

The Evolution of the South African System of Innovation since 1916

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By

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P U B L I S H I N G

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To Rooha, my mother and my sister, and the memory of my father.

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PREFACE

The origin of this book lies in a sense of disquiet with the relatively sudden exclusion of discourses on the economic history of South Africa from the centre of economic planning shortly after the election of the country's first democratic government. This may have been due to an overwhelming concern that the focus of economists and economic planners should shift definitively to the more standard economic concerns of a now "normalised" economy that had suddenly entered the global economy. The inherited economic distortions of apartheid were indeed factored into the post-apartheid economic planning paradigm but at a peripheral, rather than a central position. In a way there was a dissonance between the overwhelming political imperative to redress the massive injustices of the previous three hundred odd years of South African history and the economic prescriptions of how this redress was to be effected. Effectively, political reform was divorced from economic reform and this led to deep rooted contradictions in policy.

The analysis of South African economic history has always been problematic, specifically because of the phenomenon of apartheid which was, unlike the more common cases of colonialism, quite exceptional in the history of economic development. The debates around the foundation of the political economy of apartheid had been rich and highly contentious, and had evolved and matured considerably over the thirty odd years before the advent of democracy. While the post-apartheid political agenda recognised the complexity of the problems which the democratic government faced, the economic planning paradigm did not. Post-apartheid South Africa was, at least implicitly, analysed as a post-colonial developing economy requiring orthodox macroeconomic planning in line with the neoliberal paradigm which ruled supreme in the mid-nineties. The mid-nineties marked the zenith of neoliberal economics and this approach to economic planning in South Africa left little room for history. Partly because of this exclusion this paradigm appeared at the time wonderfully appealing in its apparent ability to render the analysis of, and the planning for, complex actual cases of economic development so simple.

Concurrently, the nineties saw the emergence into the public sphere of a new approach to economic analysis and economic planning, in the form

of a new paradigm, popularly labelled the “national systems of innovation” approach. Indeed, this term was adopted early in that decade by politicians and international economic organisations world-wide; perhaps it was adopted too glibly and without sufficient attention to the implications of the new approach to policy. Certainly, in the case of South Africa, while widely used, the application of the term was restricted to the science and technology sector and did not enter the core of economic planning. As the relevance of science and technology to the growth and development process was increasingly recognised, the status of this sector of public policy increased. This shift was aided by an increasing world-wide sense of uneasiness at the wisdom of neoliberal policy proposals, exemplified in structural adjustment programmes which were increasingly seen to impoverish developing economies, especially across Africa. In South Africa, the growing perception that the neoliberal policy approach had failed to deliver on its redistribution targets has, since the turn of the new century, led to sporadic but largely fragmented attempts to find more relevant economic policy frameworks. In this regard I feel that the systems of innovation approach can provide a viable and useful alternative policy framework.

The scope of this book is to re-examine the history of the South African political economy from the early part of the twentieth century until the present day, with the specific aim to try to understand the nature of structural continuities and ruptures in this history. Most of the critiques of the current economic policy framework are based, explicitly or implicitly, on the proposition of structural continuities from apartheid to the post-apartheid economy, which had been ignored in national economic planning. While the general approach to this history that has been adopted here is an innovation systems approach, the specific version of this approach has to be articulated clearly since the numerous versions of this approach are rarely made explicit in the literature. The one that I have followed in this study is the broadest possible rendition of innovation systems theory, one which has the possibility of becoming an alternative general theory of economics, and which has certainly brought old development theory back to the forefront in the analysis of developing economies.

This book has been long in the making. I had planned to finish it by the year 2000 and its coverage was supposed to end with the 1996 White Paper on Science and Technology. Essentially that book would have been a study of the evolution of the system of innovation until the end of apartheid, with a relatively short coda on the setting of innovation policy within the new overall planning framework. In 2001 I took on the post of

executive dean at a tertiary education institution which was shortly to become part of a large higher education sector merger and my work for the next six years was almost entirely managerial. I resumed the writing of the book when I stepped back into academia in mid-2007. The delay was fortuitous in its effect on the book. The passage of time, a huge portion of the short history of the post-apartheid South Africa, enabled a significantly improved perspective on post-apartheid economic performance and planning. The privilege of hindsight and a number of critical reviews of post-apartheid economic planning that had emerged in the meantime allowed for a more informed assessment of the post-apartheid system of innovation and have resulted in what I hope is a more finished text and one that holds more relevance for the development challenges faced by South Africa.

