempting to keep the mobile sector accountable through reactive policies at this point. While the regulatory bodies are still immature in experience with technological change with the mobile telecommunication industry, they heading in the right direction. But at this point, encouraging trade with nations that do not internalize their externalities would lead to inefficient allocation of resources and harm to the environment (Daly, 1993).

A third subject of discussion in the debate over economy and the environment relates to investments and the transfer of funds across countries. Such funds can originate from either private or public sources. The following discussion outlines the relationships between the environment and both foreign direct investments (FDI), i.e. private-sector investment, and official (government) development assistance (ODA) (Ashford and Hall, 2011). The link between global investment activities and the environment is complex. Both private and public investment in developing countries can advance or hinder important social and environmental objectives. With regards to private investment, there isn't clear evidence as to whether FDI harms the environment or whether environmental regulation impedes investment. A dynamic situation exists in which pressure on firms to invest in regions with low wages and standards to reduce costs is countered by pressure from consumers and international organizations to act responsibly. The situation is somewhat different with regards to public investments in development. Since official development assistance is subject to the rules and regulations of national and international institutions, there are mechanisms that can prevent investments that have significant negative environmental and social impacts (Ashford and Hall, 2011).

Investments from FDI and ODA across the four countries have been largely come in due to the growth of and maturation of the mobile competitive landscape. There is little indication from the source of investments that there is an environmental objective. As Ashford and Hall assert, placing sustainable development objectives at the center of foreign and public investment decisions would raise the profile of social and environmental outcomes in relation to the traditional economic indicators of success, setting precedents for other public and private financial institutions to follow (Ashford and Hall, 2011).

The impact of environmental regulation on the economy has not resulted in harmful effects on the economy, primarily because the regulations created are reactive and many have yet to be formed. However, Kenya demonstrates how environmental regulations for proper disposal of mobile phones can spur indirect economic opportunities, such as phone collection and refurbished phone distribution. Table 6.7 shows the overall summary of how each country performs according to each dimensions' indicators in the Sustainability Framework.

	Kenya	Tanzania	Uganda	Nigeria
Economy				
Improvements in competitiveness & use of capital	+	+	+	+
Economic changes	+	+	+	+
Financing growth & development	+			
Employment				
Skills	+	+	+	+
Wages	+	-	+	+
Purchasing power	0			+
Job security		-	-	
Job satisfaction				
Health & safety				
Number of jobs	+	-	+	+
Environment				
Resources	0	-	-	-
Toxic pollution	0	-	-	-
Climate change				
Ecosystem disruption	+	-	-	-
Economy-Employment Linkage				
Change in international division of labor	+	0	0	+
Changes in the nature of work	+	0	+	+
Environment-Employment Linkage				
Increased environmental footprint due to increased employment & industrial throughput	-	-	-	-
Environmental & energy improvements that impact employment	-	-	-	-
Environment-Economy Linkage				
Development & environment	-	-	0	0
Trade & environment	-	0	0	0
Investment & environment	+	-	-	-
Impacts of regulation on economy	+			

Table 6.7: Summary sustainable development assessment of the selected countries.

6.3. Willingness for Diffusion and Adoption

The growth of mobile phone coverage across Africa has been impressive. The environment for diffusion and adoption is in place due to the following factors extracted from the data and case examples examined in each of the four African countries:

- Good network coverage
- Economic status not a factor
- Relatively low charges for SMS, voice, data
- Increasing number of high end mobile phones
- Value added services
- Strong interest from users

Diffusion and adoption is shown to have a strong positive correlation with population density, but other factors matter as well. Using a spatially disaggregated dataset of mobile phone coverage and geographic characteristics, Buys, Dasgupta, Thomas and Wheeler find that the probability of having a mobile phone tower in a particular location is strongly and positively associated with potential demand factors, such as population density and per capita income, as well as the competitiveness of the mobile phone sector within the country (Buys *et al*, 2009). They also find that factors associated with higher costs – namely, higher elevation, steeper slopes, and distance from a main road and major urban centers – are negatively associated with mobile phone coverage. Empirical evidence suggests that these factors partially explain the rollout of mobile phone service within countries as well, but depend upon the topographical features of a particular country.

Mobile phone subscriptions on the continent have risen from 16 million in 2000 to 376 million in 2008 – or one-third of sub-Saharan Africa’s population. However, these figures potentially overestimate the actual number of mobile phone users, because many individuals own several handsets or have multiple SIM cards. At the same time, there could potentially be more than 376 million mobile phone users, as sharing mobile phones is a common practice in Africa (Aker and Mbiti, 2010).

