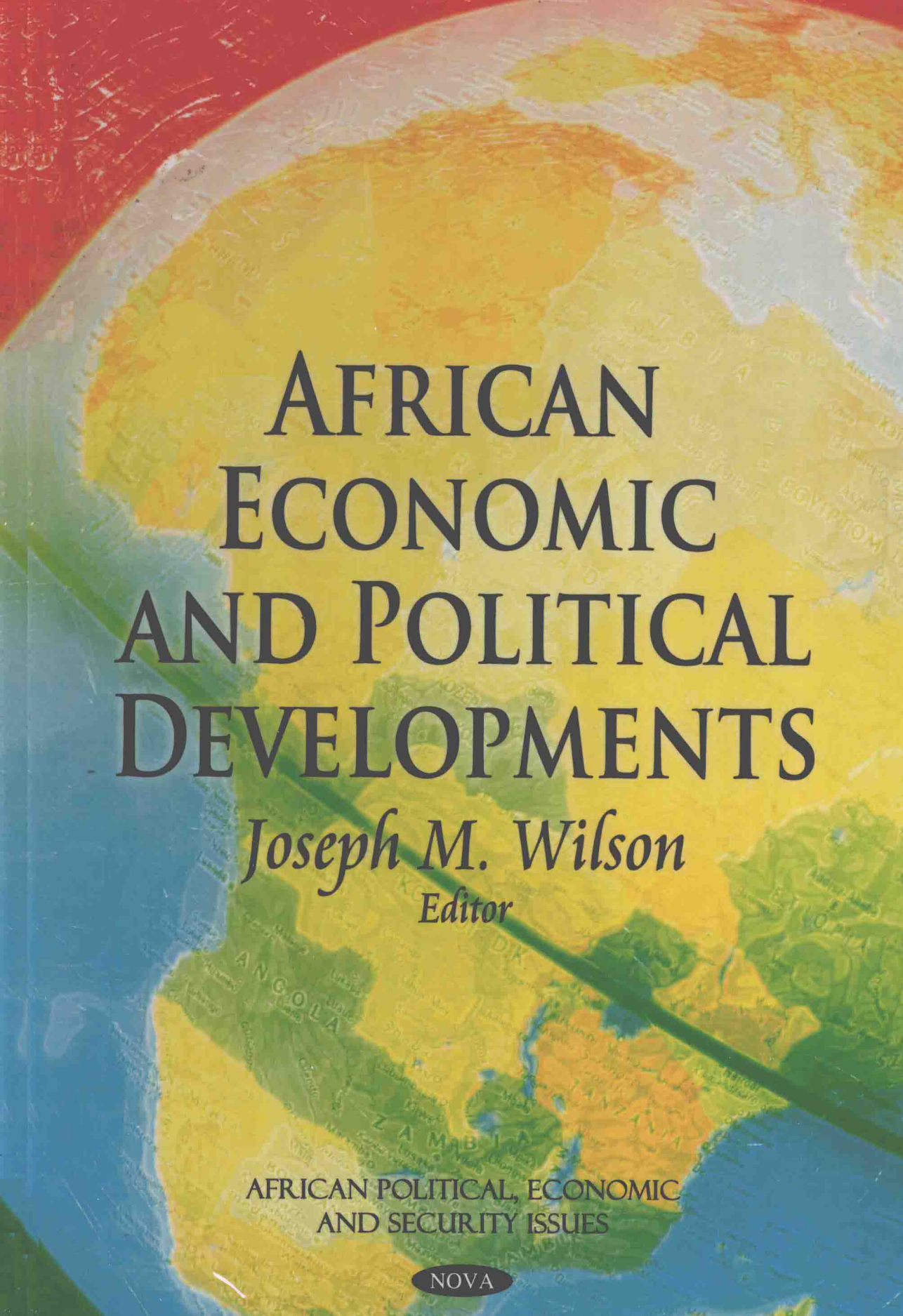
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AFRICAN POLITICAL, ECONOMIC
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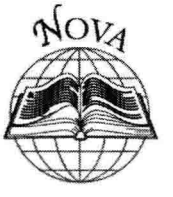
AFRICAN ECONOMIC AND POLITICAL DEVELOPMENTS

JOSEPH M. WILSON
EDITOR



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PREFACE

This book focuses on numerous economic and political issues which surround Africa today. Topics discussed herein include natural resources in rural Africa; economic growth in Africa from 1960-2003; economic transformation in theory and practice; the Central African Republic; HIV prevention in Africa; and stem cell and gene therapy applications in AIDS related research.