In the course of writing this book I had the benefit of the assistance of a number of associates. Dave Kaplan from the University of Cape Town and Michael Stettler from the University of the Witwatersrand, both read a very early draft of a part of the book and offered a number of cogent critiques, which enriched the progressive re-writing of the work. Towards the end of the work Mammo Muchie from the University of Aalborg, Denmark and the Tshwane University of Technology, South Africa and Rasigan Maharajh from the Institute for Economic Research on Innovation at the Tshwane University of Technology both gave valuable feedback. I am especially grateful to Mammo Muchie for his extensive critique of the final draft of the text. The last chapter of the book was written while I was on an Erasmus Mundus fellowship at the University of Trento. An early draft of that chapter was presented to faculty there and here I need to thank Bruno Dallago and Italo Trevisan for making that period most conducive to the completion and revision of the book. Finally I need to thank my wife, Rooha Variava, for opening up for me various sources of early twentieth century South African history and for providing a critical insight into the race-class debate which has dominated most of the post-war South African economic historiography. I also owe her a great deal for the much needed emotional support during the writing of the book.

LIST OF ABBREVIATIONS

AEB	Atomic Energy Board
AEC	Atomic Energy Corporation
AECI.....	African Explosives and Chemicals Industries
AE&I	African Explosives and Industries Limited
ANC	African National Congress
ARC.....	Agricultural Research Council
ARMSCOR	Armaments Development and Production Corporation
AsgiSA	Accelerated and Shared Growth Initiative for South Africa
CIS.....	Community Innovation Survey
COSATU	Congress of South African Trade Unions
CPSA	Communist Party of South Africa
CSIR	Council for Scientific and Industrial Research
DACST.....	Department of Arts, Culture, Science and Technology
DNE.....	Department of National Education
DOE.....	Department of Education
DST	Department of Science and Technology
DTI	Department of Trade and Industry
ESCOM	Electricity Supply Commission
FRD	Federation for Research Development
GDP	Gross Domestic Product
GEAR ...	Growth Employment and Redistribution: a Macroeconomic Strategy
HSRC.....	Human Sciences Research Council
IDC	Industrial Development Corporation
IDRC	International Development Research Centre
ISCOR	Iron and Steel Corporation
JIPSA.....	Joint Initiative on Priority Skills Acquisition
MINTEK	Council for Mineral Technology
MRC	Medical Research Council
NACI	National Advisory Council on Innovation
NCRL	National Chemical Research Laboratory
NEERI	National Electrical Engineering Research Institute
NIAST	National Institute for Aeronautics and Systems Technology
NIDR	National Institute for Defence Research
NITR	National Institute for Telecommunications Research
NMERI	National Mechanical Engineering Research Institute

NPRL.....	National Physical Research Laboratory
NRDS	National Research and Development Strategy
NRIMS	National Research Institute for Mathematical Sciences
NUCOR.....	Nuclear Development Corporation of South Africa
OECD.....	Organisation for Economic Cooperation and Development
R&D	Research and Development
RDP.....	Reconstruction and Development Programme
S&T	Science and Technology
SABS.....	South African Bureau of Standards
SACP.....	South African Communist Party
SAMES.....	South African Microelectronics Systems
SAIMR	South African Institute of Medical Research
SASOL	South African Coal and Oil
UCOR.....	Uranium Enrichment Corporation of South Africa
UNDP	United Nations Development Programme
UNESCO ...	United Nations Educational, Scientific and Cultural Organization
VFP.....	Victoria Falls Power Company Limited

INTRODUCTION

The history of South Africa's economic development, especially through the second part of the twentieth century, constitutes one of the more unique stories in the annals of economic history. It has followed and led, through complex sets of causalities, a political development path which was highly idiosyncratic. It has consequently rendered the study of the various aspects of the country's economic history through the twentieth century progressively less amenable to comparative analyses which are rooted in the assumption of commonalities. Thus the dominant historical studies of the South African case, and apartheid in particular, which have adhered too rigidly either to a Marxist or to a liberal paradigm have tended to be didactic and reductionist. South African historiographies, both economic and political, in their dense and complex intertwining, must surely constitute a dangerous source of disillusionment with distinctly structuralist analytical approaches. The potentially disastrous consequence in the post-apartheid era has been an ensuing disillusionment with historical analysis. This disillusionment, especially when set within the increasingly globalised world economy that has emerged since the nineties, has to a large extent eliminated history from post-apartheid economic planning.

The particular history that is the subject of this book is the innovation path of the South African economy and the various processes that fed into the development and formation of South Africa's national system of innovation. This area of study involves two distinct and highly contentious analytical fields and the variety of possible combinations of alternative renditions within them makes for a rich, albeit often contradictory, interpretation of South Africa's technological development path. The first is the theoretical placing of technology and the broader concept of innovation within economic discourse, with a multitude of often conflicting definitions competing for the status of the definitive explanation. The second concerns South African economic historiography, with its various renditions and the political ideologies which inform them. The polemics which have arisen from debates on the fundamental determinants of the economic structure which developed under apartheid set the overall context within which any applied analysis has to be placed, even though a perturbing facet of contemporary debates on South Africa's

economic policy is that they seem in general to be immediate and ahistorical.