The increase in mobile phone subscriptions is all the more surprising considering the prevalence of poverty in sub-Saharan Africa and the price of mobile phone handsets and services. Approximately 300 million Africans are classified as poor (living on less than USD \$1 per day), with 120 million classified as “ultra-poor” (living on less than USD \$0.50 per day) (IFPRI, 2007). For example, the price of the cheapest mobile phone in Kenya costs half the average monthly income.

Coinciding with the growth in mobile phone diffusion and adoption in developing countries over the past decade, a rich body of literature has emerged examining the determinants of mobile phone adoption. However, as Donner’s survey shows, very little of this research has been conducted by economists, and economic studies of the subject have often focused on diffusion rather than individual adoption (Donner, 2008; Balamoune-Lutz, 2003; Kshetri and Cheung, 2003). The limited economics literature on mobile phone adoption appears to be related to two factors. First, mobile phone adoption data are often limited or inaccurate, as they report subscriptions rather than individual handset or SIM ownership, which can result in serious measurement error. Second, finding credible estimation strategies to address the omitted variable bias, particularly when estimating the effect of neighbors and peers, is a significant challenge (Manski, 1993).

Despite these constraints, insights can be gained from individual and firm-level mobile phone adoption. Firm-level data from the World Bank Enterprise Surveys for Kenya, Tanzania and Uganda show that a

large percentage of firms had already adopted mobile phones in 2003, ranging from 83 to 93%. This high level of adoption appears to be correlated with the poor quality of landline services. For example, Kenyan firms reported an average of 36 days of interrupted landline service per year, with interruptions lasting an average of 37 hours. This was also the case in Tanzania and Uganda. Many firms also faced challenges in even obtaining landline service. On average, Kenyan firms had to wait 100 days to obtain landline service, with a majority of firms paying bribes to facilitate this connection. (The average bribe was reported to be worth USD \$117, compared with a GDP per capita of USD \$780). Thus, explicit and implicit landline costs could have provided powerful incentives for firms to adopt mobile phones (Aker and Mbiti, 2010).

While Kenyan firms rapidly adopted mobile phones, the individual adoption rate has been significantly lower. Data from the FinAccess surveys showed basic patterns of individual mobile phone adoption in Kenya. Between 2006 and 2009, the percentage of the Kenyan population with mobile phone coverage remained relatively static, but the number of subscriptions tripled – reaching 17 million by 2009 (GSMA, 2009). The adoption of mobile phone handsets increased from 27% in 2006 to 47% in 2009. One-third of Kenyans shared their mobile phones with friends or relatives, supporting qualitative evidence of free-riding and the use of mobile phones as a common property resource in SSA. At the same time, such patterns could also reflect cost-sharing, especially among poorer rural households for whom the cost of handsets and services is still prohibitively expensive. For these reasons, reported data on mobile phone subscriptions could significantly underestimate the number of mobile phone users; in fact, while only 47% of individuals owned a phone, 80% reported having access to a mobile phone through direct ownership or sharing.

The first mobile phone adopters were primarily male, educated, young, wealthy and urban populations, as the initial costs of handsets and services were relatively high. But secondary adopters span the demographic spectrum – young and old, rich and poor, urban and rural. By 2009, mobile phone ownership included more poor, elderly and rural individuals, in part facilitated by the introduction of lower-priced handsets and lower denomination airtime cards (Aker and Mbiti, 2010).

6.4. Motivation and Opportunity

The evolution of mobile penetration and usage by low-income consumers in the developing world is not a linear process. There are a number of key variables for operators to understand when developing strategies to drive penetration and usage amongst the poor. The first of these variables is a term called “start-up” affordability which typically includes the cost of an entry-level or second-hand mobile handset, and an initial prepaid SIM pack and all activation charges. The second variable is called “recurring” affordability which includes two key dimensions: the cost per-minute for mobile voice communication and the minimum prepaid recharge amount (either electronic or voucher) (Anderson and Moaligou).

Taking these two key variables into consideration, four distinct market types have been identified and each of these market types requires specific strategies for operators (Figure 6.4):

Recurring Affordability	Low Start-up / High Recurring	High Start-up / High Recurring
	Low Start-up / Low Recurring	High Start-up / Low Recurring
Start-up Affordability		

Figure 6.4: Factors determining motivation and opportunities in mobile phone usage.

Their study revealed that there are real opportunities for mobile network operators to serve the poor in the world’s developing markets. But operators need to understand the level of maturity of the local market, and the reality of start-up and recurring affordability of mobile telecommunications for different segments of society.

Based on the market scenarios of different countries, and even the affordability of mobile telecommunications for different demographic segments within a country, operators need to adapt their route to market approaches accordingly. They should also recognize that affordability is a dynamic process, and that a route to market approach that might have been appropriate at a certain stage of a market’s development will need to be adapted as penetration and usage practices of consumers continue to evolve.

