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## **A New Framework for African Economic Development with a Focus on Technological Innovation**

Jean-Claude MASWANA \*

### **Abstract**

Based on a brief analysis of the development paradigm shifts, growth theories and perspectives that have influenced four decades of African economic development, this paper suggests that the challenges confronting African development result primarily from continuously shifting paradigms and inconsistent growth policies that neglect the role of technological innovation. Moreover, given these challenges, achieving rates of GDP per capita change that result in an increase in average income over a long period will demand an emphasis on and adoption of technological innovation and R&D, as well as corresponding education policies. In terms of perspective, the survival of African countries in the twenty-first century undoubtedly depends on the continent's ability to apply existing scientific and technological knowledge to the achievement of economic growth, income distribution and environmental protection. Engineering the complementarity among these three objectives will require not only institutional and structural adjustments and technological innovation and adoption but also a culture of innovation that most parts of Africa do not currently perceive as a crucial factor for social change.

Keywords: Development Economics, Technology, Africa  
JEL codes: O11, O14, O55

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## 1. Introduction

Sub-Saharan Africa (henceforth SSA) may well be remembered in world history as the worst economic disaster of the twentieth century. Between 1965 and 1990, while GDP per capita grew by an average 5% annually in Asian countries and an average 2% in Latin America, no real GDP growth occurred in Africa [ECA 1998]. Rather, following the relatively strong economic growth of the 1960s, the subsequent three decades were a period of socioeconomic stagnation. SSA's average per capita income growth of 0.9% for the four decades as a whole falls short by 1.5 percentage points vis-à-vis other developing countries and is approximately 3 percentage points below that of the high-performing African (i.e. Botswana and Mauritius) and East Asian economies. Thus, whereas in 1960 average real per capita incomes in Asian and African countries were roughly similar, 30 years later, income per capita had more than tripled in Asia but risen only moderately in Africa [Agenor and Montiel 1999].

Even though in most African countries natural resources are abundant and labor surplus available, these resources have yet to be transformed to serve people's needs. Unlike many countries in other developing regions, which managed to restore growth after the lost decade of the 1980s, SSA continued to suffer stagnation and decline during the 1990s. Furthermore, despite the implementation of drastic macroeconomic policies and structural reforms in the last decade, Africa's economic performance since the early 2000s has been relatively weak.

Since the 1950s, the field of development economics has offered several theories on developing economies (especially SSA), the application of which was intended to enable these economies to overcome the problems of low growth and high poverty. However, the expected economic growth and development have yet to materialize. This failure raises two important questions that must be answered if the region is to eliminate the poverty trap and return to a path of sustainable economic growth at much higher rates. First, to what extent can the main development paradigms and growth theories behind African development policy choices explain the poor performance of the continent's development course? Second, beyond international trade environment and institutional weaknesses, what else can be done to effectively promote sustainable economic growth in Africa? Whereas it is difficult to isolate one single factor that explains Africa's poor growth performance, this analysis – based on a comparison of the policies pursued by Africa and other developing regions and the results achieved in terms of economic development – argues that the challenges confronting Africa's development come from two interrelated sources: (a) a continuous paradigm shift and (b) inconsistent pro-growth policies that virtually neglected technological innovation. Yet, if Africa is to converge to the level of income seen in Asian economies, and if prevailing levels of critical poverty are to be reduced, such innovation is crucial. Therefore, to achieve these goals, Africa must find and implement the right set of innovation policies.

The aim of this paper is to provide interested readers, particularly economic development practitioners, with an accessible non-technical summary of developmental paradigm shifts, growth theories and perspectives of African development. The intent of the literature review is to be neither exacting nor exhaustive but rather, by introducing a new emphasis on innovation as a source of growth, to broaden and enrich the debate and help develop a stronger consensus on the appropriate policies and incentives that will raise living standards throughout Africa.

The remainder of the paper is organized as follows. To illustrate how theory has shifted over time, section 2 reviews the major development paradigms, after which Section 3 summarizes the two main growth theories. Section 4 then outlines the resultant economic development performance of the SSA region, which provides evidence that the technological innovation, and corresponding policy prescriptions, discussed in Section 5 is a key factor in SSA's potential for success. Finally, section 6 presents the author's recommendations on the appropriate means by which Africa can reach its basic development objectives.

## **2. Major Development Paradigms in African Development**

No area of economics has experienced as many abrupt changes in leading paradigm during the post-World War II era as has economic development. Since economic development is a policy science, these twists and turns in development economics have had profound implications for development policy [Adelman 1999].

A development paradigm, generally understood as a model, pattern, archetype or statement of the first principle of a development process, includes a community's basic assumptions, values, goals, beliefs, expectations, theories and knowledge about improving its well-being. Practically, development paradigms determine issues such as means of economic development, areas to be prioritized, ways to achieve the paradigm, and at what cost and whose expense. In other words, development means different things to different people at different periods of time and under different ideologies. The development paradigms themselves have in turn been shaped by three factors: prevailing dominant ideologies; the evolving frontier of development economics in response to actual experience; and changing attitudes towards the roles of market, state, private sector, institutions and political regimes.

Among the most prominent development paradigms that have influenced the development path of Africa are the early development ideas of import-substitution industrialization (ISI) and basic human needs (BN), the market paradigm (MP) and the sustainable development paradigm (SDP) and its pro-poor variant. It should be noted that this categorization is not clear cut and that some prominent development ideas (such as Marxist paradigms) are not reviewed here because their impacts in Africa have been limited.

### *2.1. Early Development Ideas*

Even though pioneers of development economics such as W. Arthur Lewis, Raúl Prebisch and Walt W. Rostow differed considerably among themselves, they had certain unmistakable commonalities. First, all recommended an inward-looking development path with a leading governmental role in growth process. In addition, all three emphasized the importance of economic growth *per se*, envisaging its benefits as eventually trickling down to the poor. At that time, economic growth, measured by rising per capita income, was the focal defining characteristic of economic development; which was thought to be the transformation of a traditional subsistence-oriented economy into a dynamic capitalist economy [Lewis 1956; Rostow 1960].

During the 1950s, industrialization was generally viewed as equivalent to development, and developmental thinking was dominated by the idea of economic growth as a crucial condition for poverty reduction. Adherents of this approach, such as Lewis [1954] and Rostow [1960], viewed the problem of development as synonymous with

successfully launching the economic growth process, after which point traditional agriculturally based societies would be transformed by a virtuous circle of saving and investment into so-called modern industrialized economies.