When compared to the large histories of South Africa over the twentieth century-the evolution and implementation of apartheid, the complex development paths of the various resistance movements, the history of the labour movement, to list a few-a recount of the evolution of the country's system of innovation may seem insignificant and of interest only to those few whose area of interest lies specifically in the economics of innovation. When set within these larger histories, however, and when the ramifications of its contextualisation are explored, it can open up another source of engagement with the complex phenomenon of apartheid. The basis for this claim lies in the employment of the concept of national systems of innovation, which is a relatively recent arrival in the economist's lexicon and which is noteworthy for its uncharacteristic definitional breadth and for the unprecedented theoretical challenge that it poses for conventional economics.

The main debate over the role played by innovation in the analysis of economic growth and development is between the neoclassical paradigm, which in general assumes knowledge to be a free good that is available to all economic agents in any context, and that stream of theory, stemming from List and explicitly addressed by Schumpeter, which assigns property rights to knowledge and places innovative activity at the core of economic development. Although neoclassical theory has become the reigning paradigm since the war, the polemic has been revived in the later part of the twentieth century by the stories of a number of nations whose development paths repeatedly confounded conventional economic wisdom. The economic successes of the South East Asian economies starting with the early emergence of the Japanese post-war economy were, from the perspective of mainstream neoclassical economic orthodoxy, quite unpredictable and consequently they have provided the main source of empirical raw material for alternative explanations of economic development.

The various expositions which have emerged in opposition to neoclassical economics have coalesced, relatively recently, under the broad rubric of evolutionary theory. The main concern of the wide and often disparate group of theoretical and empirical studies which form the basis of this approach has been the analysis of the nature of innovation, its determinants and the role it plays in the process of economic development. Even more recently the concept of systems of innovation has emerged as the most coherent theoretical construct to date to define the perimeters of

the evolutionary approach to the relationship between innovation and economic development.

National systems of innovation can be loosely defined as networks of institutions within the borders established by nation states which determine the economy's ability to develop and to absorb innovations. These systems are postulated on the basic assumption that technology and innovation, which are defined to include the rules and practices which govern problem solving within a specific social context, are to a significant extent tacit and hence imperfectly transferrable across societal and national borders. Thus innovation is seen as partially context specific and idiosyncratic and it is this approach, in contrast to the orthodox economic view of technology as universally available information, which has been able to address in a systematic and meaningful manner the divergent growth and development paths of nations. National systems of innovation are therefore seen both as the product of the broadest context of economic development processes and as symptomatic of it.

One of the main defining characteristics of the evolutionary approach, the one which differentiates it fundamentally from the neoclassical orthodoxy, is the focus on the historical specificity of the development paths of nations. The abandonment of the neoclassical postulate of technology as a universally available stock of knowledge through the broadening of the definition of technology to include practices, routines and institutions, invokes a concept of innovation as a cultural product contingent on the context wherein it originates. However, the rejection of the postulate of generalised sets of economic laws does not mean a total renunciation of structuralism by evolutionary theorists. The imperative to design policy within most schools of thought in economics necessarily checks the definite move of the theoretical foundations of most approaches to a post-structuralist base. Thus, simultaneously with the emerging emphasis on specificities, there has arisen within the evolutionary approach a recognition of the need to identify commonalities in patterns of technological and economic development as a counterweight to the concern with specific histories and in order to provide a basis for a qualified normative position.

In the search for commonalities, the South East Asian success stories have obviously provided a rich empirical source for the isolation of the preconditions for those quantum leaps in development paths which defy the predictions of the economics orthodoxy. Accounts of the presence and relative importance of various conditions have varied considerably but there is a broad agreement on which conditions are necessary, though not by any means sufficient, for the set of structural transformations required

for high and unprecedented growth rates. Among those prerequisites which have been identified as common to most of the success stories are high levels of investment in human capital formation, a broad accord between state, labour and capital within the context of a loosely defined capitalist framework, a large and growing internal market, and the political will and ability to focus on selected sectors of the economy as the basis of the kick start for the growth process, regardless of the current state of those sectors.