It should also be recognized that affordability will not be the only barrier to pervasive penetration and usage of mobile telephony in the long-term. Socio-cultural factors, such as attitudes towards female empowerment, will also need to be recognized by operators in their marketing and communication strategies. This will be the next frontier driving motivations and opportunities of mobile phones in the developing world.

6.5. Current Capacity

The examination of mobile telephony technology in Kenya, Tanzania, Uganda, and Nigeria all demonstrate capacity to tackle major problems caused by poverty. While most of the data is either lacking or shows that much of the state of their systems of innovation – technological, institutions, and policies – are still young; they indicate proxies in place to examine the problems. And with the diffusion and adoption of mobile phones, not only will this raise the awareness of options and solutions, but it will also provide services to directly address the issues.

It is encouraging to see that innovation and knowledge centers have been established in each of the countries studied. These are ideal settings for ICT skills to be nurtured. While there are centers in Kenya, Uganda, and Nigeria that established by MNCs, with others that are locally-run, it is important that the growth and leadership is run by the endogenous populations in order to develop a sense of ownership of the solutions.

7. Recommendations

Mobile phone technology has seen unprecedented growth around the world. Underdeveloped and low-resource environments have not discouraged technological diffusion and adoption; in fact, growth rates have arguably been higher than much of the rest of the world. The CAGR ranged from mid-50% to 70% over the course of the past decade for the four countries examined in this thesis, compared to nearly 50% for all of Africa. However, the importance of sustainable development, complete with the Economic-Employment-Environment triangle, has not been felt in the development agenda of these countries, much less in the priorities of industrialized nations.

As a recap, this thesis started with an overview of existing models of economic development and growth as they related to factor endowments in Chapter 2. The effects of economic growth on sustainability and a holistic approach to sustainability were discussed in Chapter 3. Chapter 4 presented a regional analysis of the mobile industry covering technological options, institutions, and policies – the elements of an innovation system – for the countries studied in this thesis, Kenya, Tanzania, Uganda, and Nigeria. Then Chapter 5 presented data on the effects that elements of the mobile telephony innovation system had on sustainable development. Based on the relationship between mobile telephony technology and sustainable development, Chapter 6 analyzes the data against the indicators within the Sustainability Framework. From the comparison of technology options, institutions, and policies within each of the four country's mobile innovation system and across each of the countries, it is clear where the strengths and weaknesses are for mobile telephony's influence on sustainable development.

In this final chapter, the thesis synthesizes strategies, including options for technology, institutions, and policies that promote sustainability. The section below will cover recommendations on appropriate and effective options and pathways that could be employed so that mobile telephony technology can facilitate sustainability. The recommendations will be followed by a discussion of potential barriers to realization. This chapter, and ultimately the thesis, will conclude with suggestions for future work and research, and a final reflection on the potential of mobile telephony to contribute positively to sustainable development.

7.1. Focused Recommendations

Recommendation 1: Continued policies that encourage diffusion and adoption

As the previous chapters illustrate rapid increases in adoption over the past decade, adoption rates still remain low in many parts of SSA, widely ranging from 2% in Ethiopia to 98% in Botswana. This is partly due to the cost: the technology is still financially out of reach for about half of the continent's population. In Niger, the cost of a one-minute call off-network is USD \$0.38 per minute, representing 40% of a household's daily income.

This is where the telecommunications regulatory environment can play a key role in fostering increased mobile phone adoption. Recall condition when over 75% of countries in SSA lacked mobile phone network was associated with monopolistic networks. When half of the telecommunications market liberalized, with 24% partially deregulated and 26% remaining as monopolies, by 2009, mobile phone networks existed in every country.

When the Kenya Communications Act liberalized the telecommunications sector in Kenya, four primary MNOs formed and led to tremendous mobile subscriber growth, from 17,000 subscribers to 20 million in approximately a decade. Tanzania's fully competitive telecommunications sector has also seen

significant mobile subscriber growth, but is not as far along as Kenya. Uganda's telecommunications market was also transformed when it was liberalized, leading to more than a third of the population with mobile subscriptions. Nigeria's mobile telecommunications competitive space growing so fast that MNOs are aggressively trying to expand network infrastructure. The multi-MNO business environment has created healthy competition to lower prices significantly for end-users. Continued policies to encourage competition will enable new subscribers among lower-income groups.

China's initial growth was led by its increased investment in the export and manufacturing sectors. To sustain long-term economic growth, there is a dramatic shift towards more endogenous innovation and technological development. India's growth emphasized placing more control in the hands of institutions and policy-makers, rather than leaning towards investment in technology. However, they are also seeing the IT and telecommunications sector as a growing contributor to their GDP and job creation, and are investing accordingly. Thus, it is promising that the mobile telecommunication policies of many SSA countries are oriented towards technological innovation and adoption.