As regards policy, the prevailing theoretical winds indicated a strong inclination to turn to the interventionist state as a key development instrument, a trend motivated by the desire to bring about long-term change in the economic structure [Hunt 1989] and cut pre-independence colonial ties identified with the market mechanism [Ranis 2004]. Moreover, because the international trade scene, dominated by structuralist economists like Prebisch [1959], Singer [1950] and Myrdal [1957], was considered hostile and unfriendly to development, African countries were advised to increasingly produce the goods they needed for their own consumption. This recommendation inevitably led to an inward-oriented industrial path through progressive import substitution, which requires selective protection implemented by a strongly interventionist state.

In other respects, Lewis [1956] shows that, under certain circumstances, expansion of the money supply and associated price inflation can accelerate the rate of growth in a country through surplus labor. This acceleration can occur when credit is created in favor of private capitalists or when it is used to finance government capital formation, provided that the projects financed generate increased output fairly quickly.

The above development ideas, which had already been implemented in Latin America in the form of import-substitution industrialization, represented the development scene when African countries gained their independence during the 1960s.

## *2.2. Import Substitution Model*

Import-substitution industry (ISI) is a development strategy by which a technologically backward economy tries to accelerate industrial investment primarily for the home market through heavy reliance on government manipulation of market prices, barriers to entry and access to imports and finance [Felix 1989]. Such import substitution was at the heart of African development strategies during the 1960s and 1970s when African countries established industries to produce consumer goods intended mostly for the new urban middle classes.

In the aftermath of African independences, the primary focus of economic development was to speed up the process of industrialization. Since newly emerging firms needed protection to help them close the productivity gap, the infant-industry argument was applied throughout Africa. That is, as noted above, industrialization was perceived as being at the heart of the development process because (compared with other sectors) it could offer higher productivity, larger positive externalities, more economic independence and longer term comparative advantages (particularly given anticipated declines in the terms of primary product trading). Added to this view was a widespread belief that unregulated capitalist development would lead to unacceptable income-distributional consequences. These factors gave rise to a major emphasis on planning and the role of the state in guiding industrial development, particularly as policy makers and government officials were thought to have good information relative to private entities.

To guide development efforts, African governments employed three sets of policies: direct public investment in state-owned enterprises, licensing of private industrial activities and the establishment of industrial-development banks [Dervis and Page 1984]. Given investment's high dependence on imported capital goods, there was a basic need for long-term foreign-exchange credit. Thus, the industrial-development banks were the primary channel through which long-term credit from bilateral and multilateral donors and

financial institutions were made available to the large public companies. As a result, domestic savings mobilization became almost neglected. To maximize the pace of economic development, governments were advised, among others things, to do the following:

- contain premature increases in subsistence incomes via tax policy;
- judiciously expand the money supply to help finance capital formation; and
- protect the domestic capitalist sector from foreign competition in order to compensate for the distorted operation of the law of comparative advantage.

In this context, the need to generate an exportable surplus of manufactured goods emerged as a very important requirement for sustained growth without a balance-of-payments crisis. According to Dervis and Page [1984], it became clear that the infant-industry argument had been applied to infant import-substitution activity but not to infant export industries. On the contrary, the latter had suffered from the anti-export bias of an incentive structure reinforced by chronic overvaluation of exchange rates.

It should be noted that, because of the broadly accepted belief that import substitution entailed import replication and hence adoption of identical technologies to those used in advanced countries [Hunt 1989], ISI did not pay explicit attention to technology choices. Nevertheless, ISI often required foreign investors to employ native workers in skilled positions and purchase inputs from domestic producers as ways of ensuring technology transfers.

Moreover, African countries applied ISI in different doses depending on their ideological orientations. For instance, following its independence, Kenya pursued a policy of import substitution through restrictions on imports, price controls, the establishment of marketing boards and the nationalization of industry – all of which led to economic stagnation and had a devastating effect on the country's citizens. In its case, Tanzania pursued *ujamaa*, or “African socialism,” which involved the nationalization of trade, absolute price controls and the abolition of private ownership [Erixon 2005]. In both Kenya and Tanzania, as everywhere else throughout the continent, ISI delivered very poor results in terms of productivity improvement, structural transformation of the economy, export diversification and income inequality [ECA 2004].

Overall, despite wide acceptance of ISI in the early postwar decades as a positive component of the catch-up efforts of late developing economies, indications pointing to low returns, inefficiency, low capacity utilization and low labor productivity resulted in the strategy losing favor in the 1970s to be gradually replaced by the basic needs (BN) paradigm.

### 2.3. *Basic Needs Paradigm*

The basic (human) needs paradigm arose in reaction to the implicit ISI assumption that economic growth would automatically take care of both the human and social dimensions. In other words, economic growth was expected to trickle down to the poor and middle classes, thereby benefiting society as a whole. However, ultimately, no such trickle down occurred.

Perceptions of basic needs during the mid- to late 1970s [ILO 1976] switched emphasis from economic growth to the provision of certain minimum requirements for an adequate lifestyle (e.g. food, water, shelter, housing, health and education). Moreover, by focusing on the provision of primary services in rural areas, basic needs reversed the priority given to economic growth [Lipton 1977]. At the same time, because of its emphasis on human capital investments, BN aimed at increasing the purchasing power of the middle

classes and poorer members of society, precluding, by definition, an emphasis on the maximization of economic growth. Rather, policies aimed at stimulating and increasing the purchasing power of the poor and other lower income or excluded groups.

Moreover, BN's tenets did not concentrate only on material aspects but rather were connected with the concept of security (i.e. freedom from fear and freedom from want). This immaterial sphere of BN has long been supported by Amartya Sen [cited in Desai 2001] whose great contribution was to recommend that the state concentrate its capabilities on providing not manufacturing industries but goods and services through more progressive taxation, public provision of consumption goods to the poor and development of new technologies to aid in the productivity of low income workers [Hunt 1989].

Major policy implications following from the BN paradigm include the use of a package of policy instruments to promote small farm production (land reform, agriculture research, credit and marketing); commitment of resources to research the development of small-scale labor-intensive production technologies; promotion of local associations (self-help groups, and credit and savings groups); and expansion/revision of technologies and methods and public service provision in order to reach the poor more effectively. Thus, whereas the expanding capitalist nucleus is a paradigm of capital concentration, BN is a paradigm of capital dispersal [Hunt 1989].

Meanwhile, on the early 1980's financial front, while BN policies were still being formulated, the Leadership Development Centre's (LDC) interest on loans skyrocketed when the United States attempted to reduce inflation by enforcing stringent monetary policies. At the same time, raw material prices around the globe fell sharply, drastically reducing the LDC debt-servicing capacity. Many African countries virtually defaulted on their loans and required still more loans and other foreign aid assistance. Since new loans from private sources had become inaccessible, these nations had to rely heavily on the World Bank or the International Monetary Fund (IMF). Abandoning the BN paradigm, international financial institutions (IFIs) demanded drastic structural changes in these countries as a condition for loans. Again, the focus of development moved from the social to the merely economic.