There are, however, preconditions to these conditions and here the analysis for the economist grows murkier as the borders of the discipline as they have been defined by the dominating neoclassical paradigm are transgressed and explanations are sought in fields of study which themselves fall into the interdisciplinary interstices. One such field is the study of nationalism, its various definitions and manifestations, and the contextual determinants of its emergence. Lall (1994) argues that the one common characteristic of the Asian “tigers” has been the absence of common economic policy blueprints. This in itself points to the need to find a deeper layer to the explanation of their immediately obvious commonality, which is their unanticipated success. This layer may consist of specific manifestations of a nationalist drive operating within a context of a broad internal consensus and motivated by the will to attain a standing and a voice in the international political and economic arena. From this perspective it would then be profitable for the analyst to examine the conditions under which ethnic affirmation, transmuted into nationalism, can foster the set of conditions which enable the shunting of the development process into the fast track. Gellner (1987: 15) proposes that the prime requirement of a modern (as opposed to a traditional) society is a “realistic and well-based expectation of economic growth ... which, over time, allows everyone to become richer”. This, Gellner argues, is the binding glue of the nation state which, he is at pains to point out, is not based on “natural” ethnic determinants, such as race, language, or religion, but instead actually requires a willed and forced amnesia of diverse and potentially infinitely divisible, and divisive, ethnic origins. The implication of this proposition is that a slowdown of the growth process, and worse, its reversal, sets up the conditions for the breakdown of the nation state, with the consequent deleterious feedback effects into the development and growth process. The second half of this century is littered with such cases, the most dramatic of which was the Soviet Union and its various satellites. Where the economic slowdown and the threat of recession appear, divisive ethnic affirmations often re-emerge to threaten the recently formed nation states. Even rapid growth rates, when

accompanied by unchanging or even worsening income inequalities, can pose a significant danger to the stability of the nation state. The unpredictable economic success stories, on the other hand, consist of those nations, the newly industrialised countries, which managed to attain, against the expectations of orthodox economic theory, unprecedented growth rates in the economic well-being of their general citizenry. However the rapid set of political and societal crises engendered by the series of international financial crises starting with the collapse of the South East Asian economies in the nineties are a cautionary reminder of the fragility of the newly emerging nation states and the contingency of their stability and permanence on economic success.

The emphasis on growth allocates a central position to innovation within the evolution of the modern nation state and Gellner lists the prerequisites of sustainable innovative efforts as ultimately residing in the political freedom of the general populace to attain economic power within a context which is characterised by the absence of constitutional and institutional constraints on the drive to equality¹. Thus, the various characteristics of systems of innovation can be useful as a taxonomic device to identify the positioning of specific nation states in the global drive to modernity. At the same time this approach would draw out those conditions and circumstances which could transform the nationalistic drive into an insurmountable obstacle to development or which may be a source of crisis in the future development path of those economies which have already managed the quantum leap to the fast growth track. Nationalism and especially a nationalism which has powered economic miracles can also engender xenophobia and a consequent rigidity which may prove

1 Gellner (1987: 15) points out that

“Innovation ... presupposes unceasing occupational mobility, certainly as between generations, and often within single life-spans. [This] requires that members of such a society must be able to communicate in speech and writing, in a formal, precise, context-free manner - in other words they must be educated, literate and capable of orderly, standardised presentation of messages. ... Men cooperating on complex tasks involving high technology must be able to read, and to be able to read the same idiom. Men on the move between diverse jobs, in enterprises with distinct and independent hierarchies, can only cooperate without friction if the baseline assumption is one of rough equality: all men as such are equal, and ranking is *ad hoc* and task-specific. Inequality is temporarily vested in individuals, in virtue of wealth, role-occupancy, or achievement; it is not permanently vested in entire hereditary groups.”

In the South African context none of these conditions could be attained within the framework of apartheid.

disastrous in the face of dramatically changing global conditions. However, the liabilities of “successful” nationalism and the newly defined national affirmation are not the main concern of this study. What is pertinent to the South African case is the examination of the preconditions for the leap into a high growth path rather than the consequences of those conditions once the leap has been made.

In the case of South Africa, apartheid, in a manner that was distinct from the segregation model that predated it, constitutes a particularly extreme example of an ethnic and nationalist agenda which determined the development path of the country and the evolution of its national system of innovation. This statement does not imply a one way causality, as liberal economic historians propose. That would be as simplistic as the alternative explanation stemming from the extreme Marxist revisionist position that apartheid was the product of the tension in the relationship of power between imperial (English) and indigenous (Afrikaner) ownership of the means of production and that its shape was the result of a resolution of this conflict through an intra-white redefinition of the ownership base of capital. One of the main defining features of apartheid, and of particular concern to the study of its particular imprint on the country’s emerging system of innovation, was that the affirmation of national identity on the basis of racial dominance was enacted in a country where the oppressed constituted the vast majority of the country’s population. It was not simply the case that the South African polity failed to attain the Gellner’s pre-condition for the emergence of a modern nation state. Apartheid was premised on ethnic difference as its defining feature and was therefore by definition anti-modern within the post-colonial context. This uniquely reactionary aspect, the rejection of the requirements of modernity, constitutes the foremost defining characteristic of the system of innovation that emerged under apartheid, a feature that was largely absent in a pre-apartheid segregation period that could still be located within a colonial set of references.