There is a strong correlation between mobile phone coverage, the types of services offered, the price of such services, and the telecommunications market structure for a particular country. Each country studied has a regulatory authority in charge of the telecommunications regulatory environment and can continue to be proactive in ensuring competition. In markets with limited competition, profit-maximizing firms would offer more limited services at higher prices. The data from the countries selected shows that increased competition has led to increased affordability and accessibility. Overall, these patterns suggest that more competitive telecommunications environments can be beneficial for poor consumers.

Recommendation 2: Technology transfer mechanisms

While there has been tremendous progress in the last decade, Africa's adoption of modern technology still lags behind other nations. For many countries, investments in new technologies have been largely neglected. Underinvestment in technology in Africa represents serious market and government failures that can be overcome through public-private partnerships. African governments must invest in improving the business climate and more specifically, the regulatory environment. They should also invest in complementary infrastructure, such as roads and electricity, in order to take advantage of and have proper access to new technologies. There is scope to utilize public and private partnerships especially as it pertains to large infrastructural projects. Also critically important is to increase investments in research and extension services to improve access to information of clients, such as farmers and patients. The adoption of technological innovations must be prioritized by African governments so that accelerated and sustainable growth can be achieved in 2011 (Kimenyi and Moyo, 2011).

There are already several mechanisms that are in place or can be expanded for countries in SSA to promote and facilitate technology transfer. From the examples studied, successful mechanisms include providing information on new and emerging technologies through multi-stakeholder and international partnerships, industrial technology alliances, developing international cooperation and partnerships and encouraging trade and FDI (UNECA, 2010).

- **Promoting technology transfer through university-industry-government partnerships**

One way of promoting the acquisition, adaptation, upgrading and diffusion of new and emerging technologies, as well as birth and growth of firms, is to improve the relationships between knowledge and skill producers (academia), knowledge users and product/service providers

(industry) and regulators/policy makers (government) (Leydesdorff and Etzkowitz, 2001). In other words, improving such interactions will breed a healthy innovation system to facilitate the continuous process of radical and incremental advances in the mobile telecommunications industry.

University programs, such as those highlighted across Africa, University of Nairobi, Strathmore University, and Makerere University, to name a few, already have academic programs to research and develop mobile applications. They are in position to pair with local MNOs and policy institutions to focus on commercialization of their technology. Examples like MIT and Nokia's EPROM program in East Africa bridges local academic institutions with those abroad and industry partners to prepare students to return to their communities with appropriate mobile content or services that meet local community needs.

Incubation centers established by MNCs can also transfer technology used abroad and drive employment creation within communities and in the region. These partnerships are critical to emphasize a focus on the needs of the end-users.

The three types of stakeholders represent the key players of any national or regional innovation system. It doesn't impose boundary restrictions in relations, interactions and location of innovations and entrepreneurship or the roles of the players. Academia-industry-government relations are playing an increasingly important role in promoting firm formation and technology transfer and diffusion. Therefore, policy-makers should stimulate such relations, ensuring their contribution toward economic and social development. This can be done through increased funding and investment.

Such promotion may take the form of cooperation in R&D through joint research projects in the field of common interest, strengthening the R&D capacity of the least developed party, exchange of scientists and researchers and fostering relations between research centers, among others.

Such collaboration also helps familiarize individuals in private and public institutions with the culture of partner countries and promote understanding. Such knowledge may be vital to foreign firms seeking to establish abroad or access technology and other resources located in other countries. In a knowledge economy, foreign investors are seeking to move to places where the cost of skills, knowledge and technology development are still low. African countries could utilize international R&D collaboration to leverage their R&D budgets, build domestic technological base, acquire international reputation and develop good policies. To achieve this goal, Africa has to sharpen its science and technology diplomacy to conclude S&T cooperation agreements with developed and developing countries in its areas of interest.

- **Industrial Technology Alliances**

Industrial technology alliances, as defined by the US National Science Foundation (NSF), are industrial technology linkages with the aim of co-developing new products or capabilities through R&D collaboration (www.nsf.gov). There are at least four factors that promote the development of technology alliances (Suarez-Villa, 2004):

- the multidisciplinary nature of R&D activities
- the complexity of R&D
- the uncertainty of commercial success of R&D products
- the high cost of R&D activities

Firms may seek alliances to spread the cost, risks and uncertainty, especially in knowledge intensive fields. Some of these partnerships may strategically position a firm to gain access to new markets and to public and private resources of its partner(s) and avoid regulatory and registration hurdles in foreign countries.