#### *2.4. Market Paradigms*

Centered on what came to be known as "structural adjustment programs," the new development paradigm emerging in the early 1980s required debtor governments wanting to reschedule their debts or borrow additional loans to impose very strict economic programs. Specifically, African countries had to deregulate their economies using long-term structural reforms; liberalize trade and investment; privatize state enterprises and enact short-term stabilization measures like cutbacks in government expenditures, high interest rates and currency devaluation. Put simply, countries had to cut spending to decrease their debt and stabilize their currency.

In direct contrast to BN, governments were now obligated to limit their costs by slashing social spending (e.g. education, health and social services), devaluing the national currency (via lowered export earnings and increased import costs), creating strict limits on food subsidies, cutting workers' jobs and wages (especially workers in government industries and services), taking over small subsistence farms for large-scale export crop farming and promoting the privatization of public enterprises. Structural adjustment programs also required African countries to adopt policies like monetary tightening (high interest rates and/or reduced access to credit) and reductions in barriers to trade and foreign



investment and ownership [Lensik 1996]. As is apparent, the market paradigm constituted a complete reversal of the BN prescriptions.

It should be noted that the external debt crisis of the 1980s coincided with the advent of neoliberal economic thinking in the United States and within two of the IMF–World Bank’s most powerful and influential shareholders. In addition, 1981 saw the publication by the World Bank of *Accelerated Development in Sub-Saharan Africa*, a widely circulated and influential report that emphasized the importance of correct pricing policies and reduced government intervention in economic activities as two key steps to reviving African growth rates. Officially, the market paradigm was preoccupied with efficiency in resource allocation and its implications for growth. In practice, however, structural adjustment policies (SAPs) were considered by many to have been imposed to ensure debt repayment and economic restructuring at the cost of social development.

Breaking with the prominent role of local governments in designing development plan, IFIs became the major and sole leading institutions in charge of African development. As a solution to the continent’s problems of low growth and structural mass poverty, countries adopted the structural adjustment package designed by the International Monetary Fund and the World Bank to move towards a deregulated open economy and lead to integration with the global economy. However, these programs sought to leave accumulation and growth to free market forces without paying adequate attention to shortcomings of domestic markets and enterprises, physical and human infrastructure, and institutions.

In the field of industrial policy, the market paradigm recommended a broad range of liberalization policies and the removal of import-substitution mechanisms. That is, instead of trade barriers to protect domestic import substituting industries, it recommended promotion of export-based industries that would lead on the one hand, to competitive efficiency in the exporting industries and on the other, to a pattern of industrialization based on the country’s comparative advantages [Hirway 1998].

These policies and the IMF’s role in implementing them have been criticized by developing country governments and development organizations as having worsened the situation of poor and lower income people, as well as having contributed to the degradation of the natural environment [Mihevc 1995]. Not only has the SAP model of development come under criticism by many NGOs and other groups, but as early as 1987, it had already been shown that SAP’s macroeconomic emphasis was inconsistent with the long-term development interests of the region, particularly in light of the negative impact its corresponding policy measures had on the poor and the vulnerable [e.g. Cornia *et al.* 1987]. On the basis of such criticism, later versions of the policy package began paying attention to these aspects, leading to a revival of interest in the analysis of poverty alleviation and sustainable development.

#### 2.5. Sustainable Development Paradigm

Sustainable development can be defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs [WCED 1987]. Development economists suggest that this definition implies a balance between three pillars: a nation’s economic, social and environmental needs. Economic needs relate to the growth of various sectors in the economy, social needs relate to equitable distribution of the rewards from growth, and environmental needs relate to quantity and quality of the natural resource stock and the environment.

As regards the latter, it is arduous to separate economic development issues from environmental issues: many forms of development erode the environmental resources upon which they are necessarily based, and environmental degradation can undermine economic development. Thus, because poverty appears to be both a major cause and effect of global environmental problems, it is futile to attempt to deal with environmental problems without using a broad enough perspective to encompass the factors underlying world poverty and international inequality (WCED 1987).

The sustainable development paradigm was very well articulated in the World Bank's 1991 World Development Report, which concluded that the challenge to policy makers in developing countries is to exploit the complementarities between state and the market. The report also recommended an enabling climate (one that includes competition to foster innovation and cost efficiency), the strategies of openness to trade, and export-led industrialization and macroeconomic stability as essential parts of a stable development environment.

Because the mid-1980s saw a major shift towards an emphasis on government failure, constraining the state was seen as a prerequisite for growth. However, the 1990s saw this position moderated to one of making the state work with the market through improved governance structures and more inclusive political processes. Thus, the primary responsibility of the state then became to address coordination failure when opportunities were substantial but in need of purposive government action for realization [Ndulu 2005].

Since the mid-1990s, because of market principles whose status remains high coupled with the increasing role of the World Trade Organization (WTO) as a newcomer among IFIs, sustainable development concerns have been given lower priority. Rather, concerns have been moving toward the seemingly unreachable African global competitiveness and the still prominent role of the policy set termed the Washington Consensus, a shift that has reduced the commitment to environmental improvement and changed production and consumption patterns. Additionally, social and ecological considerations have been neglected and quickly outpaced by an almost unchecked promotion of a free market economy. Consequently, a neoliberal model of economic development – one driven by the demands of transnational corporations – overshadows and at times supercedes development implementation policies directed at introducing social and ecological aspects of sustainability.

In recent years, sustainable development has been readjusted to meet the millennium development goals (MDGs) agreed upon by U.N. member states to reduce global poverty and improve living standards by 2015, thereby converting it into a poverty reduction strategy (PRS) alternative to structural adjustment policies. Launched by the IFIs in September 1999, the PRS approach emphasized participatory, country-owned national development strategies for reducing poverty. However, early evidence suggests that the approach suffers from significant incoherence with other issues like pro-poor trade, food security and environmental sustainability. Moreover, participation has been largely theoretical in that macroeconomic and structural reform policies are still too often developed outside the country.

## *2.6. Influence of External Ideas*

International financial institutions, whose influence on the formulation of country development strategies has made them central players in the numerous African policy reconfigurations over the last 45 years, have had a pervasive influence on African

development thinking. Overall, IFIs have influenced the ideological and technical content of chosen strategies, as well as the levels and character of official development assistance.

As shown in the previous sections, during four decades of development efforts, Africa has moved from one focus to the other, with all paradigms shifts, like any social change, involving some of the following costs:

- Confusion in goals – i.e. whereas economic growth and poverty were claimed to be the goals, the facts point to debt services;
- Abandonment of ongoing project/program leadership resulting in white elephants and demobilization of energies;
- Loss in accumulated knowledge and skills – e.g. excellent analysts trained in planning became unfit as market evaluators;
- Increasing conflicts among development actors – i.e. NGOs, widely supported during the BN era, found no clear role under the market paradigm, turning them into strong critics of IFIs; and
- Macroeconomic instability and social unrest resulting from abrupt cuts in food subsidies and other social benefits.