As an ideology, apartheid, and racist tenets in general, could not possibly constitute the basis for a modernising economy. It did not provide a revolutionary construct of interconnected premises about human relationships on which a concerted and complex programme of political and economic policy could be formed. It had the one conservative, and at the time already reactionary, premise of racial superiority as its core “truth”. In a way it was this very simplicity of its value underpinning that permitted a high degree of flexibility in the political and economic

programmes which were devised to maintain racial dominance.² Simultaneously of course this also implied a lack of consistency in such programmes with frequent and often disruptive alterations in economic policy.

The development of the capitalist sector in South Africa's history also manifests a remarkable flexibility in its interaction with the state and certainly a high degree of durability.³ Around the turn of the century the requirements of the mining sector determined the fundamental and traumatic reshaping of the rural-urban economic relationship for black workers and black peasantry, not only in South Africa but throughout a substantial portion of Southern Africa. Mining interests virtually dictated the various acts of legislation which affected the labour supply for this sector and it was only when the pursuit of these interests infringed on the existing privilege of white workers, that political tensions arose between state and capital. This tension was eased progressively under apartheid as the wave of successful Afrikaner nationalism motivated policies that effectively eroded the inherited correspondence between white ethnic groupings and the command over the means of production. The archaic nature of the system of innovation which emerged under apartheid does not therefore necessarily imply that it was not viable or that it was contrary

2 The move from an essentialist assumption of racial superiority which rested on faith and could not therefore be refuted through rational arguments to the model of "separate development" as designed by Verwoerd can be construed as a shift to rationality within the apartheid agenda. Separate development was premised on distinct cultural differences which could be cited as an evident observable fact which only required a convenient amnesia of the origins of such differences and of their attendant hierarchical ordering in state policy to be used as the empirical basis for the justification of apartheid on 'pragmatic' grounds.

3 Adam (1971, 1972) argues that the conflict between state and business was on issues of strategy, rather than on the "basic principles of white rule" (Adam, 1972:147). He identifies the basis of the accord between these two sectors as follows

"Only economic strength enables the government to defy external pressure and to control the sounding board of internal opposition. The entrepreneurs on their part are aware that only the Apartheid order, and especially the prohibition of effective non-white unions, ensures a relatively cheap labour force. Any political advance of the non-whites would enable them to force economic concessions to the detriment of white profit rates. Thus far, Apartheid has not been an obstacle to the present boom, but one of its important prerequisites." (Adam, 1972:148)

Adam does point out that at the time of writing (1970) there was already evidence that the requirements of secondary industry for skilled workers was starting to pose a serious obstacle to future growth prospects.

to the interests of the principals of the apartheid regime, whether these were whites in general or white capital in particular.

The success of apartheid,⁴ the fact that it was able to survive for over forty years in the post-colonial period, was due to two main related factors. In the first place there emerged during apartheid a convergence between the interests of the Afrikaner nationalist movement and the colonial and neo-colonial owners of the means of production within an inherited structural context. This convergence ratified the economic exploitation of the disenfranchised mass of the population. The association between intra-white ethnic divisions and the ownership of the means of production was thus effectively eroded and a new dominant correspondence between ethnicity and economic power emerged. Economic power became irrevocably determined by race within a resource rich economy where the beneficiaries of a predatory state constituted a small proportion of the population. This provides the source of the rapid development of specific technological core competencies within the context of a national system of innovation that in its entirety was ill suited for development. It was a system with some salient features that, within the post-apartheid context, still strongly inhibit the transformation of the country into a globally competitive modern economy. The second factor was the integration of South Africa's industrial structure within the western capitalist system and the concomitant political linkages in the cold war era. These linkages served to mitigate extensively the efforts of the international anti-apartheid movement to isolate the South African economy. Concurrently the overtly capitalist nature of the South African economy, especially within the context of the cold war period, served to reinforce the specific technological development paths which emerged within the unique setting of apartheid.

The focus on ethnicity as a basis for the study of South African economic development may perhaps be construed as a liberal argument for the distortions imposed by a racist "ideology" on the otherwise efficient functioning of markets. This would be a fallacious association emerging from the race-class debates which have dominated South African economic historiographies. Thus within the context of the debate between the liberal (race) account of the economic history of apartheid and the Marxist revisionist (class) account it may be thought that this stand falls within the liberal camp. However, this debate has long ceased to be

4 In this regard, Adam (1972: 16) argues that

"The Apartheid system has been viewed as simply the most outdated relic of a dying colonialism, yet possibly it is one of the most advanced and effective patterns of rational, oligarchic domination."