Chapter 1 - This chapter uses the Solow model to examine economic growth and convergence in Africa and compare it to those in the rest of the world. Income per capita is correlated positively with saving rates and negatively with population growth rates, though the explanatory power of these two variables is much higher in the World data set than the Africa data set. The empirical findings reject absolute convergence in income per capita but are broadly supportive of conditional convergence at an estimated average annual rate in Africa of 0.3% (compared to 0.8% in the World). It is also shown that the speed of convergence is far from constant over time: it has been generally higher since the late 1990s compared to the 1970s and 1980s, but has been uniformly lower in Africa than in the rest of the World.

Chapter 2 - Economic development is critically important for the wellbeing of all societies. It may broadly be defined as the presence of greater wealth, education, industrialization, and urbanization. More generally, economic development tends to foster a greater degree of democracy, interstate peace and domestic stability, high standard of living, and longer life expectancy. Despite the foregoing benefits of economic development, African countries have, for the most part, had a history of poor economic performance. I posit that good leadership, political stability, competent civil service, mass education and vocational training, and open and competitive markets are some of the most important ingredients that would foster Africa's chances of economic development.

The purpose of this chapter is two fold: first, I outline the key benefits of economic development; second, I point out the most important factors that would bring about economic development in Africa.

Chapter 3 - There is consensus in the international community that development and poverty alleviation in rural Africa are among the most urgent global agendas for the 21st century. Many rural Africans have traditionally depended on natural resources. Land use patterns are highly heterogeneous across diverse agro-ecological/farming systems and even within the systems, some being more extensive, while others being more intensive. These days a range of factors, including increasing population pressure and global climate change,

has made it impossible for development through conventional extensive technologies or degradational pathways to be sustainable as a viable strategy. To achieve both development and environmental goals, sound agricultural intensification technologies through more intensive and efficient use of inputs internal to systems, or conservationary pathways, must be identified and tailored to specific local needs and conditions to be adopted by rural households, while enabling policy and infrastructure should be availed by government and development agencies.

This chapter investigates the challenges that Africa has faced in rural development and natural resource management and seeks guidance for policies and research. Firstly, the chapter gives an overview of the current state of heterogeneous agro-ecological and farming systems and the development challenges posed by population growth and climate change in rural Africa. The authors propose a conceptual framework to guide empirical research in effectively examining the multi-dimensional aspects of the evolution of farming systems/resource management and review how the framework is applied at meso-level in the recent literature. Secondly, a case study from a Rift Valley community in western Kenya is presented to show micro-level evidence of diverse portfolios of technology options in a semi-arid environment.

It turns out that some conservationary pathways may exist to promote more sustainable development in rural Africa, possibly through the better integration of system components, i.e., crop and livestock, and the inclusion of agroforestry into the farming systems. Concurrently, there are also degradational pathways entailing substantial trade-offs between promoting economic development vs. conserving natural resources. To promote conservationary development pathways, policies not only need to identify optimal technology portfolios best suited to local conditions and exploit the complementarities among system components but also to provide education with farmers to augment their human capital assets and to promote stable non-farm/off-farm income opportunities to enable investment in resource management. The chapter concludes by synthesising the findings for policy implications and by presenting another emerging challenge of rising food/fuel prices and a subsequent future research agenda.

Chapter 4 - Encouraging signs of growth acceleration in Africa may herald a new development era of rapid transformation. In an effort to promote the future success of African transformation, the authors herein provide an extensive literature review on development economics and empirical observations from successfully transformed countries, along with analytic narratives on the transformations of Thailand and Mexico. To conclude, the authors derive six key messages for African transformation. The authors find that the traditional development economics theory is consistent with the transformation practice of successful countries. However, this theory needs to be broadened in light of rising inequalities during transformation. Success vitally depends on agricultural development; early withdrawal of public support away from agriculture slows down transformation, and the resulting inequalities are recognized as a persistent development challenge. Transformation also depends on industrialization strategies, but the authors find that winner-picking industrialization negatively affects other aspects of development, whereas home-grown, export-oriented industrialization led by private entrepreneurs opens up broader opportunities for sustainable growth. Finally, government support will be required to create a business-promoting environment and to offer incentives for African entrepreneurs to lead growth.