These arrangements are crucial in enabling underdeveloped and developing countries lagging behind to quickly gain access to knowledge, learn, diffuse and adopt technology without needing to rediscover the “wheel.” Recall Rodrik’s concept of self-discovery where a country discovers what it’s good at from many existing products and processes. The most significant instances of productive diversification are indeed the result of concerted government action and of public-private collaboration. The development process in LDCs is largely about structural change. What is involved is not just inventing new products or processes, but “discovering” a certain good, which can already be established in global markets, that can be produced at home and at low cost (Rodrik, 2007). Each country and each environment needs uniquely tailored solutions that mix top-down frameworks with local knowledge. Entrepreneurs and businesses must experiment with technologies from established producers abroad and adapt them to local conditions. The countries studied exemplify this discovery by using mobile telephony technology (i.e. technology developed abroad) and developing suitable and appropriate applications with local knowledge to meet their local needs.

The risk of developing, producing, distributing and marketing new products is drastically reduced in industrial alliances such as joint ventures because even LDCs may easily obtain exclusive access to its market especially where the government has a stake in the firm. Key to these arrangements is the fact that government plays a facilitating role in technology transfer through international industrial alliances and partnerships by completing science and technology agreements with other governments.

- **Encouraging Trade and FDI**

This is an area of opportunity for SSA, especially for the selected countries in this research. However, given the 2008 global economic crisis which left LDCs increasingly vulnerable to external shocks due to dependence on exports and FDI, this technology transfer mechanism should be viewed as merely a tool of a broader toolkit to be used with caution and when there is appropriate and secure developmental protection in place. While the African region is still viewed as a risky environment for investors, the growth of companies and supporting policies will increase further financing of growth and development in the near future. Figure 5.6 demonstrated that all sources of finance view telecommunications as a worthy investment. Thus, the growth of MNOs and telecom businesses will further attract more international trade and financing.

Improving physical and mobile telecommunications infrastructure will also attract more FDI. One route for this is to establish a system for venture development, incubation through industry associations or institutional bodies. This is a core role that the innovation and incubation centers in the countries studied can play to create regional network of incubators and open developer community spaces. Industry players like Google have established their first incubator and seed financing facility called Umbono. Established in Cape Town, their objective is to support the growth of the entire internet infrastructure as part of their Africa strategy (Dirk, 2011).

Recommendation 3: Data tracking and reporting mechanisms

While many of the examples and studies in this thesis research provide some evidence of the positive relationship between mobile phones and economic growth, they are still negatively affected by

endogeneity⁴¹ issues. Mobile phone penetration rates are subject to significant measurement error, leading to potential bias in the coefficient estimates. Perhaps more importantly, finding credible exogenous instruments for mobile phone penetration in the context of a cross-country growth regression is a challenge. There are many questions about the validity of metrics and hence the direction of causality. This is necessary in order to identify the magnitude of the impact of mobile phones on GDP growth in Africa with more accuracy. Yet to the extent that mobile phone adoption is associated with increases in consumer surplus, changes in measured GDP will not capture the true welfare gains this technology.

Recognizing the efforts underway to assess and collect information on the impact of technology options, institutions, and policies on sustainable development, it will be necessary to improve the reliability of mechanisms to continuously collect and maintain data related to knowledge acquisition and generation. As demonstrated in the countries studied, data is missing even in relatively more advanced African countries. Organizations such as United Nations Economic Commission for Africa (UNECA) and African Union (AU) and its New Partnership for Africa's Development Agency should commit resources to collect such information to support informed policy-making. Such mechanisms are the responsibility of the institutions in these countries.

Recommendation 4: Sustainability as a priority

This is an area where attention is severely lacking. Chapter 6 highlights that the environmental dimension of sustainable development is currently performing poorly relative to the economic and employment pillars. But there are proxies and signals, such as regulatory authorities, and reactive environmentally-friendly policies, in place to set a path towards environmental development. While the rapid growth in mobile phones has demonstrated improvements for the economic and social development, the potential for mobile technology to also improve environmental development is often ignored or a secondary priority. Technological innovation, in fact, can offer important opportunities for responding more effectively to challenges in areas such as natural resource management, agriculture, health, water, sanitation, and energy.

A number of factors (i.e. market failure, inappropriate pricing, risks, lack of knowledge, etc.) affect the adoption of environmentally friendly technologies. African governments, often preoccupied with other pressing needs, assign less priority to issues of environmental technology. Africa, therefore, needs science and technology policies that are rooted in African values, but informed by environmental perspectives that are directed towards sustainable growth and development.