reductionist and more complex assessments of the interrelation between apartheid and capitalism have emerged as a consequence. Class distinctions and class conflict have always been associated with ethnicity within the South African context. Throughout the pre-apartheid segregation period this was manifested in the struggle over the access to economic power between English and Afrikaans speaking white South Africans and provided the motive power behind Afrikaner nationalism. The highly effective strategy of the apartheid mandarins after the 1948 elections accomplished the successful resolution of this conflict through the democratisation of the access to economic power within the white population. This was achieved through the interpenetration of capital across ethnic divisions among whites which generated a realignment of the social division lines within that group.⁵

After that, and throughout South African post-war economic history until 1994, ethnicity as the effective qualifying basis for access to economic power was explicitly defined in racial terms. Thus, while the country's various subjugated populations became subsumed within the general category of 'non-whites', constitutionally excluded from equality with whites, the policy of separate development aimed at the fragmentation of opposition by the granting of differentiated sets of political and economic rights to different racial groupings within the disenfranchised majority. Apartheid was premised on difference and the core of its strategy, primarily through its education policies and its restrictions on economic and spatial mobility, was to deepen the correlation between ethnicity and economic power. This is the heritage that the country's first democratic government faced and still faces, an enduring effective differentiated access to economic power rooted in ethnicity. It constitutes

5 The transition from ethnicity to class as the primary intra-white differentiating criterion is identified by Adam (1972: 179), when he argues that

"... the historical division between the English- and Afrikaans-speaking populace is rapidly being replaced by class contradictions between the two groups. As an entrepreneur, an Afrikaner has more in common with his English speaking counterparts than with his poorer fellow Nationalists. ... With their growing economic control over a relatively powerful industrial state, with increasing urbanization, and diminishing isolation ... the dominant interests of the political rulers have come to resemble those of the formerly hated industrialists."

The erosion of the identity defining prowess of ethnic differences with the liberalisation of the access to economic power across ethnic demarcation lines fulfils Gellner's condition for a modernising society. Of course, the oddity of the South African case is that this process occurred within a wider context which flouted, through legislation, this requirement.

the most formidable block to the attainment of Gellner's prerequisites for a modern economy and encapsulates the whole plethora of other, essentially secondary, obstacles to the development of the type of national system of innovation that is required for a rapid growth path. The success or failure of economic policy in the post-apartheid era, whether it can lay the foundation for another economic success story, will rest on its ability to redefine ethnic identity in terms of nationhood through an effective plan to redress the inherited inequalities of income, wealth and opportunities.

The particular history developed in this work contains little reference to actual inventions or innovations developed or adopted in South Africa since 1916. In that regard several thorough reviews already exist.⁶ This recount concerns, rather, the evolution of the institutional context within which innovation occurred in South Africa. In the process it is hoped that it also opens up the space for some reflections on the nature of the context itself. This should contribute to a rigorous assessment of the continuities and rupture in the evolution of the South African system of innovation. In turn that assessment should enable the development of a new perspective on the assessment of post-apartheid economic policy formulation. The rest of this book is roughly divided into two sections, one theoretical and the other applied.

The following two chapters review the theoretical space within which this study is set. The first deals with the concept of national systems of innovation, its genealogy and domain. The main focus of this chapter is on extent of the areas of concern which are addressed by this term and the wide range of inter-related disciplines which are enlisted in its service. The definitional and operational breath of this concept which is seen by its adherents as analytically rich can also constitute a threat to its theoretical integrity, especially when compared to the clear delimiters which demarcate the neoclassical paradigm. This is one of the issues that will be addressed in this chapter.

The second chapter deals with alternative renditions of twentieth century South African economic history in order to anchor this study within the prevalent debates that have occurred in this field. Broadly speaking the debates fall in either of two camps. The first is based on the

6 Brown (1977) and Kros (1993) offer South African histories of technological innovations in a number of fields. Kingwill (1990) intersperses a history of the Council for Scientific and Industrial Research (CSIR) with that of technological achievements. Landgren (1989) details the history of technological development within the military sector. Kaplan (1990) and the series of Industrial Strategy Project reports published in 1995 offer a series of detailed industry studies which include detailed chronologies of the courses of the relevant technological changes.

assumption of racial domination as the core explanation of the course of South African history. Within this account, which has been largely appropriated by liberal economists, economic rationality is judged to have been perverted by the requirements of racial discrimination, especially during the apartheid era. The recurrent pronouncement of the liberal camp is that market rationality would not have tolerated the costs imposed by segregation and apartheid through “distortions” such as compartmentalised labour markets and international isolation and that in the absence of state coercion market functioning would have inevitably moved to eliminate the discrimination inherited from the colonial era. The second camp, which emerged on the basis of a rejection of the assumption of some optimally efficient market organisation whose rationality was perverted by the requirements of ethnic affirmation, deals more cogently, albeit in a theoretically restricted fashion, with the exercise of power. Marxist historians point out that the origins of state intervention in the labour markets arose from the requirements of the business (mining) sector and that until the seventies low labour costs generated exceedingly high profit rates. From the perspective of this approach the increasing pressure on the state to relax the constraints of job reservation and to provide better skills development programmes for black workers from the late seventies onwards constitute evidence that capitalism was the principal behind apartheid. The shift from a Keynesian to an overtly market friendly macroeconomic planning framework and the rift between the state and organised labour in the transition to democracy is also quoted as incontrovertible evidence of the dominating role that capitalist interests have played over the course of South Africa’s history.