Chapter 5 - Following the end of the apartheid era in South Africa in the early 1990s, the United States sought to increase economic relations with sub-Saharan Africa. President Clinton instituted several measures that dealt with investment, debt relief, and trade. Congress required the President to develop a trade and development policy for Africa.

The economic challenges facing Africa today are serious. Unlike the period from 1960 to 1973, when economic growth in sub-Saharan Africa was relatively strong, since 1973 the countries of sub-Saharan Africa have grown at rates well below other developing countries. There are some signs of improvement, but problems such as HIV/AIDS and the debt burden are constraining African economic growth.

In May 2000, Congress approved a new U.S. trade and investment policy for sub-Saharan Africa in the African Growth and Opportunity Act. U.S. trade with and investment in sub-Saharan Africa have comprised only 1-2% of U.S. totals for the world. AGOA extends preferential treatment to imports from eligible countries that are pursuing market reform measures. Data show that U.S. imports under AGOA are mostly energy products, but imports to date of other products have grown. AGOA mandated that U.S. officials meet regularly with their counterparts in sub-Saharan Africa, and five of these meetings have been held.

AGOA also directed the President to provide U.S. government technical assistance and trade capacity support to AGOA beneficiary countries. Government agencies that have roles in this effort include the U.S. Agency for International Development, the Assistant U.S. Trade Representative for Africa (established by statute under AGOA), the Overseas Private Investment Corporation, the Export-Import Bank, the U.S. and Foreign Commercial Service, and the Trade and Development Agency. In addition to bilateral programs, the United States is a member of several multilateral institutions that provide trade capacity building.

In AGOA, Congress declared that free-trade agreements should be negotiated, where feasible, with interested sub-Saharan African countries. Related to this provision, negotiations on a free-trade agreement with the Southern African Customs Union, which includes South Africa and four other countries, began in June 2003, but were suspended in April 2006.

Several topics may be important to the 110th Congress in the oversight of AGOA and in potential legislation amending the act. These issues concern expanding the number of beneficiary countries which use AGOA benefits; diversifying AGOA exports away from primary commodities such as oil; making trade capacity building more effective for AGOA beneficiaries; and strengthening the link between poverty reduction and trade in Africa.

Chapter 6 - While Ghana has achieved sustained growth and poverty reduction in the last 20 years, its development pattern is characterised by an increasing income gap between north and south and the north lags far behind the south in income growth and poverty reduction. This chapter evaluates the avenues through which regional disparities can be improved with growth and focuses on agricultural opportunities, particularly in northern Ghana. Using an economywide, multimarket model and based on time series production data between 1991 and 2000 and Ghana Living Standards Survey data of 1991/92 and 1998/99, this chapter analyzes the possible poverty reduction trends up to 2015 by assuming different patterns of growth. The results show that agriculture-led growth has a larger poverty reducing effect than nonagriculture-led growth. Within agriculture, growth in staple crop production reduces poverty more than export crops. In northern Ghana, the staple crops whose growth exerts the largest effect on poverty reduction are groundnut, cassava and cowpea. However, despite the large effects of the agriculture-led growth, the projections of poverty rates in the regions, particularly Upper East are still high implying a need for complementary avenues for poverty

reduction. A review of the literature shows that while the north generally is a net migration area, the rewards of migration have been limited because people who migrate have no skills and are, therefore, limited to entering the informal job market where wages are low. The implication is to enhance this labor with education and skills. Ultimately, the regions must attract production investment to boost economic activity and generate local growth. The state must play a leading role in investing in productive and social infrastructure as a way of facilitating the environment for private sector operators.

Chapter 7 - An economywide, multimarket model is constructed for Ghana and the effects of agricultural soil erosion on crop yields are explicitly modeled at the subnational regional level for eight main staple crops. The model is used to evaluate the aggregate economic costs of soil erosion by taking into account economywide linkages between production and consumption, across sectors and agricultural subsectors. To fill a gap in the literature regarding economic cost analysis of soil erosion, this chapter also analyzes the poverty implications of land degradation. The model predicts that land degradation reduces agricultural income in Ghana by a total of US$4.2 billion over the period 2006–2015, which is approximately 5 percent of total agricultural GDP in these 10 years. The effect of soil loss on poverty is also significant at the national level, equivalent to a 5.4 percentage point increase in the poverty rate in 2015 compared to the case of no soil loss. Moreover, soil loss causes a slowing of poverty reduction over time in the three northern regions, which currently have the highest poverty rates in the country.