The continuous shift in development paradigm has, *ipso facto*, resulted in policies that lack consistency, with too frequent instances of policy reversal. The resulting confusion has led African leaders to lose any sense of the direction in which to take their people and made them completely reliant on external assistance. Even when a vision has been articulated, the lack of a functioning bureaucracy has weakened the linkages between vision and practice. Moreover, heavy reliance on outside expertise limits opportunities for learning from one's own mistakes, a vital element in all learning. Not only has frequent paradigm shift been detrimental to the African development process, but the failure to understand the idiosyncratic nature of economic growth has also led to wrong policy prescriptions that have worsened even further the circumstances needing to be changed.

In sum, established development paradigms have not matched the complexity of African constraints and have often led to false optimism about the future. Specifically, the ideas chosen and implemented to guide African development – ideas that have played an important role in the continent's evolution – have to a large extent determined what the outcomes would be. When development policies are not adapted to the country's context, the outcomes are less effective or even undesirable. Moreover, when the paradigms are flawed, progress is distorted and often stunted. Thus, since past approaches have failed, it is important that future policy making be guided by appropriate theories, especially in the area of economic growth.

### **3. Models of Economic Growth**

#### *3.1. Early Growth Models*

Despite the shift in emphasis from economic growth to human and poverty concerns, it is still widely agreed that economic growth should remain a critical factor in the development process. However, even though the field of economics has made great progress, economists' views on the nature and causes of the wealth of nations are today more than usually divergent. Indeed, the wealth of nations is still as central a theme now as in Adam Smith's 1776 treatise. Smith's conceptualization of economic growth was simple: greater division of labor generates increases in production and productivity, thereby promoting technological progress through specialization and adaptation of new techniques. The accumulation of physical capital is both a *cause* and a *consequence* of this

specialization process, which, since the only restriction on the division of labor is market size, is reinforced by domestic and international trade.

Classical economists took for granted the idea that a complex network of interdependencies among economic, technological and institutional forces provides the backdrop for the long-term growth of any given economy. Indeed, the first three chapters of Smith's *Wealth of Nations* are devoted to an examination of the forces that give shape to the social division of labor and their links to human invention aimed at discovering new, more efficient ways of doing things, including the design and construction of new machines. [Katz 2001].

Smith's ideas, followed by those of later thinkers, had a lasting influence on current understanding of economic growth. Among Smith's followers, Roy F. Harrod and Evsey D. Domar provided the simplest and best-known production function for the analysis of economic development. This Harrod-Domar model, developed in the 1930s, suggests that the economy's rate of growth depends on the level of saving and the savings ratio, the productivity of investment (the economy's capital-output ratio) and the depreciation rate. The primary implications of the Harrod-Domar model, used in developing nations to facilitate examination of the relationships between growth and capital requirements, are that economic growth requires policies that encourage saving and/or generate technological advances, which in turn lowers capital-output ratio. In this context, a savings gap can be met by borrowing from overseas [Gylfason 1999].

In the mid-1950s, Robert Solow pioneered the neoclassic theory of modern economic growth, which in essence attempts to explain growth in terms of the productivity of labor. Solow's model features a neoclassical production function that explains the level of output in terms of two factor inputs – labor and capital. This aggregate production function features constant returns to scale and returns to each input that fall asymptotically to zero; however, because some inputs cannot be accumulated, the model cannot generate sustained growth unless technology – or more specifically, the standard of living of a population in terms of average quantity (and quality) of machinery and equipment for each worker – is assumed to improve exogenously. Nevertheless, Solow's model does explain the growth in an economy by breaking down the aggregate output (GDP) into contributions of growth inputs (labor, capital and technology).

Solow [1956] was one of the few besides Schumpeter to emphasize the importance of technology in generating growth. Together, Solow and the other growth theorists have clearly demonstrated that the simple accumulation of capital factor cannot alone account for long-lasting growth and that eventually growth will stop growing as it reaches the point at which the returns to an additional unit of capital fall so low that adding new equipment and machinery is no longer profitable [Lucas 1988].

Solow's model, which views technology as a continuous ever-expanding set of knowledge created specifically by economic forces, has strongly shaped economists' policy recommendations and the kinds of policies many governments have followed. A number of economists have used this basic framework to make elaborate calculations of the relative contributions of expanding (and improving) labor supplies and increasing capital investment to driving growth [Cortright 2001].

One key feature of neoclassical models is that technological innovation – the development of new technological ideas or designs – is exogenously available to the system. One important prediction, known as convergence, has had powerful implications for the course of economic development. Solow's convergence, specifically, predicts that free

movement of capital at the global level will shift to less developed countries in which capital productivity (and hence the rate of profit) is very high because of its relative scarcity. This inflow of foreign investment into developing countries will raise worker productivity and income, which in turn will lead to convergence of the average per capita income in these economically backward countries towards the higher incomes of more advanced economies.

Yet, despite neoclassical growth economists' own conclusions that capital accumulation alone cannot account for continuing growth in developed countries, the full implications of this assumption have yet to be presented in the empirical and policy-oriented literature. Rather, based on predictions of harmonious growth, the policy recommendations that come out of neoclassical growth theory encourage savings and investment at large. That is, given enough time, and except for differences in tastes and natural resource endowments, all countries are expected to naturally and rapidly converge to the same level of well-being.

Moreover, even though technology is a central component of the neoclassical growth model, technological prescriptions are not emphasized in policy formulation. Thus, because technology was thought to be exogenously determined by factors behind the government's control, African policy makers did not concentrate on funding research and development (R&D). Nevertheless, during the 1980s, as new sets of questions began to emerge among development theorists, the limitations of neoclassical ideas of economic growth like Solow's model and its later variants became gradually more evident. Moreover, subsequent empirical work confirmed the important role of human capital in growth [Mankiw *et al.* 1992].

### *3.2. Endogenous Growth Models: Human Capital and Knowledge*

The obvious shortcoming of the neoclassical model – that long-run per capita growth is determined by the exogenous rate of technological progress – was modified in the 1980s by a group of models that explain long-term economic growth endogenously. These models achieve such endogeneity by relaxing the assumption of diminishing returns to capital, by rendering technological progress endogenous to the model, and by providing mechanisms through which economic and social policies can affect long-term growth through their effects on human and physical capital accumulation.

In an influential seminal work, Romer [1990] suggests that in modern economic growth, R&D activities linked to industrial patterns of specialization are determined within each nation. Because the most intensively used input in such research is human capital, the microeconomic decisions made on the allocation of human capital in R&D or in the production of goods directly are what really determine the return on new investments and hence the sustainability of long-term economic growth. Indeed, Romer [1990] observes that whereas the raw materials used have changed little overtime, technical progress has made the *instructions* followed to combine them vastly more sophisticated. Thus, the driving force behind economic growth is technical progress, which should therefore be modeled endogenously.

Such endogenous innovation overcomes diminishing returns to physical capital, thus allowing per capita accumulation of capital and economic growth to be sustained at a positive rate indefinitely. In other words, if public and private sector investments in human capital and innovation are optimal, an economy can attain a perpetually constant rate of growth in output and consumption. It then follows that poor countries fail to achieve higher

rates of growth because they fail to generate or use new technological ideas to reap greater economic opportunities.

New growth theory, and the increasing returns associated with knowledge, has many implications for economic development policy [Cortright 2001]. Perhaps most important, policy makers need to pay careful attention to all the factors that provide incentives for knowledge creation (R&D; public institutions; the education system; and entrepreneurship, as well as tolerance for diversity, macroeconomic expectations and openness to trade). Yet, even though these new ideas on the roles of human capital and knowledge capital have had a remarkable influence on economic literature, policy makers in most developing countries have found them difficult to digest. For instance, Africa has made an enormous effort to seek macroeconomic stability but has done very little to implement policies that stimulate a closer relationship between production, technological innovation and demand for specialized human capital.

As illustrated by the move from the Solow framework to the external emphasis of the endogenous growth perspectives, innovation may well have been the critical missing element in policy implementation in Africa as a whole. In turn, this missing factor may have led to the disappointing economic development performance in SSA specifically.

#### **4. African Growth and Development Performance**

The overall performance of African economies during the different decades corresponds approximately to the development paradigms outlined above. This section outlines both overall performance and performance prior to and following 1980.

##### *4.1. Overall Performance*

After decades of serving as the testing ground for various alternatives of development models and growth theories, sub-Saharan Africa, as 1960-2002 data show, still retained a low average real GDP growth that was continuously decelerating. During 1960-2002, the growth performance of the entire region was weak, with an average growth rate of 3.3%, a figure that barely exceeds the average population growth rate of about 3% and is less than half what is needed to achieve the MDG of halving the number of people living in extreme poverty (US\$1 or less per day). As Figure 1 shows, GDP growth was substantially higher in the 1960s to mid-1970s, with the lowest level coming later. The growth rate was 5% in 1961-1968 (the era of import-substitution industrialization), dropped to 3.1% in the 1970-1979 period (the basic human needs era), plunged to 2.2% in 1980-1989 (the market paradigm era), averaged 1.9% in 1990-1999 (the sustainable development era), and improved to 2.9% in 2000-2003. In per capita terms, African performance started at a higher level in the 1970s but has not improved compared to the impressive leap in Asia (see Figure 2). Rather, African economic growth remains too unstable and insufficient to significantly reduce poverty. Furthermore, it is worth noting that economic growth has been driven primarily by factor accumulation, with little role played by total factor productivity (TFP) growth [Tahari *et al.* 2004].

[Insert Fig. 1 and Fig. 2 about here]

According to a recent report by the Economic Commission for Africa (2005), during the 1990s, the continent saw the slowest progress overall and suffered reverses in crucial areas. In SSA, the number of people living in extreme poverty rose from 217 million in 1990 to 290 million in 2000, while adult life expectancy declined from a little over 50 years

to 46 years. Based on the trends of the past 15 years, SSA will not achieve the MDGs on time.

This continuous decline in growth rate was accompanied in the 1970s by a significant decline in agricultural contribution (compared to the 1960s) and in the 1980s and 1990s by a decline in the contribution of the tertiary sector [Tahari *et al.* 2004]. Moreover, over the last decades, in contrast to increases in Asia, the contribution of industry to economic growth in SSA has stayed relatively unchanged (see Figure 3), while the average investment-GDP ratio in sub-Saharan Africa during 1960-2002 (at about 21%) was lower than that for low-income countries worldwide (about 25%). Moreover, after reaching its peak (25%) in 1980, the performance of domestic saving in sub-Saharan Africa has deteriorated significantly over time while the saving rate in Asia has increased (see Figure 4). It should be noted that four decades ago, the SSA savings rate (averaging 20% in 1964) was higher than that of South Asia (less than 15%) during the same period. The latter region surpassed Africa's level in the late 1980s.

[Insert Fig. 3 and Fig. 4 about here]

#### 4.2. 1960 to 1980

In the post-independence era, the results of import-substitution strategies enabling African countries to begin modernizing production structures inherited from the colonial period were seen in the 1970s in an average annual industrial growth rate of 5.5% (followed by a 2.5% contraction between 1980 and 1984 and a 0.4% growth rate from 1984 to 1987). Manufacturing as a proportion of GDP increased rapidly and industrial employment and its share of overall employment also rose. Nevertheless, these strategies soon ran into problems [Bruton 1998]. The development of final goods production led to a rapid increase in imports of intermediate and capital goods, which in turn worsened trade imbalances and balance-of-payments deficits. In addition, small domestic markets generated insufficient demand for the products of emerging industries, thereby preventing industries from taking advantage of economies of scale [ECA 2004].

Since the 1960s, whereas Africa's strategies have remained tied to import-substitution strategies that concentrate on supplying domestic markets, in Asia, ever since the late 1960s, export promotion has been designed to meet the dual purpose of importing capital goods (and new technologies) and exporting goods to boost growth and maintain long-term equilibrium in the balance of payments. As a result, Africa has missed valuable opportunities for rapid resource-based growth, perhaps because of deficient learning capacity derived from low investment in human capital or institutional or political incentives to seek artificial monopoly rents created by inward-looking industrialization.

Moreover, on the policy front, African and (for example) Asian countries have differed in their approach to technology. Initially, to reduce risk, African countries chose strategies based on turnkey technology transfers; however, this choice led to greater external dependency, particularly through technical maintenance contracts. In contrast, Asian countries developed strategies based on local mastery of new technologies. Thus, in both Africa and Asia, access to new technology came through imports rather than local invention and innovation [Bhagwati 1978], but in Asia this importation was accompanied by considerable local effort towards learning, adaptation and imitation of the imported technologies [Amsden 1990].

### 4.3. 1980 Onward

African development in the 1980s was largely dominated by structural adjustment policies whose stated principal objective (implemented in the framework of the market paradigm) was to foster strong economic growth in SSA. As shown earlier in Figures 1, 2 and 4, this objective was in no way reached. Rather, structural adjustment policies and the IMF's role in implementing them in Africa have been criticized by local governments and development organizations alike as having worsened the situation of poor and lower income people and having contributed to the degradation of the natural environment [Mihevc 1995]. Additionally, even though school enrollment improved tremendously in SSA during the 1970's BN era – from roughly 50% in 1970 to 80% in 1980 – since the late 1980s, it has remained almost unchanged.

Under the SAPs, African countries liberalized trade through the reduction of tariff and non-tariff barriers and the devaluation of currencies to help exporters. The aim was to boost exports and growth, thereby fostering the integration of Africa into the global economy. However, from the 1980s onwards, the results were disappointing: between 1980 and 1997, the share of industry in GDP fell from 39% to 32%. During a similar time frame, the annual growth of manufacturing value added in SSA was erratic and lower on average than that of Asia (see Figure 5). Moreover, over the entire two decades, Africa's share in world manufactured exports remained unchanged at 0.8%, while Latin America's share rose from 1.9% in 1980 to 4.6% in 2000. Asia's performance was even more significant, with its share in global manufactures trade reaching 21.5% in 2000, up from only 7.1% in 1980 [UNCTAD 2003].

[Insert Fig. 5 about here]

According to the Economic Commission for Africa [2004], Africa's high share of primary commodities in exports has been costly in terms of trade losses because the impacts of declining real commodity prices on external indebtedness and investment have hampered income growth and poverty reduction [UNCTAD 2003]. Furthermore, between 1970 and 1997, non-oil-exporting African countries suffered cumulative trade losses of almost 120% of GDP [World Bank 2000]. Such trade losses have exacted a heavy toll in the form of high levels of indebtedness. Indeed, from the late 1980s to mid-1999, the ratio of external debt stock to exports deteriorated significantly, reaching more than 300% before dipping to below 200% in 2000. These figures are far above the ratios for the 1970s.

Paradoxically, despite its heavy commodity dependence, as a result of low value added in its exported products, Africa has even lost market share for its non-fuel commodity exports. Even though intraregional trade has grown in value in some regional economic communities, it has never surpassed 13% of the total exports of any community.

At the same time, over the 1996-2000 period, the continent's share of high-technology exports averaged 5% of manufactured exports compared to 30% for East Asia-Pacific (see Figure 6). Thus, the high-technology sector in exports lags behind the Asian countries' successful competitiveness in the international market. For SSA, the lack of global competitiveness on the African continent has only just begun to improve slightly for a limited number of countries. The growth competitiveness index (the measure of macroeconomic environment, institutional setting and technological readiness) ranks the following among the top seven African countries: South Africa (41st), Botswana (45th), Mauritius (49th), Namibia (52nd), Ghana (68th), Gambia (75th), and Kenya (78th) (WEF



2005). Moreover, as of 2004, the technology index (which combines three subindices that measure the quality of the environment for innovation, the capacity to receive international technology and export goods with technological content and the degree of assimilation of new information and telecommunications technologies) ranked the sub-Saharan African countries that occupy the highest positions in the world as follows: South Africa (40th), Mauritius (44th), Botswana (64th), Namibia (66th), Ghana (78th) and Kenya (72nd) [WEF 2005].

[Insert Fig. 6 about here]

#### 4.4. *Economic Development Constraints*

As regards the engines of growth for Africa, it should be noted that at present neither the inward nor the outward strategy seems available. First, because the population is so poor, internal demand in Africa is too weak and volatile to sustain growth [Easterly and Kraay 2000], meaning that local demand by itself is insufficient for returns to scale to be reaped at the firm level. Furthermore, the continent has inherited from colonization an infrastructure geared towards exports not intra-African trade [Hopkins 1973]. As a result, African markets are not integrated and intra-African trade is difficult in spite of improved road networks. This situation implies that any strategy exclusively based on domestic African demand is likely to result in disappointment.

Another challenge confronting Africa's development comes from constraints imposed by a hostile international economic order. The Economic Commission for Africa's 2004 report takes the view that OECD trade policies are a serious constraint to Africa's integration into the global economy. African exports have been handicapped by industrial country policies such as tariff escalation, tariff peaks and agricultural protectionism. This implies that export-led industrialization has no bright prospects in Africa.

Additionally, the core theoretical criticism of the currently recommended export-led growth is that it suffers from a fallacy of composition that assumes all countries capable of growing through reliance on demand growth in other countries [Blecker 2003]. When such an approach is pursued globally, there is a danger of a beggar-thy-neighbor outcome in which all nations try to grow on the back of the demand expansion in other countries, eventually producing a global excess supply and further trade losses [Palley 2002].

To achieve rates of change to GDP per capita that result in an increase of average income and reduce the shortfalls in growth rate required to meet MDGs (see Table 1), economic growth in Africa would have to be maintained at a rate of least 7% per year for at least four decades [ECA 2005]. However, this level of economic performance over a long period demands some distinctive thinking about the type of growth engine needed to overcome many of the existing impediments.

[Insert Table 1 about here]

With very few exceptions, the majority of recent growth miracles have relied largely on the growth of industry and modern services [Chenery *et al.* 1986] because the rates of growth achievable in manufacturing and modern services are much higher than those in agriculture and mining. Thus, Africa will not catch up with developed countries until it expands its manufacturing and modern service sectors. Beyond international trade environment and its legendary institutional weaknesses, is still any available option the

continent can embrace in its quest for sustainable economic growth? From the endogenous growth perspective, then, it appears that the basic constraint to the African economic development may be found not in the supply to the world market of natural resources but in the capacity to absorb these resources and invest them productively. However, to support its industrial expansion, African technological and innovation capacities are currently extremely low [Ndulu and Van de Walle 1996), thereby impairing Africa's capacity to use and transform its natural resources and limiting its possibilities for forward and backward linkages.

## **5. The Key to Sustainable Growth in Africa: Technological Innovation**

### *5.1. Technological Innovation*

The United Nations' Millenium Project [2005] report points out that in much of South-East Asia and the Asian Pacific, science, technology and innovation have helped to largely eliminate poverty and hunger, and have driven remarkable economic growth. However, their potential to help solve poverty and hunger in other developing regions – most notably Africa – is underappreciated.

Moreover, a 2003 study by the CSLS using several sources of international data on labor productivity, poverty and income inequality finds that across developing countries, productivity growth plays a substantial role in reducing poverty. This conclusion suggests that African countries, in attempting to reach their poverty reduction objectives, should pursue policies that foster productivity growth via technological innovation. Clearly, because policies that promote such technological innovation in SSA would be beneficial to long-term sustainable growth, technological innovation should be placed at the heart of the African development process. Yet, as the parameters of international trade shift gradually in favor of science and technology-based competitiveness, the transformation of the continent's rich endowment of natural resources and agricultural raw material into added-value products is limited. Thus, the abundance of natural resources and low-cost labor does not itself necessarily constitute decisive comparative advantages for the continent.

Rather, in contrast to advanced economies that cannot grow without generating new knowledge, poor countries can grow simply by applying existing knowledge to their own economy. That is, as demonstrated by the South-East Asian experience, the primary requisite for catching up is not the generation of new knowledge but simply the adoption of existing knowledge and its adaptation to local conditions [Fafchamps 2000]. Therefore, typical policy recommendations for filling the knowledge gap emphasize fostering innovations and saving research costs through local adaptation of fundamental research performed elsewhere and joint research with developed countries

In terms of requirements for sustainable development, it is now being recognized that the key to substitutability is the technological innovation that not only enhances substitutability across forms of capital but also promotes economic growth, which in turn allows high investment in human capital formation. Indeed, as Kyriakou [2002] points out, preserving the natural capital restoration option for future generations may prove irrelevant if the technical and economic ability to afford restoration/recovery is unavailable.

Technically, the creative intelligence of the human mind is capable of production, yet for eons Africa has been starving without any serious attempts at new combinations of its natural endowments and human capital. For example, during this time, rural populations living on top of iron mines have had a great need for bicycles and other manufactured

goods, while local people exporting quinine have been dying from malaria because they cannot afford to buy the finished product made from their previously exported raw materials. In other words, as long as the creative power embodied in labor is not productively stimulated in SSA, industrialization and development will simply remain a mirage.

## 5.2. *Priorities and Policies*

If technological change is the most important engine of growth; technological innovation is the primary requirement for this transformation to take place. The role of policy then becomes to speed up the innovation, imitation and adaptation of technologies, as well as to engender educational reform and eventually affordable R&D.

According to Aubert [2004], in low-income countries whose institutional capabilities are limited, policies should focus on a basic investment in the technological infrastructure vital to promoting technology-led development that goes beyond merely meeting survival needs. Overall, basic technologies should help in developing nontraditional exports as an entry point for institutional and technology development as done in Korea in the 1960s, Mexico in the 1970s and Mauritius only recently.

Nevertheless, technological knowledge does not simply happen to societies; rather, it is a process that countries must consciously and actively promote and nurture and for which certain socioeconomic preconditions must be met [Nwokeabia 2002]. Such conscious efforts by public/private institutions should provide support for innovation, adaptation and R&D, and give both incentives and assistance to enterprises in the domain of technology management and training. Table 2 briefly identifies key aspects of the technology policy recommendations that can enhance manufacturing productivity in SSA. In addition to the education policies outlined at the bottom of the table, policy types are identified on three levels – innovation, adaptation/absorption and R&D – depending on the nature of the desired technologies.

[Insert Table 2 about here]

### 5.2.1. *Innovation Policies*

The central objective of firm-level technology policy should be to encourage and support internal learning process in existing firms and to enhance incentives for innovation and imitation. However, among successful small-scale exporters in Asia and Latin America, the most important source of technological capabilities identified is internal technical effort [Biggs *et al.* 1995]. The problem in Africa is that the internal firm efforts of firms, with the exception of a few large multinationals, appear to be fewer than needed, limited in scope and sporadic rather than continuous. Thus, without the availability of adequate external learning channels to increase the inflow of new knowledge, internal learning activities can do little to upgrade skills towards internationally comparable levels [Biggs *et al.* 1995].

To date, development policy makers and practitioners alike have failed to appreciate the innovative capability of most traditional industries: technological change is in fact based primarily on learning by doing and tacit and indigenous knowledge – accumulated and transmitted over generations – derived from peoples' experiences. From indigenous knowledge, individuals can create innovation. However, because lack of recognition also inhibits future innovations [Nwokeabia 2002], such knowledge must be recognized and rewarded; otherwise, it will be restricted by the owners and kept out of the general public. In other respects, appropriate social incentives, such as rewarding village mechanics for

assembling a bicycle completely from local materials, need to be set. Similarly, the emphasis should now turn from providing microloans for trade-related business to generating innovative technological ideas.

Myriad concepts, large and small, play a role in economic growth. In many ways, structuring businesses to encourage innovation by front-line workers is as important to the knowledge economy as undertaking scientific research. Because every worker in an organization, from the top down, can become a knowledge worker if given the opportunity [Romer 1993], firms should increasingly take advantage of each person's innate curiosity and willingness to experiment. Moreover, the existence of this innate creativity points to a need for the democratization and popularization of science and technology. Thus, awards recognizing the outstanding innovative spirit and successful imitation/adaptation should be promoted at the grassroots level and academic publication databases should be made accessible in national languages to both specialized and general publics alike. Additionally, a patent system should be available and accompanied by innovation awareness campaigns. In rural areas, NGOs' efforts should increasingly focus on setting up microtechno-innovation circles, testing centers and advisory services. Furthermore, the principal objectives of industry-wide innovation policies in SSA should focus on creating industry-specific training centers to both nurture innovation and improve managerial problem-solving skills.

#### *5.2.2. Adaptation Policies*

Because the key to catching up is to copy and absorb technological improvements invented elsewhere and emulate advanced economies, foreign technology should be promoted in conjunction with endogenous knowledge. It is clear that African countries should tap into the tremendous knowledge and technology available worldwide by adapting these resources to their needs and capabilities. Consequently, countries should use appropriate mechanisms for scouting, screening and transforming foreign technologies, including reverse engineering. The past experience of Asian countries illustrates the advantages of tapping into Western knowledge and technology and using them as a source of competitiveness [Aubert 2001].

Adaptation accompanying such measures would include subsidies for technology adoption, special depreciation allowances for specific types of machinery, and public testing programs and consultation centers for small and medium-sized manufacturing firms. Absorptive capacity sets limits on how much and what type of technology can be transferred by determining the feasibility and costs of technology-specific training. Thus, to enhance the technical capacity of African countries, demonstrations should be organized of basic adapted technologies for improving welfare, education, and agriculture.

The adoption, absorption, mastering, adaptation and application of external technologies depend on the strength and efficiency of the national system of innovation in relation to indigenous R&D capabilities and related international networks. In this respect, measures to attract immigrant workers or to link them through an exchange network would intensify efforts to improve industrial adaptation capabilities. However, because the technical capacity of a nation (its ability to use and master technology) includes the entrepreneurial capability to make and implement technical choices, it also includes mastery of technology to the point of designing the next installation locally, of acting as one's own prime contractor, of carrying out adaptations and, eventually, of developing new products and processes based on original R&D [Rao and Weiss 1984].

#### *5.2.3. Research and Development Policies*

Policy measures in the framework of R&D span a wide range of issues but, as illustrated in China and Malaysia, may include the foreign direct investment (FDI) crucial to stimulating innovation and bringing new technology and knowledge to a country. Equally, FDI is an important driving force behind improvement of a country's business climate and governance conditions. Therefore, an environment conducive to FDI, together with vertical and horizontal links to local companies, should be encouraged in key labor-intensive industries. Additionally, particular importance should be accorded to national policies affecting technology transfer; which includes ownership rights, import content, replacement of expatriate workers, investment incentives, industrial property rights and competitive conditions. Moreover, since size matters in technological boost and research and development, merger should also be encouraged.

Development strategies should focus on creating new knowledge not only in universities and laboratories but also in businesses. Additional supportive measures should involve tax incentives for entrepreneurial and R&D activities; availability of technical information, either online or via technical libraries; promotion of information sharing among firms; and the development of research centers of excellence that can attract top international research expertise, which then feeds into the local knowledge base.

#### 5.2.4. Education Policies

The ability of a specific economy to adopt domestically developed technology rapidly and absorb technologies from foreign sources is crucially dependent on the quality of its education. Lucas [1988] observes that the experience of the newly industrialized countries (NICs) of eastern Asia suggests that learning by doing is more relevant than formal education for long-term growth. Therefore, education, rather than providing only formal instruction, should also emphasize on-the-job-training. Africa is particularly hurt by its lack of trained manpower, particularly in technical fields, suggesting that *the types of human resources complementary to technological innovation require a drastic reorientation of education curricula*. What matters for R&D is not only the share of workers with a college education, but also the share of workers with the right type of education in fields such as engineering and systems information. The relevant educational background would include specialties in engineering, business administration and other related fields, particularly those technical areas required by the technology being adopted.

Yet, if not accompanied by vocational training and an emphasis on scientific and technical skills, the provision of education to large segments of the population remains a costly luxury. Enlarging markets and providing a supportive environment for business cannot bring rapid sustainable growth if it fails to increase vocational and technical education. In other respects, a focus on science and technology also implies a shift from primary education to higher education insofar as technological assimilation is so critically dependent on the quality of higher education.

Other measures should focus on training managers to have long-term horizons and a problem-solving mentality. Additionally, since the task-level efficiency of African workers is recognized to be generally low by international standards [Biggs *et al.* 1995], the objective of task-level policies to improve this deficiency should be to raise the quality of enterprise managers and provide more systematic worker training. As policy reforms promote increased export production, learning by doing should also play a significant role in raising task-level efficiency. Thus, policymakers should focus on collective learning mechanisms, particularly programs like industry-specific training delivered by NGOs, business associations, donors and governments.

## 6. Further Considerations and Conclusion

The purpose of this paper is to provide a summary and analysis of the development paradigm shifts, growth theories and perspectives in African development that have influenced the course of African economic development over the last four decades. Based on the paper's first inquiry question, the discussion has shown that dominant development paradigms could explain the poor performance of Africa in that frequent policy shifts involved inestimable costs such as confusion in goals; abandonment of ongoing project/program leadership, loss in accumulated knowledge and skills, increasing conflicts among development actors and macroeconomic instability. The continuous shift in development paradigm has, *ipso facto*, resulted in growth policies that lack consistency, with too frequent instances of policy reversal. Inconsistent pro-growth policies, in turn, have neglected technological innovation in the growth process. This latter particularly, whose crucial role is illustrated by lessons from the Asian economies, is seen as a major potential contributor to the reversal of Africa's development misfortune.

Tackling the second inquiry question, the paper concludes (referring to the endogenous growth perspective) that African countries, in attempting to reach their poverty reduction objectives and sustainable development, should pursue policies that foster productivity growth via technological innovation. To organize and nurture technological and innovation culture, the paper recommends a four-pillar policy respectively on innovation, adaptation, research and development, and education.

The outcome of these previous empirical perspectives is that Africa has been unable to fully take advantage of its natural resource potential and is presently challenged by important scientific and technological developments that are rapidly transforming international trade and ways of doing business. Therefore, if prevailing levels of critical poverty are to be reduced and African income converged to the level seen in Asian economies, Africa must find and implement the right set of innovation policies for technological innovation.

The rate of growth in any economy is determined by the accumulation of physical and human capital, the efficiency of resource allocation, and the ability to acquire and apply modern technology. What is required for faster growth is change in the economic environment that facilitates both the accumulation of production factors and their efficient allocation, and the introduction of better technologies. African economic performance suggests that the accumulation of capital and infrastructure *per se* is ineffective unless local technological capabilities are upgraded.

Additionally, even though the role of the private sector is crucial, policy intervention is needed to create an environment appropriate for nurturing innovation, technology adoption and R&D. The first component of any such environment is a sound macroeconomic policy, one based on fiscal balance and low inflation, a developed financial system, appropriate infrastructure, and a commitment to continued structural reforms and elimination of gross distortions in price and incentive structures. Fundamentally, a technological revolution in SSA should ensure the enactment of transparency rules to eliminate entrenched corruption practices in politics and rent-seeking incentives in the market economy. The corresponding supportive measures should include the structure of property rights, the extent to which courts of law apply and enforce abstract but clear rules inexpensively and quickly, the size of the government and its effectiveness in delivering

public goods, and the openness of the economy to trade and investment with the outside world.

At the regional level, the African Forum on Science and Technology for Development (AFSTD) was established by the New Partnership for Africa's Development (NEPAD) to promote the application of science and technology for economic growth and poverty reduction. It is the hope of such forums that African governments should depart from their meaningless rhetoric and multiplication of institutions in favor of a clear commitment to the strategic goals for innovation. By doing so, they can solve the major problems in Africa's economic and social development and achieve new breakthroughs in key and core fields.

Economic growth, income distribution and environmental protection are complementary, which calls for public policies to facilitate their mutual reinforcement. However, this complementarity cannot be harmoniously achieved without technological innovation and the cultural background that generates it. Since, in some parts of Africa, an innovation culture is not yet (or no longer) perceived as a crucial factor for social change, there is an urgent need for it to be cultivated and cherished.

In terms of the real challenges ahead, it should be emphasized that knowledge rather than natural resources will facilitate growth and development in the twenty-first century. Thus, the survival of African countries in this century will undoubtedly depend on sufficient technological personnel. Such a quality of human capital allows a firm or country to develop its production potential by absorbing, adapting and improving imported technology. Within a technological innovation framework, economic development ceases to be simply the expansion of existing productive capacity and becomes rather the extension of the economy's ability to produce different products and services. It therefore includes technological change and the birth of new institutions that facilitate such a shift.

In any event, given its significantly higher rate of population growth and higher incidence and severity of poverty, it is apparent that Africa's future depends on its economies fostering, nurturing and sustaining a faster growth imagination in its people, and imagination that should be systematic and organized. In contrast, Africa's current inability to apply much scientific knowledge to production simply condemns millions of the African people to a continued life of poverty.

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