The attraction of the second approach lies in its counter-intuitive stance, its semi-deconstructive erosion of what appears to be the prime characteristic of apartheid and its antecedents. It does however share two characteristics with the opposing camp. The first is its claim to provide a totally deterministic explanation of the phenomenon. The second is its simplistic discourse on power. Power is seen as a means to an end, however that end is defined. Power is thus purely instrumental and it is denied the possibility to be an end in itself, to alter the nature of the agent who exercises power. The extreme versions of both the liberal explanation and the Marxist revisionist approach thus fail to open up the analysis to the consideration of the myriad idiosyncratic nontrivial manifestations that emerge in specific contexts. Technology and power are two closely interrelated discourses. Technology choices proceed from sets of power relations, within the scientific community, within factor and commodity markets, within the relationship between institutions which pertain to state

and market and from the relationship between the local and the global economy. Technology endows power, almost inevitably in a non-equitable fashion, thus reinforcing or eroding current power relations in a multitude of relevant contexts. Moreover, the outcome of innovation is never fully predictable, especially with respect to the distribution of power.

The commonalities between the two accounts also imply that the association between the discourse on race and liberal account of economic history could be accidental. A Marxist historian could easily adopt a race position and bewail the fact that apartheid impeded the progression of the country's broad economic base from a pre-capitalist to the capitalist stage which would have set the basis for a socialist revolution⁷. However, if we move away from the glib race account of South African economic history and abandon the inherent presumption of the efficiency of untrammelled markets, the analysis of ethnic affirmation can provide the basis for the understanding of the development of South Africa's innovation system. Here we therefore open a new discourse based on the evolution of systems wherein the interplay of ethnicity, race and power within a specific historical context can enable the analyst to understand the nature and viability of the South African system of innovation.

The rest of this book deals with a selective narrative of the institutional development process within which the innovation base of the South African economy evolved. The choice of a starting point for any particular account is inevitably arbitrary to some extent. In the case of this particular history a convenient commencement date is 1916, the year that saw the first concerted attempt at the formulation of a national science and technology policy framework for South Africa. This emerged from the combination of a changing global context and the set of conditions peculiar to the South African political economy. This first science and technology plan emerged shortly after the formation of the Union of South Africa and during the First World War which heralded the end of colonialism and ushered in technology as the main determinant of the fortunes of nations.

7 In his essay "Nationalism and Marxism" Gellner argues that Marx was in favour of free trade since it would eliminate the obstacles posed by national boundaries and national identities to the emergence of a world wide proletarian consciousness. Gellner (1994: 13) quotes the *Communist Manifesto* as evidence of this position:

"The nationality of the worker is neither French, nor English, nor German, it is *labor* ... His government is neither French, nor English, nor German, it is *capital*. His native air is neither French, nor German, nor English, it is *factory air*."

The history of the evolution of the South African innovation system over the period considered in this work is treated in three parts. The first period between 1916 and 1948 sees the state, with some interruptions, proceeding on a path which had the potential to eventually establish a science and technology base appropriate for a modernising economy. This section covers the period of segregation which preceded apartheid and concerns the internal conflicts which, along with a dependence on the policy making centre of the British Empire, determined the vagaries of policies on science and technology as well as industrial and trade policies which had a direct effect on the development of South Africa's system of innovation. The end of this period marks the failure of the state to resolve these contradictions and the fossilisation of the country's technology base in an evolutionary cul-de-sac. It is difficult to envisage the progression towards modernity, hesitant though it was that was initiated in the years preceding 1948 within the apartheid context which emerged after the victory of the National Party. This incompatibility is not proposed because authoritarian regimes and modernisation are assumed to be mutually exclusive, but because the specifically racist nature of domination within South Africa where the oppressed constituted the large majority of the labour force eventually posed insurmountable structural obstacles to the development of a modern economy.