Sustainable land management (SLM) is the key to reducing agricultural soil loss. The present findings indicate that through the adoption of conventional SLM practices, the declining trend in land productivity can be reversed, and that use of a combination of conventional and modern SLM practices would generate an aggregate economic benefit of US$6.4 billion over the period 2006–2015. SLM practices would therefore significantly reduce poverty in Ghana, particularly in the three northern regions.

Chapter 8 - Tea is Burundi's second largest cash crop after coffee, contributing approximately $10 million to export earnings, equivalent to 12 percent of total merchandize exports. It is produced in five regions by estates and smallholders (30 and 70 percent, respectively) and is the key source of income to some 60,000 smallholders and 5,000 tea plantation and estate laborers. Most production, transformation, trade, marketing, and regulatory aspects of the industry are handled by the parastatal Office du Thé du Burundi. Despite its importance, the industry faces numerous constraints, including structural inefficiencies of the tea plantations and tea estates, poor incentives to smallholders and estate laborers, limited use of purchased inputs and non-existent research and extension services. These constraints have led to a considerable decline in the quality and hence the price of Burundian tea.

This chapter argues that reviving the sector requires broad-based policy reforms which should, eventually, lead to privatization of the tea companies. However, before any concrete steps are undertaken, a number of issues must be examined. First, according to official estimates, the daily wage rate at the plantations can exceed $2.00, considered to be high. Yet, severe labor shortages have been reported, in turn, raising the issue of accuracy of statistics or, perhaps, security concerns that plantation workers (especially women) face deterring them from working in tea plantations. Second, more work must be carried out in order to examine whether producers who grow tea on areas with low quality soils will be profitable under a new structure of the industry. Third, the sustainability of the eucalyptus plantations, the key

source of energy to the tea factories, should be examined. Fourth, the key reasons behind the discontinuation of fertilizer use should be identified. While the official explanation is procurement bottlenecks, high fertilizer prices may have played a role as well.

However, regardless of the answers to the above questions, the reform process is likely to be difficult for a number of reasons. First, Burundi has no experience with successful privatization initiatives, especially for large entities such as the tea companies. Second, because numerous donors have financed past tea projects, the key decisions must be a collective outcome of all concerned actors (i.e., the government and all donors). Third, transferring assets currently held by the parastatal to private entities is likely to be viewed with suspicion in light of the recent conflict and political sensitivities. Finally, because of security issues along with frequent changes in government, Burundi's investment climate is considered risky, implying that investors will be willing to buy assets only with considerable discount.

Chapter 9 - In March 2003, a rebellion led by former Army Chief of Staff Francois Bozize ousted President Ange Patasse from power. In 2005, the Bozize government organized presidential and legislative elections. In May 2005, Bozize defeated former Prime Minster Martin Ziguele and his ruling party won 42 out of the 105 seats in the National Assembly. The Central African Republic (CAR) has been impacted by the crisis in the Darfur region of Sudan and suffers from internal rebellion. Fighting between rebel groups and government forces has displaced more than 70,000 people in northeastern CAR. In September 2007, the European Union approved the deployment of a 4,000 man peacekeeping force to Chad and CAR.

Chapter 10 - Geographically speaking, AIDS the usually fatal result of an HIV infection, is primarily instantiated in parts of sub-Saharan Africa, which also contains two-thirds of the world's cases of HIV infection. There were more than 2.1 million AIDS deaths there in 2006, more than 70% of the world's total from complications related to HIV. Put simply, people live with HIV in most parts of the world but tend to get infected by HIV more often and die more quickly of AIDS in sub-Saharan Africa. A fifteen year old boy in Botswana has over a 90% chance of dying of AIDS (UNAIDS, 2000 cited in Barnett and Whiteside, 2006). zWhile statistics such as these are well known, what is surprising is that suffering and death on this scale was foreseen and allowed to develop.