To address these environmental concerns, particularly in areas that are far from set targets, such as environmental health, the application of appropriate science and technology is paramount. By investing in human resources and providing an environment for innovation, Africa can solve its own problems and improve human well-being. To be successful, however these technologies must dovetail with the broader effort of enhancing the capabilities of firms to compete in domestic and international markets (UN, 2004). The UNEP's strategy of establishing advisory and information centers, possibly leveraging the existing innovation centers focused on mobile phone technology, to introduce cleaner and more

⁴¹ In an econometric model, a parameter or variable is said to be endogenous when there is a correlation between the parameter or variable and the error term. Endogeneity can arise as a result of measurement error, autoregression with autocorrelated errors, simultaneity, omitted variables, and sample selection errors. Broadly, a loop of causality between the independent and dependent variables of a model leads to endogeneity (Peter Kennedy, "A Guide to Econometrics," 6th Edition, 2008.).

environmentally friendly production can be adopted (UNEP and Nicholas Ashford, 1994). Similarly, UNIDO's Cleaner and Sustainable Production Unit would provide valuable and transferrable knowledge around information dissemination and awareness creation, professional training, in-plant assessments and demonstrations, policy advice, and support for the transfer of Environmentally Sound Technologies (www.unido.org/cp). Additionally, the cooperation of public and private firms to create new opportunities using refurbished mobile phones and electronic devices, as was observed in the case of Kenya, should be expanded.

Unlike China and India, who are experiencing great difficulty transitioning to a low-carbon economy because they are stuck in their current stage of economic development, many countries in SSA that are leveraging innovation in mobile telephony are still the early stages of development and have a chance to prioritize sustainable development.

Harvard Kennedy School Professor of International Development Calestous Juma argues that "development cooperation has often been driven by diplomatic considerations that are devoid of serious operational content [and] much of what passes for development cooperation is focused on 'discourses' about a variety of possible options for development, rather than development action (Juma, C., 2006)." To turn this situation around and overcome these obstacles, experts call for the application of a combination of high-end and low-tech science and technology. The emphasis should be on technologies that have been proven successful and can be replicated with local capacity and resources.

Additional proxies indicating directions towards sustainable development include the African Ministerial Conference on the Environment (AMCEN), established in Cairo in 1985 under the auspices of the AU, has taken up the mandate to provide advocacy for environmental protection in Africa while ensuring that social and economic development is realized at all levels. AMCEN led the process for the development of the action plan for the Environment Initiative for the NEPAD and it has repeatedly argued that technology support and capacity building issues are key priorities in addressing the sustainable management of Africa's environmental resources. Furthermore, at the international level, further strengthening this position, in February 2006, the Heads of State and governments of six African countries (Burkina Faso, Kenya, Lesotho, Gambia, Tunisia, and Rwanda) adopted the UNEP-led Bali Strategic Plan for Technology Support and Capacity Building in the field of environment, as an expression of their high-level political commitment to promoting technology support and sustainability measures in their countries and in Africa. The Plan complements and supplements initiatives instituted under NEPAD and AMCEN and serves as a pilot study for further initiatives (Webersik and Wilson, 2008).

Recommendation 5: Mobile technology to counter external economic shocks

Recall the agrarian transformation that China underwent enabled growth through increasing the export and manufacturing sectors. However, this has since made China increasingly vulnerable to the global economic crisis. India was caught in a similar situation, though the effects of the crisis were less damaging because their exports played a more limited role in economic development, and also did not attract export-oriented investment. Both countries have signaled dramatic shifts towards domestic innovation technological innovation in the ICT sectors.

The main policy lesson to be learned from the impact of the economic crisis on LDCs is that although they should not ignore short-term, counter-cyclical measures, their ability to use such measures is limited as compared with other developing countries, and they need additional assistance in external financing. For countries in SSA, expanding the domestic market by stimulating demand requires a significant and flexible economic structure and industrial base, which the mobile industry and grow.

Thus, they need to make attempts to reduce their vulnerability to external shocks by changing their development strategies by expanding their domestic market and mobile industry through investment in technological innovation via routes discussed above and support of their local MNOs (South Centre, 2010).

SSA should embark on long-term strategies and policies that are conducive to the diversification of their economies, which may include a combination of emphasizing industrialization in the mobile industry while protecting agricultural development to also reduce vulnerabilities to external shocks. The global crisis has encouraged reconsideration of longer-term development policies and strategies in LDCs, since the pattern of global growth are likely to undergo significant changes. In particular, there can be less reliance on the export markets of the developed countries and on direct investments from their firms. It is thus even more important for SSA to build domestic economic capacity, to diversify their sources of production and growth and to expand their technological capability in the mobile telecommunications arena. This requires consideration of long-term policies on trade, industrial development and other areas, and generally of the appropriate roles of the state and market.

7.2 Barriers and Mitigation

The statistical data on ICT use in developing countries is however still lacking and the data available is mainly highlighting the digital divide. There are two primary challenges to addressing this gap: data and identification. To measure the determinants of mobile phone adoption, as well as its impacts, access to financial services and remittances, reliable and accurate data at the individual, household and village-level are needed. Yet obtaining access to mobile phone coverage and usage data, even at aggregate levels, is notoriously difficult and often bound by strict rules of non-disclosure and privacy concerns. In such cases, researchers will need to partner with mobile phone service providers and local institutions in SSA to collect such data. Furthermore, in the absence of randomized rollout of mobile phone coverage and services, establishing credible causality pathways is difficult, especially for economy-wide services like M-PESA. Nevertheless, as NGOs, mobile phone service providers and donors pilot new interventions, there are opportunities for researchers to partner with such organizations to use behavioral evaluations of these projects using experimental or non-experimental techniques (Aker and Mbiti, 2010).

The other barrier is scale. Most of the examples highlighted in this document demonstrated impact on a local, community level. A particular government might not want to support liberalized telecommunications markets, as they could improve access to information and threaten their authority. This could be the case in certain countries in SSA: 27% of non-democracies still have a monopolistic telecommunications structure as compared with 15% of democracies (many of the monopolies in democratic countries are island countries, where multiple carriers might not be appropriate) (Aker and Mbiti, 2010). Yet even democracies struggle with mobile communication: In 2007, the Kenyan government briefly considered shutting down text messaging as it was being used to incite violence (Goldstein and Rotich, 2008). During the time of writing this thesis, the recent events that took place in Egypt certainly corroborated the importance of the social media, mobile phones, and other connection technologies. At a basic level, text messages and voice calls enabled the Egyptian citizens to coordinate, stay informed, and communicate. When the government began interfering with Internet and mobile networks towards the end of January, innovative applications that converted voicemail to text feeds output to social media outlets like Twitter demonstrated the value of mobile technology and the rapid

rate at which such technologies can be developed⁴². Mobile phones also gave protesters a sense of ownership over the events. Their videos and photos will also be used to shape the narrative. Democracies also had higher mobile coverage rates as compared to non-democracies, described in Chapters 4, 5 and above in the recommendations. In order for such mobile innovation to contribute to sustainable development, these innovations must be scalable. Creating a well-connected innovation system as mentioned above in the recommendations will allow such innovations to scale to the majority.

Another barrier to sustainable development is that the indicators within linkages currently counter-act each other. For example, in the employment-environment linkage, environmental improvements hinder employment and increased employment and industrial throughout still inevitably increase the country's environmental footprint. This barrier can potentially be mitigated by first setting environmental targets early on, rather than reactively at the end of the development value chain, and promoting diffusion and adoption of mobile telephony technology around the environmental targets.

7.3 Future Work

To determine whether and how mobile phones can be an effective-poverty reduction tool in SSA, our current knowledge, unanswered questions and potential areas of future research still needs to be identified. Of the five recommendations through which mobile phones could impact sustainable development, current research primarily focuses the short- to medium-term effects, as well as micro-scale impacts, of mobile phones on search costs, market behavior, and price dispersion. This research is useful, but it is a small subset of what could and should be known. Below are potential areas of future work in the short-, medium- and long-term.

Short-term research

The variety of appropriate technologies introduced in SSA – such as improved seeds, solar-cooking stoves and agricultural techniques – have been diffused and adopted to varying degrees. However, it is clear that mobile phone adoption has occurred at a staggering rate on the continent. Yet few empirical economic studies examine causal linkages of mobile phone adoption, reiterating the importance of Recommendation 3 above. This could be due to a variety of factors, including unreliable or non-existent data on individual-level adoption (leading to measurement error), the multiple economic and social benefits of mobile phones (making it difficult to assess direct benefits vs. costs) and the impact of the community (i.e. neighbors and peers) on individual-level adoption. All of these factors make it difficult to develop an estimation strategy. Identifying the determinants of the level and rate of mobile phone adoption in SSA can provide important insights into future demand for mobile-based services and products, as well as demand for the variety of other appropriate technologies.

Environmental sustainability and targets to drive improvements along the indicators in this research are still treated reactively and in many cases as a secondary priority. Thus, goals should be set immediately and development strategies should be designed early in the technological and development value chain. As mentioned in Recommendation 4, this should be at the priority of the regulatory authorities responsible for policy-making coupled with tight communication with private firms mostly responsible for the development of mobile phone technological innovation.

⁴² Google and Twitter teamed up to launch a speech-to-text recognition technology that converted voicemails left to a specific phone number into tweets sent out with the “#egypt” hash tag, all developed over the course of a weekend.

Medium-term research

While mobile phones can facilitate communication among members of social network, they also have the potential to fundamentally change the way these networks function. Past research has discovered that new technologies, such as radio and television in the SSA environment, have had both positive and negative impacts on social relationships and behavior in developing countries (Olken, 2009). For example, in Niger, the introduction of mobile phones can reduce the magnitude of a border effect (a discontinuity in prices or in quantities of trade at the border between countries) across different ethnic regions in Niger (Aker and Klein, 2010). Research should investigate if mobile phones will change the nature of such relationships in Africa. As seen in the data from the studied countries, especially Kenya and Tanzania, mobile phone technology can strengthen some social networks by allowing individuals to communicate more frequently and firms to communicate across large distances, and broaden other networks as traders and firms conduct business in new markets. At the same time, mobile phone technology could potentially weaken local social networks and community norms, as individuals are able to reach beyond their inner circle to access credit and services. Understanding the effects of mobile phones on these networks will be very important.

The impact of m-money systems, like M-PESA in Kenya, on microeconomic and macroeconomic outcomes is a rich area of research, especially as these systems expand their geographic coverage and range of services. While m-money systems have the potential to create a new class of currency as they grow in magnitude, a large potential impact of these systems is in the area of international money transfer. The World Bank estimates that officially recorded remittance flows to developing countries reached USD \$338 billion in 2008, with USD \$21 billion in transfers to SSA (World Bank, 2009). M-money transfer systems could change the duration, frequency and magnitude of these remittances, thereby affecting households' business opportunities, educational investments and income. The diffusion and adoption of m-money transfers in SSA provides a unique opportunity to measure the impact of this service on migration patterns, remittance flows and welfare outcomes.

Long-term research

Mobile phone-based development projects are often born from the assumption that mobile phones can improve communication, coordination and service delivery. Yet the use of mobile phone technology in these contexts may not always optimize market functionality. Some firms have begun using mobile phones as a mechanism for distributing cash transfers. While this approach could be more efficient, it is not without risks: it could potentially target the wrong populations (if individuals do not have mobile phones) or increase beneficiaries' risk (if they must travel to find an agent to withdraw the cash). While this provides one example, it suggests that rigorous impact evaluations of mobile phone development projects are needed to determine whether, how and under what conditions mobile-based solutions are better to their current or alternative options (Aker and Mbiti, 2010).

Further research is also required to understand the drivers and conditions for promoting technology transfer to account for national differences among African countries. It will be interesting, for instance, to uncover why some of Africa's relatively larger economies such as Morocco and Zimbabwe seem to have underperformed according to some of the sustainability indicators and proxies in this thesis. Such research might reveal more specific and preferred modes of technology transfer and the motives in order to make policy decisions encourage such transfers, especially in designing incentives for R&D expertise, ICT skill development and foreign and domestic investment.

Africa's need for improved physical infrastructure, school buildings, computer networks, power generation and especially telecommunication system, opened a lucrative window of opportunity for Chinese firms. China's recent investment in Africa over the past decade is part of a more active international strategy based on non-intervention. Increased aid, debt cancellation, and a boom in Chinese-African trade, with a strategic Chinese focus on oil, have proven mutually advantageous for China and African state elites. But this can bring significant economic and political consequences. By offering aid without preconditions, China has presented an attractive alternative to conditional Western aid, and gained valuable diplomatic support to defend its international interests. However, a generally asymmetrical relationship differing little from previous African-Western patterns, alongside support of authoritarian governments at the expense of human rights, make the economic consequences of increased Chinese involvement in Africa mixed at best, while the political consequences are potentially harmful (Tull, 2006). More attention and work must be directed to explore potential effects and design protections for vulnerable African nations.

7.4 Conclusions

Mobile phone adoption in SSA has grown significantly over the past decade and now covers 60% of the population. This thesis presents evidence that mobile phones have the potential to benefit consumer and producer welfare, and perhaps broader economic development. As the prices of both handsets and airtime continue to fall with increased competition, the mobile phone will reach nearly all income levels. MNOs are continuing to innovate in their push to reach more subscribers. The challenge is now to ensure complementary access to public goods and the development of appropriate policies to evaluate and propagate the benefits of mobile phones throughout the continent.

The future offers real opportunities for development and growth in Africa. Technological innovations and institutional developments play a critical role in maintaining a sound environment in the SSA region. If the focus of development shifts from mere economic growth to sustainable development, many stakeholders and citizens can play a more decisive role, not only in turning the economic fortunes of their countries around but also in enhancing the quality of the environment.

To achieve these goals, countries need to mobilize their science, technology and innovation development agents (i.e. those responsible for promoting investment, small and medium-sized firms, trade and industry and diplomacy) to emphasize the need to facilitate the recommendations above and improve sustainability.

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