The second part of this history, which covers the period of apartheid between 1948 and 1994, looks at the erosion of comprehensive national science, technology and innovation planning, in spite of accelerating drives on specific technological fronts. This occurred precisely because of the incompatibility between the requirements of a process of modernisation and the exigencies of apartheid. In the process the state relinquished the role of a prime mover and shaper of the evolutionary path of the nation's system of innovation. Some technology initiatives during apartheid were intensive and achieved successes but these initiatives were specific and their success was evaluated within the paradigm of apartheid. They were mostly driven by the perceived national strategic needs of an increasingly embattled regime and were key constituents of the rapidly growing military-industrial complex.⁸ The abandonment of control, at a

8 Fine and Rustonjee (1996: 246) object to the validity of a "military-industrial complex" as an explanatory framework for the analysis of the power relations underlying South Africa's industrial development under apartheid on the basis that "the existence of security and industrial imperatives do not in themselves explain the extent and composition of the defence industry. Rather, the development of the defence ministry has been intimately related to the interests and evolution of the [minerals-energy complex]". I do not use the notion of a military-industrial

certain aggregate level, over this component of a nation's development path may seem incompatible with a regime which was in the process of laying down the details of the complex edifice of grand and petty apartheid and which had no reservations about imposing extreme control measures over the populace in the process. This is the question that will be explored throughout this section.

The third part of the history starts off with the publication of the White Paper on Science and Technology in 1996, in order to locate it within a set of oppositions and continuities *vis-à-vis* this history. The analysis of the evolution of the South African system of innovation since the demise of apartheid is predicated on the assumption that over time structures develop a momentum and that the cultures which inform policy endure, especially when divested of opprobrious racist connotations. In this part the role assigned to science, technology and innovation policy is examined within the context of the rapidly changing nature of the state's macroeconomic planning vision and the determinants of that change.

The White Paper of 1996 was drafted shortly after the collapse of apartheid and within a global context which, in the aftermath of the collapse of the Soviet Union, was in a process of radical flux and redefinition. The White Paper is itself the resultant of a wider economic policy discourse whose identification was, and still is, is the source of a current highly acrimonious debate. In the final part of this work the implications of this study for the future of South Africa's innovation system are discussed. The underlying argument presented here is that the South African economic system was grievously unprepared for the world into which it emerged from apartheid and that the shock of the transition in conjunction with the policy options that were adopted have been damaging for the prospects of creating a viable system of innovation suited to the country's development requirements.

This discussion is located within a global context especially with regard to the increasing empirical irrelevance of the concept of a specifically "national" system of innovation. In this section the concept of regional (supra-national) innovation systems is used to explore the possible evolution paths that the South African system faces in a global context which is marked by the emergence of economic blocs. South

complex as the overriding explanation of the shape of the industrialisation process but rather as arising from the recognition that the military imperatives of an increasingly embattled and isolated apartheid regime did stimulate specific patterns of investment and innovation, no doubt generating unprecedented rent seeking opportunities for established capitalist interests which would otherwise not have occurred in the process.

Africa's economic fortunes have become crucial to the future of sub-Saharan Africa and the relationship has become reciprocal.

As a study of twentieth century South African economic history this particular exercise is at some levels a "top down" narrative. State policy on science, technology and innovation was too rarefied an area, given the glaring inequities and the overt and extreme nature of the political and economic oppression which were to be combated, to become a significant focus of the liberation struggle. It becomes therefore a history of the oppressor, but even then it is a history rendered more in terms of an account of what is ignored and omitted and which gains meaning within the context in which it is set. In contrast to the plethora of racist policy formulation affecting the rights to work, to education, to freedoms of speech, association and habitation, there were no overtly "apartheid" science, technology and innovation policies. In fact if such policies, both formal and implicit, that were enacted in South Africa before the advent of democracy were to be de-contextualised the uninformed reader would find it difficult to discern the country of origin, except to conclude that it was rich in mineral resources and had a small highly skilled population. Even the level of R&D spending on defence would not raise eyebrows since the proportion of the total defence budget that was allocated to R&D fell in the same category as a number of medium sized economies across the world⁹. It is this very rift between official policy and the realities of the conditions to which it was meant to apply that constitutes the defining characteristic of planning in this field and requires the conceptual breath of a system of innovation analysis to capture the essence of science and technology planning within the South African context.

The apparent innocuousness of this particular part of the apartheid heritage renders it perhaps more problematic in the debates on post-apartheid policies for reconstruction and development. Generally speaking, the development of the country's system of innovation was affected, but not fundamentally addressed, by the successful outcome of the liberation struggle. The low priority placed on science and technology policy formulation in particular and on policies to enrich the country's system of innovation in general by its first democratic government, in contrast to policies adopted by newly industrialised economies, is partially

9 Landgren (1989: 51) points out that

"...(b)y 1983, two per cent of the South African defence budget was spent on research and development. This is approximately the same level of spending as in Canada, Switzerland, Italy, Japan and Norway ... in 1971 ... South Africa was on par with such countries as Spain, Portugal and Greece as to the proportion of GNP spent on R&D."

a heritage of the history that is recounted in this study. It is also symptomatic of the tenacity of the ubiquitous structure which evolved since 1948 and which has successfully reproduced itself and the power relations that it serves.