Chapter 11 - The aim of this study was to develop, implement and evaluate a motivation-based HIV-related risk reduction intervention for employees in a tertiary institution using a pre-post test intervention design. All 330 employees were invited through email, telephonic contacts, posters, flyers and word of mouth to participate in the study. At pre test, 233 employees completed a survey regarding HIV-related knowledge, risk perceptions, behavioural intentions and risk behavior. Participants were then assigned to either an experimental (intervention; n = 104) or a control group (n = 129). The participants in the intervention group were invited to attend the four intervention sessions on HIV risk reduction. Post intervention data indicated that employees in the HIV-risk reduction intervention enhanced their knowledge and behavioural intentions but could not strengthen their sexual communication skills nor reduce their risk behaviour.

Chapter 12 - The continent of Africa carries by far the largest global burden of HIV and its complications. Despite a growing number of patients on Highly Active Retroviral Therapy (HAART), the incidence of severe complications such as the related malignancies is rising in our setting. This is posing significant logistical concerns affecting resource allocation, health

economics and major ethical considerations. Stem cell replacement therapy is gaining in momentum as a therapeutic option for malignancies, genetic and chronic disorders. Coupling this with opportunities to genetically manipulate the stem cell for additional benefit and advantage embedded within the expanding population of engrafted cells looks very appealing. Several centres in developed environments are now extending this technology to manage, particularly, the AIDS associated lymphomas (ARL) and as additional options for genetic based therapeutic vaccine modalities in persons living with HIV. In principle the concept involves the engineering of autologous stem cells with specific genetic cargo aimed at conferring several levels of intrinsic resistance to the retroviral infection into the stem cell graft before reinfusion back to the patient. Once immune reconstitution has taken place with these clones of manipulated stem cell progeny, the immunological repertoire derived from the graft will exhibit inherent resistance to the causative viral infection and its propagation. This will theoretically obviate the need for life long specific therapy in such patients. Several issues relating to this treatment modality require careful consideration both from ethical and logistical perspectives. This chapter reveals data on rising disease burdens of ARL in our communities in South Africa, where background HIV prevalence is extremely high, and explores the feasibility, economics and sustainability of these stem cell and gene therapy approaches. The future of the region depends on a definitive and cost effective approach to HIV management, could this be the way forward.

Chapter 13 - This chapter focuses on Ethiopia's primary education sector. It argues that country's efforts to increase the number of pupils enrolled would benefit from further decentralisation. However, in order to address equity issues, a certain degree of central intervention should be maintained and should be based on rational calculations rather than political negotiations. Decentralisation theory is analysed and applied to the education sector, illustrating the possibilities and risks of losing positive externalities linked with primary education. This chapter firstly analyses the primary education sector in Ethiopia, secondly compares this to neighbouring Eritrea and Kenya primary education sectors, thirdly develops a set of proposal and finally summarises the findings and constraints to the proposals' implementation.

Chapter 14 - This study examined barriers to the implementation of PMTCT program in the Eastern Cape, South Africa. Indepth interviews were conducted with 3 provincial PMTCT officials and 22 PMTCT co-ordinators. Four focus group discussions were conducted with 21 LSA officials and another four with 71 PMTCT clients. The results show that there are barriers to implementation of PMTCT services at all levels. Provincial: inadequate human/physical resources, poor management systems, multiple competing demands, lack of co-ordination/integration. District: inadequate human resources, limited geographical coverage, poor program receptiveness, lack of proper monitoring, lack of integration, co-ordination/communication. Facility: limited PMTCT trained nurses, poor infrastructure, poor management system, lack of support/supervision, negative attitude by some of the nurses, poor health care organisation and inability to access health facility. Household: lack of support/cooperation, stigma/discrimination and traditional beliefs. Community: stigma/discrimination. Lessons learned in this study should be considered when identifying best practices for expanding and providing PMTCT services.

Chapter 15 - In South Africa, as in many other countries in Africa, a large amount of state housing stock was constructed during the 1950s-1970s. In South Africa, this policy of state-constructed housing units went hand in hand with apartheid policies, preventing black people

from urbanising. In this country, as in the rest of the world, a concerted effort (begun by the apartheid government, but continued in the post-apartheid period) has been made since the 1980s by the state to privatise these housing units. At the time of its implementation, the privatisation policy was criticised for generally reducing the role of the state; creating landlordism; and also for purely practical reasons, such as the problem of determining the rightful owners of these units. Yet, despite these conceptual points of criticism, there is a scarcity of research focusing on the actual housing outcomes of this privatisation process. This chapter examines the housing outcomes of the privatisation process on the basis of an empirical survey of approximately 390 such units in the Mangaung Township near Bloemfontein in central South Africa.

Chapter 16 - Cost estimates for mechanical service are prepared by mechanical engineers and quantity surveyors that specialize in mechanical engineering service. The factors influencing the cost estimates produced by these estimators are determined in this chapter by the use of structured questionnaire. The respondents were 88 quantity surveying firms, 108 construction firms and 29 mechanical service firms constituting 68% of the estimating firms involved in mechanical service cost estimating in Nigeria.

The data collected were analyzed using factor analysis. The factor extraction gave a six-factor solution with eigen values greater than 1 and explained 58.2%. The factor groupings were estimating requirement, firm's requirement, project complexity and project information. Other factors having influence on the level of accuracy of mechanical service cost estimates were market requirement and contract requirement.

CONTENTS

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Chapter 1

ECONOMIC GROWTH IN AFRICA, 1960-2003: EVIDENCE FROM THE SOLOW GROWTH MODEL

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ABSTRACT

This chapter uses the Solow model to examine economic growth and convergence in Africa and compare it to those in the rest of the world. Income per capita is correlated positively with saving rates and negatively with population growth rates, though the explanatory power of these two variables is much higher in the World data set than the Africa data set. The empirical findings reject absolute convergence in income per capita but are broadly supportive of conditional convergence at an estimated average annual rate in Africa of 0.3% (compared to 0.8% in the World). It is also shown that the speed of convergence is far from constant over time: it has been generally higher since the late 1990s compared to the 1970s and 1980s, but has been uniformly lower in Africa than in the rest of the World.

Keywords: Solow Model, Economic Growth, Convergence.

JEL classification: O40.

INTRODUCTION

This chapter investigates the experience of African countries with economic growth and convergence in income per capita using the Solow (1956) model of economic growth. The Solow model is one of the most widely used models in economics. Its usefulness and

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popularity are easily demonstrated by the extremely wide range of economic applications which employ it as a building block.[1] Not surprisingly, a substantial amount of empirical research has been devoted to the investigation of the validity of the Solow model's predictions. The most influential of these studies is the contribution by Mankiw, Romer, and Weil (1992), who concluded that the empirical evidence is strongly consistent with (a somewhat modified) Solow model.[2]

This chapter uses the Mankiw, Romer, and Weil (1992) methodology in order to examine economic growth and convergence in Africa since 1960, and compare it to the experience of the rest of the world.[3]

First, the paper tests the *standard* Solow model, using a data set of 38 African countries covering the period 1960-2003, and a broader data set of 99 countries over 1960-2003. The empirical results suggest that Solow's predictions are largely consistent with the data: the standard of living is correlated positively with saving rates and negatively with population growth rates. However, these two variables explain two-thirds (67%) of the *World* sample's cross-country variation in income per capita, but only about a third (29%) for the *Africa* data set.

Next, the paper tests several *augmented* variants of the Solow model, which allow for additional determinants of an economy's steady-state standard of living. There is some evidence that income per capita is related positively to trade openness and negatively to government size.

Third, the paper's empirical evidence fails to support *absolute* convergence in income per capita for either data set. However, the results are generally supportive of *conditional* convergence, though more strongly for the *World* data set. This implies that countries may be generally approaching different steady states, but when saving and population growth rates are taken into account, there is convergence at an estimated rate of 0.3% (in Africa) to 0.8% (in the World) a year.

Finally, the paper estimates time-varying convergence rates for both sets of countries. The main findings are that the speed of convergence varies significantly over time, has been uniformly lower in Africa than in the rest of the world, and has been higher since the late 1990s relative to the 1970s and 1980s.

The rest of the paper is organized as follows. The empirical methodology is outlined in section 2, while section 3 discusses the data sources and definitions. The empirical results are presented and discussed in section 4. Section 5 concludes.

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[1] Consider, for example, the following three recent working papers in areas as diverse as business-cycles (Arias, Hansen, and Ohanian, 2006), environmental economics (Brock and Taylor, 2004), and health and development (Acemoglou and Johnson, 2006).

[2] These results, however, have been challenged by Bernanke and Gurkaynak (2001), who argue that an alternative class of growth models, the so-called endogenous growth models, are more consistent with the data. See Romer (1990) and Rebelo (1991) for two of the leading endogenous growth models. Aghion and Howitt (1998) present an excellent survey.

[3] Karras (2007) provides a similar study, but uses an earlier data set (PWT6.1) with a shorter time period.

EMPIRICAL METHODOLOGY

The methodology follows the approach of Mankiw, Romer, and Weil (1992). Assume that the production function is given by the Cobb-Douglas specification

$$Y_t = K_t^{\beta}\left[A_t N_t\right]^{1-\beta}, \tag{1}$$

where Y is output, K is the capital stock, A captures the level of technology, N is employment, and $0 < \beta < 1$. Exogenous growth rates for N and A are given by: $\dot{N}_t / N_t = n$ and $\dot{A}_t / A_t = a$, where a dot indicates a time derivative. A standard assumption of the Solow (1956) model is that a constant fraction of income, s, is saved ($0 < s < 1$). Mankiw, Romer and Weil (1992) show that this implies that the level of income per capita at the steady state will be given by:

$$\ln\left(\frac{Y}{N}\right) = a + \frac{\beta}{1-\beta}\ln(s) - \frac{\beta}{1-\beta}\ln(n) + \varepsilon, \tag{2}$$

where ε is an error term. This will form the basis of our first cross-sectional estimated equation:

$$\ln\left(\frac{Y}{N}\right)_i = \gamma_0 + \gamma_1 \ln(\bar{s}_i) + \gamma_2 \ln(\bar{n}_i) + \varepsilon_i, \tag{3}$$

where i is indexing over countries and a bar will indicate country-specific average values over a certain time period. Thus, $\bar{s}$ is the average saving rate, $\bar{n}$ the average population growth rate, and the γ's are the parameters to be estimated. Simple inspection of (2) and (3) establishes the Solow model's predictions: $\gamma_0 > 0$, $\gamma_1 > 0$ (so that a higher saving rate raises the steady-state level of per capita income), and $\gamma_2 < 0$ (so that a higher population growth rate reduces the steady-state level of income per capita).

To allow for the possibility of additional factors determining the steady state, "augmented" versions of the Solow model can be estimated.[4] Here we focus on two additional variables: the government size and the degree of the economy's trade openness. Letting G denote government purchases, EX exports, and IM imports, we define government size as G / Y, the government's share of GDP, and trade openness as $OPEN = (EX + IM) / Y$, total trade as a fraction of GDP. Then, the augmented version of equation (3) is:

$$\ln\left(\frac{Y}{N}\right)_i = \delta_0 + \delta_1 \ln(\bar{s}_i) + \delta_2 \ln(\bar{n}_i) + \delta_3 \ln\overline{(G/Y)}_i + \delta_4 \ln \overline{OPEN}_i + \omega_i, \tag{4}$$

[4] See Barro (1997) for several examples.

where $\overline{G/Y}$ is average government size, $\overline{OPEN}$ is average trade openness, ω is the error term, and the δ 's are the parameters to be estimated. Once more, the theoretical implication is that $\delta_1 > 0$ and $\delta_2 < 0$. In terms of the two new variables, δ_3 is ambiguous in sign, as the distortionary effects of taxes may or may not be offset by the productive effects of government activities; while δ_4 is expected to be positive.[5]

The Solow framework can also be used to investigate the speed of convergence to the steady state. Letting $y_t \equiv Y_t / N_t$ denote per capita income, and λ be the convergence rate, the model also implies:

$$\ln(y_T) - \ln(y_0) = (1 - e^{-\lambda T})\ln(y^{ss}) - (1 - e^{-\lambda T})\ln(y_0). \qquad (5)$$

Testing for unconditional (or, "absolute") convergence, we start by assuming that the steady-state values are the same for each country. Then equation (5) can be written is regression format as

$$[\ln(y_T) - \ln(y_0)]_i = \theta_0 + \theta_1 \ln(y_0)_i + \upsilon_i, \qquad (6)$$

where θ_0 is a constant, the slope coefficient is $\theta_1 = -(1 - e^{-\lambda T})$, and υ is the error term. Note that a positive (negative) λ implies a negative (positive) θ_1. Absolute convergence ($\theta_1 < 0$) then means that the higher an economy's income per capita is at the beginning of the period, the lower its growth rate will be over the subsequent time period. In other words, poor countries will grow faster than rich ones, closing the gap at the annual rate λ. Of course, if θ_1 is positive, the implied λ is negative, so that the poor are growing more slowly than the rich: there is divergence.

More realistically, however, countries do not all converge to the same income per capita, because the fundamental determinants of their steady states are not identical. Conditional convergence allows these steady-state values in equation (5) to differ. Substituting from (2), equation (5) can now be written in regression format:

$$[\ln(y_T) - \ln(y_0)]_i = \phi_0 + \phi_1 \ln(y_0)_i + \phi_2 \ln(\bar{s}_i) + \phi_3 \ln(\bar{n}_i) + \nu_i, \qquad (7)$$

where ϕ_0 is a constant, $\phi_1 = -(1 - e^{-\lambda T})$, ν an error term, and the Solow model still predicts $\phi_2 > 0$ and $\phi_3 < 0$. Once again, ϕ_1 is negative (positive) if λ is positive (negative). But a negative ϕ_1 implies *conditional* convergence: a country that is further away from its steady state will experience faster growth than a country that is closer to its steady state, but there is no guarantee that the two countries are converging to the same steady state (the steady

[5] See Frankel and Romer (1999) and Karras (2003).

states will be the same only if $\phi_2 = \phi_3 = 0$). Note that the Solow model actually predicts conditional (but not necessarily absolute) convergence.

Finally, we will allow for a time-varying conditional convergence parameter, λ_t, by estimating equation (7) for a number of rolling, overlapping windows of length k. This way we can investigate how the speed of convergence has changed over time.[6]

THE DATA

All data are obtained from the Penn World Table (PWT, Mark 6.2), documented in Heston, Summers, and Aden (2006; see also Summers and Heston, 1991). Two data sets have been constructed, as described below.

Data Set I (the *African* Data Set) consists of the 38 African economies for which data on all series exist for each year of the 1960-2003 period.[7] Figures 1 and 2 present scatterplots for the *African* Data Set. Figure 1 plots the 2003 value of GDP per capita (in logarithmic scale) against the investment rate, averaged over the 1960-2003 period. As can be seen from the graph, GDP per capita in 2003 has ranged from $687 in Ethiopia to $16,464 in Mauritius, while average investment rates vary from 2.5% of GDP in Rwanda to more than 33% of GDP in Zambia. Despite the Solow model's prediction, Figure 1 does not show a clear positive relationship between GDP per capita and the investment rate.

Figure 2 plots again the 2003 value of GDP per capita (also in logarithmic scale) against the population growth rate, averaged over the same 1950-2003 period. As can be seen from the graph, average population growth rates have ranged from 1.4% in Mauritius to 3.2% in Kenya. This time, consistent with the Solow model's prediction, Figure 2 shows a negative relationship between per capita GDP and population growth.

For the sake of comparison, we also construct *Data Set II* (the *World* Data Set), which consists of all 99 economies for which data on the series are available for each year of the 1960-2003 period. Figures 3 and 4 present scatter plots for the *World* Data Set. Figure 3 plots the 2003 value of GDP per capita (in logarithmic scale) against the investment rate, averaged over the 1960-2003 period.

As the graph shows, GDP per capita in this Data Set has ranged from $584 in Guinea-Bissau to (again) $49,000 in Luxembourg, while investment rates vary from 2.5% of GDP in Rwanda to 44% of GDP in Singapore. Consistent with the Solow model's predictions, Figure 3 shows a clear positive relationship between GDP per capita and the investment rate for the *World* data set.

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[6] One can also estimate time-varying absolute convergence parameters following the same technique on regression (6). As our objective here is to evaluate the Solow model, however, we skip this exercise and focus on conditional convergence.

[7] The 38 economies are Algeria, Benin, Burkina Faso, Burundi, Cameroon, Cape Verde, Chad, Comoros, Republic of Congo, Ivory Coast, Egypt, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritius, Morocco, Mozambique, Niger, Nigeria, Rwanda, Senegal, Seychelles, South Africa, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe.