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Output, Employment and Financial Sanctions in South Africa

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Abstract

The effects of the marked slowdown in the growth of the capital stock in South Africa since 1985, associated with political uncertainty and financial sanctions, and future growth prospects are quantified using a modified version of the Lewis development model. This is done by estimating production functions for the nonprimary and mining sectors of the South African economy involving skilled (white) labor, unskilled (nonwhite) labor and capital. It is concluded that each 1 percent change in the growth rate of the capital stock leads to at 0.8 percent change in output growth, and hence the fall in investment since 1985 has lead to significant falls in growth, employment and real wages.

JEL Classification Numbers:
121,226,441

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Output and employment prospects are an important issue in any country, but particularly so in South Africa, where social unrest and financial sanctions from abroad led to a marked slowdown in growth in 1985, principally owing to the termination of access to foreign capital markets. This paper presents empirical estimates of the supply side of the South African economy and uses the results to look at the interrelationship between investment, growth, white wages, and nonwhite employment. It also quantifies the effects of the marked reduction in the investment ratio since 1985 and of future prospects under different scenarios.

A stylized model of the South African economy is outlined and estimated. Capital, unskilled (nonwhite) labor, and skilled (white) labor are used in production. White wages are assumed to vary in order to keep the labor force fully employed, while for the nonwhite labor force the wage rate is given, and employment which is determined residually.

The results from the production function indicate that each percentage increase in the rate of growth of the capital stock raises nonwhite employment by 1.5 percent a year and white real wages by 0.3 percent. As a result, output rises by 0.8 percent a year. These estimates indicate that the marked fall in investment in South Africa since 1985 has had a significant effect on growth, employment, and real wages.

I. Introduction

Output and employment prospects are an important issue in any country, but particularly so in South Africa, where social unrest and financial sanctions from abroad led to a marked slowdown in growth in 1985, principally due to the termination of access to foreign capital markets. 1/ In this study empirical estimates of the supply side of the South African economy are presented, and the results used to look at the interrelationship between investment, growth, white wages and nonwhite employment. The effects of the marked reduction in the investment ratio since 1985, and of future prospects under different scenarios, are quantified.

A stylized model of the South African economy is outlined and estimated. The model has two sectors: the homelands; and mining, European agriculture and industry. The homelands provide a reserve labor force, and the available wage defines the going rate for nonwhite workers in the rest of the economy. In mining, industry and European agriculture, capital, unskilled (nonwhite) labor and skilled (white) labor are used. White wages are assumed to vary in order to keep the labor force fully employed, while for the nonwhite labor force it is the wage rate which is given, and employment which is determined residually.

Previous studies of this type have been almost exclusively theoretical. 2/ By using econometric estimates of the underlying production functions for different sectors of the South African economy, this study quantifies the supply side relationships in the economy. The results indicate that nonwhite employment prospects are highly dependent on the rate of growth of the capital stock, while white real wages are less so. A return to the growth rate of the capital stock experienced in the early 1980s would allow substantial increases in nonwhite employment; on the other hand, a continuation of the low rates of growth experienced in the period since 1985 would produce inadequate nonwhite employment opportunities and falling white real wages.

The plan of the study is as follows. The next section considers the effect of financial sanctions on domestic investment, and discusses projections for the capital stock, labor force, and nonwhite wage rates. In Section 3 the model is presented in more detail, including consideration of the validity of certain key assumptions, and estimates of production functions for nonprimary industry and mining are reported. The implications

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1/ As a result of these sanctions the rate of growth of the capital stock slowed from 4 percent per annum in the early 1980s to 1 percent in the later half of the decade.

2/ Iyengar and Porter (1990) is an exception. They calibrate a simple computational equilibrium model and use it to look at aspects of labor market constraints in South Africa. However, since the analysis abstracts from effect of different levels of the capital stock, it is somewhat tangential to the issues considered in this paper.

of this model for future employment, wages and the underlying growth potential of the economy are discussed in Section 4. Section 5 uses the model to quantify the cost of the financial sanctions imposed in 1985 on white wages and nonwhite employment, while Section 6 contains conclusions.

II. Financial Sanctions, Capital, Labor, and Nonwhite Wages

The rise in uncertainty associated with social unrest and the imposition of financial sanctions in mid-1985 resulted in an abrupt reduction in investment in the South African economy, and slowdown in the rate of growth of the capital stock. The upper panel of Chart 1 which shows the behavior of domestic fixed investment as a ratio to GDP since 1980, reveals the abrupt fall in the investment ratio in 1985; comparing the period 1980-84 with 1986-89 the average value falls by some 7 percent of GDP, from 26 to 19 percent. 1/ Of course, this fall corresponds to a period of uncertainty as to the political future of the economy, as well as financial sanctions. However, the two effects are almost impossible to separate, since sanctions were both a cause and a reflection of these problems; for the rest of this paper the words financial sanctions will be taken to include the associated uncertainty.

The middle panel of Chart 1 shows the effect of this fall in investment on the path of the capital stock (measured in logarithms so that the slope corresponds to the rate of growth); its rate of growth fell from 4 percent per annum in the early 1980s to 1 percent after 1985. 2/ The calculations behind the fall in the growth of the capital stock are fairly simple. The rate of depreciation of the capital stock is around 5 percent per annum. In the early 1980s the average capital output ratio was around 3. It follows that capital depreciation represents some 15 percent of GDP, while every increment in investment of 3.0 percent of GDP above this value represented a rise of 1 percent on the growth rate of the capital stock. Due to the fast growth of capital, by the latter half of the 1980s the capital output ratio

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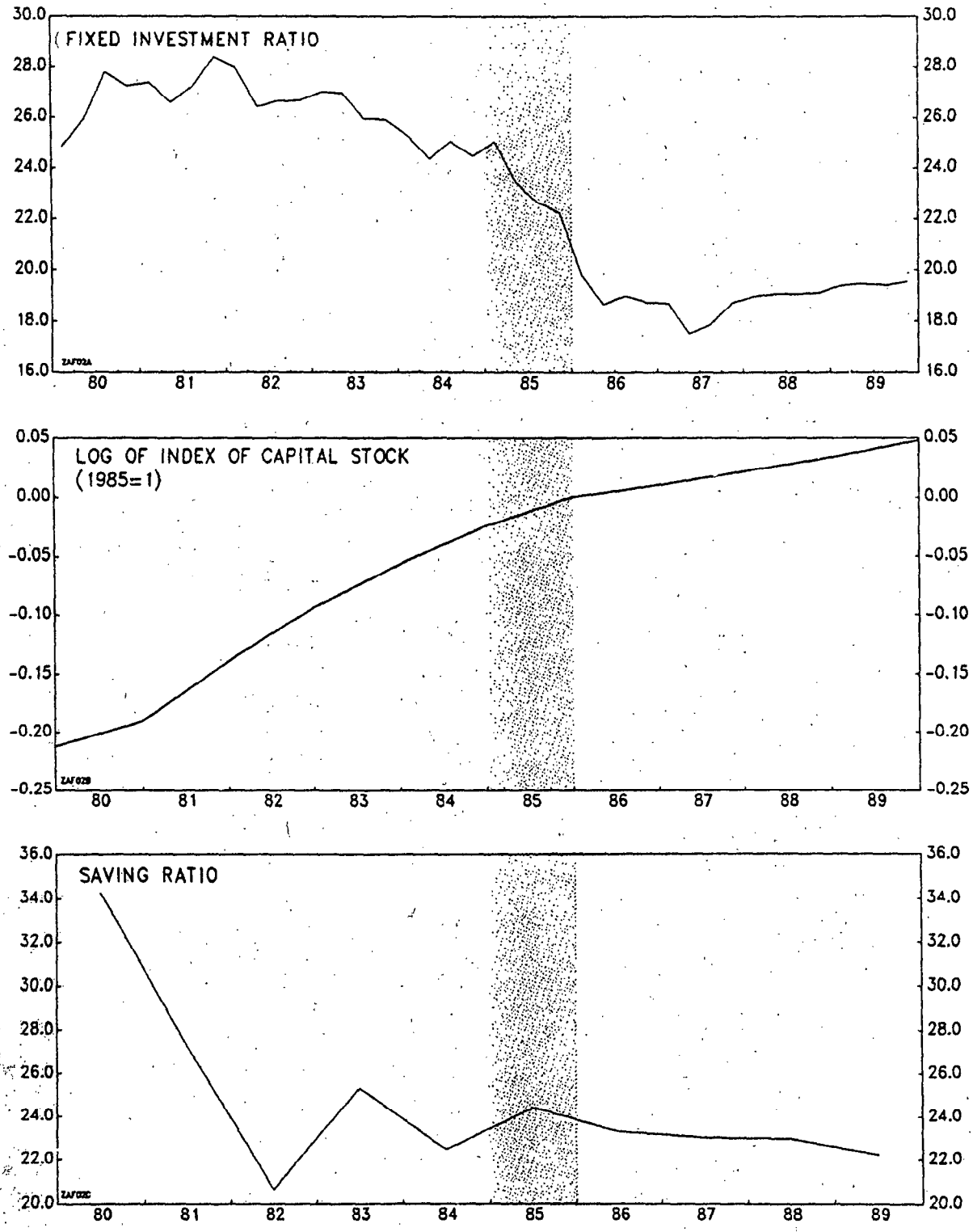
1/ This reduction does not correspond to the experience of other developing countries. While there is some fall over the 1980s, particularly in Africa and the Western Hemisphere, these falls occur in the early 1980s. The only area of the world in which investment fell in the mid-1980s was the Middle East, which was clearly due to the fall in the oil price (World Economic Outlook (1990)). Hence, it appears reasonable to attribute the reduction in investment to financial sanctions, rather than more general economic forces.

2/ This slowdown in the rate of growth of the capital stock did not result in a shift in the composition of the capital stock towards business investment; the capital stock associated with community, social and personal services grew at 2.4 percent between 1985 and 1989, above the average for all sectors. Indeed, from 1985 to 1989 the capital stock actually fell in agriculture, manufacturing, electricity, gas and water, construction, and transport, storage and communication.

CHART 1

SOUTH AFRICA

INVESTMENT, CAPITAL AND SAVING



Sources: South African Reserve Bank, Quarterly Bulletin.

had risen to around 3.2, implying a depreciation of 16 percent of GDP, with 3.2 percent of GDP being needed for every percentage rise in the capital stock. Since none of the critical parameters in this calculation are likely to change significantly in the medium term, this simple rule of thumb can probably be projected into the future.

The bottom panel graphs the domestic saving ratio. This ratio was very high in the early 1980s, largely as a result of the high gold price ruling at that time. Since 1982, however, there is no obvious trend; clearly, with heightened uncertainty contributing to the fall in investment, domestic saving did not rise to make up for the cutback in international funds.

The future path of the capital stock depends critically on access to new foreign saving; from Chart 1 it appears that national saving has been stable over the recent past, and capital service outflows are projected to continue to be large. In the absence of new foreign saving becoming available, and a rebuilding of confidence that would be associated with this, it is reasonable to project the investment output ratio for South Africa to be similar to the recent past, at around 19 percent, implying a future rise in the capital stock of some 1 percent per annum. On the other hand, were increased foreign saving to become available and confidence to rebound, the investment ratio would rise. It is assumed that it would return to the level of the early 1980s, around 26 percent, 1/ which would lead to a growth rate of the capital stock of about 3 percent per annum given the current capital output ratio.

Future growth prospects also depend on the expansion of the labor force. Projections of the available labor force involves two factors, the size of the working age population and the participation rate. Sadie (1988) contains projections by age and race for five-year periods from 1990 to 2005. The rates of growth of the white and nonwhite populations of working age (defined as 15-64) are shown in Table 1. The white population is projected to grow by under 1 percent per annum, the nonwhite by around 3 percent. 2/

Participation rates can be calculated by taking the ratio of the employable labor force to the working age population. For whites, the calculations for 1970, 1980 and 1985 show no obvious trend. 3/ Hence, as there is no reason to project a change in participation rates, the labor force is projected to grow in line with the working age population.

1/ There is also, of course, the possibility of a catch up effect as investment which was postponed due to lack of access to foreign saving is reactivated. Since we are interested in medium term prospects for the economy these effects will be ignored.

2/ Within this the most under privileged group, blacks, are growing fastest.

3/ The numbers are 62.4, 64.8 and 61.3 percent respectively.

Table 1. South Africa: Rate of Growth of Working Age Population, 15-64

(In percent)

	White	Nonwhite
1980-85	1.8	3.1
1985-90	0.9	3.1
1990-95	0.8	3.0
1995-2000	0.7	2.9
2000-2005	0.7	2.8

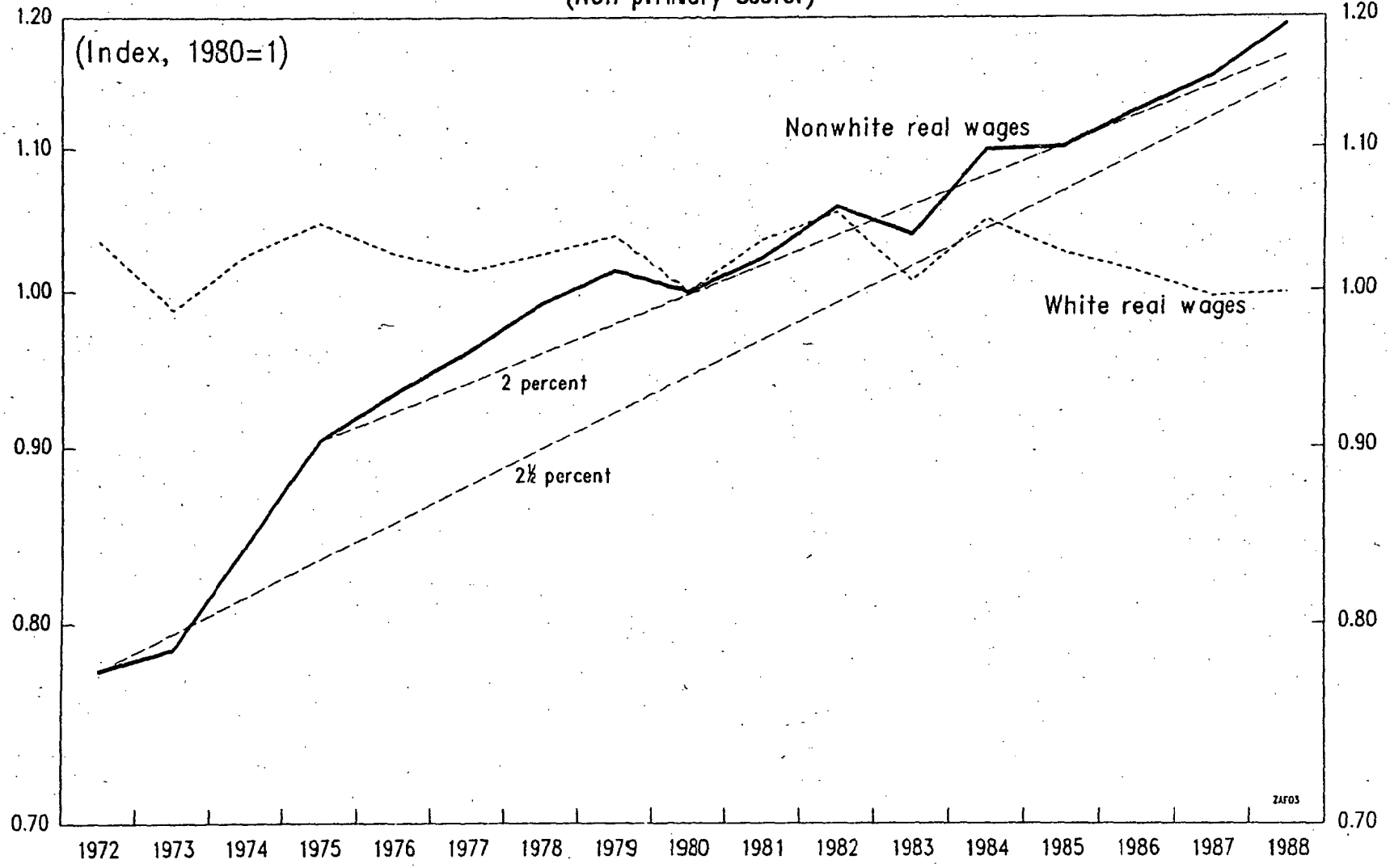
Source: Sadie (1988)

CHART 2

SOUTH AFRICA

REAL PRODUCT WAGES

(Non-primary Sector)



Source: South African Statistics, 1988.

For the nonwhite population, it is assumed that employment depends upon the (exogenously determined) wage rate, and hence the critical factor is the rate of growth of nonwhite wages. Nonwhite real product wages in the nonprimary sector are shown in Chart 2 (the data are in logarithms, so the slope is equal to the growth rate); the data show an acceleration in nonwhite real wages in the early 1970s, followed by a fairly steady increase from 1974 to the present day. The trend growth since 1974 is approximately 2 percent per annum, which is extrapolated as a projection for the future. Results using a growth rate of 2 1/2 percent are also reported. White real product wages are also shown for comparison. They show little trend in the period up until 1984, followed by some fall subsequently. While the change in behavior is not particularly marked, this period also corresponds to a marked slowing of the rate of growth of the white labor force (see Table 1), which would normally be expected to raise white real wages.

III. The Model

Many models of the South African economy use a three factor production function comprising capital, skilled (generally white) labor, and unskilled (nonwhite) labor (Knight (1964), Porter (1979 and 1990), Lundahl (1982) and Findlay and Lundahl (1987)). 1/ For example, in the model proposed by Lundahl (1982) there are three sectors of the economy; the reserves, European agriculture, and industry. In the reserves, unskilled nonwhite labor is combined with a fixed amount of land in production. In mining and European agriculture, unskilled nonwhite labor is used with capital, while in the industrial sector capital, skilled white labor, and nonwhite labor (both skilled and unskilled) are utilized. The white labor force is assumed to be fully employed, at the real wage rate implied by the production function. For the nonwhite labor force, the marginal product of labor on the reserves gives a floor to unskilled wages. To the extent that this constraint bites, wages are fixed and changes in employment clear the market.

The model used in this paper is a simplified version of this line of analysis; the simplifications largely corresponding to the availability of data. For example, while the reserves and European agriculture are clearly an important sector of the economy, the lack of reliable data prevents an attempt to estimate production functions, although the role of these sectors in providing a floor for unskilled nonwhite wages is taken into account. In addition, while it is clear that both the white and nonwhite labor forces encompass a mixture of skill levels, data on renumeration and costs is only available on a racial basis; hence, the model splits labor into nonwhite and white workers, rather than the more satisfactory breakdown into skilled and unskilled categories.

1/ This represents a modified version of the Lewis development model (Lewis (1954)).

The economy is divided into two types of production, namely mining and nonprimary industry. In both sectors capital is combined with white (largely skilled) labor, and nonwhite (largely unskilled) labor. The production functions take the form,

$$Y_M = Y_M(W_M, B_M, K_M)$$
$$Y_I = Y_I(W_I, B_I, K_I), \qquad (1)$$

where W represents white labor, B is nonwhite labor, K is capital and subscripts I and M represent industry and mining. The importance of the nonprimary and mining sectors covered by the data in this study in total output, capital and employment are shown in Table 2 below. The data, which come from a quarterly survey of production, covers over four fifths of the formal economy as estimated by more general surveys, but only about 40 percent of the available nonwhite labor force. Clearly there is a large part of nonwhite employment which is not covered in the formal sector of the economy. However, this sector is crucial to an improved outlook for the future since it is the main potential engine for future wealth creation.

It is necessary to close the model by making assumptions about the path of either prices or quantities. It is assumed that the future course of capital stock is fixed by external considerations, and white labor is fully employed. For the nonwhite labor force, on the other hand, it is assumed that the wage rate is fixed externally at some minimum value, with equilibrium being achieved through variations in employment, not wages. 1/ Formally, these assumptions can be written as,

$$K_M + K_I = \kappa, \text{ (and } R_M = R_I)$$
$$W_M + W_I = \Omega, \text{ (and } \Delta w^W_M / w^W_M = \Delta w^W_I / w^W_I)$$
$$w^B_M = \omega^B_M, \; w^B_I = \omega^B_I, \text{ (and } \Delta w^B_M / w^B_M = \Delta w^B_I / w^B_I) \qquad (2)$$

where greek letters represent fixed values, R is the rate of return on capital, and w^W and w^B are the real wage rates for white and nonwhite labor. Real wages are assumed to grow at the same rate across sectors, however their level can vary between the mining and nonprimary sectors due to the existence of differences in average skills, non-pecuniary benefits and impediments to labor mobility. 2/3/

1/ For discussions of whether black wages are responsive to the level of economic growth see McGrath (1990) and Hofmeyr (1990).

2/ Knight (1982) discusses why this might imply inequality between wages in different sectors of the economy.

3/ Keeping black wages at a low level raises white incomes by increasing the real return to white labor and capital. This assumption fits in with the rationale of apartheid, that of maximizing incomes for the white minority; this paper models apartheid as a system which differentiates the work force, driving down the wages for nonwhite labor in order to maximize white incomes. For more sophisticated models of apartheid controls, see the references cited above.

Table 2. South Africa: The Nonprimary and Mining Sectors in the Economy

(Percentage of total, 1988)

	Nonprimary	Mining	Total
Output	75	13	88
Employment:			
Whites	78	5	83
Nonwhites 1/	65 (34)	14 (8)	79 (42)
Capital	77	9	86

Sources: South African Statistics, 1988; and Bulletin of Statistics, March 1990.

1/ Figures in parentheses are percentages of economically active population. Data refer to 1987.

Notes: Total employment uses data from the standardized employment series produced by the Department of Manpower. For the nonwhite labor force, these data do not include most informal sector jobs.

Table 3. South Africa: Education Levels of the Black and White Labor Force

(In Percent)

	1980		1985	
	Whites	Blacks	Whites	Blacks
Below Standard 2	1.2	41.8	0.8	33.3
Standard 2-9	44.2	45.1	36.0	61.6
Standard 10	31.0	1.7	31.1	3.5
Diplomas and Degrees	23.6	1.6	32.1	1.6

Source: South African Labor Statistics, 1989.

Notes: The data does not include Asians or Colored groups.

A key assumption underlying the approach used in this paper is that there exists a homogeneous nonwhite labor force. Table 3 gives data on education levels for the economically active population by race. There has been some improvement between 1980 and 1985 in the numbers of blacks with low education levels, but little change in the numbers with higher qualifications. In 1985 blacks represented just 10 percent of those with a high-school diploma or above, accounting for 1.6 percent of the black economically active population. Hence, while acknowledging that any factor of production has a certain amount of heterogeneity, the assumption of a largely unskilled nonwhite labor force appears reasonable. 1/ In the estimation, technological progress can be biased towards different factors of production; hence any gradual change in the status of nonwhite labor will be reflected in nonwhite labor augmenting technological progress. 2/

IV. Estimation Technique

Given the importance of complementarity or substitutability between factors, equation (1) was estimated using a transcendental logarithmic functional form (translog) because of its flexibility and ease of estimation. 3/ In view of the possible importance of shifts in the character of factor inputs, particularly the nonwhite labor force, technological change was modeled in a very general manner, so as to allow for the possibility of factor biases in productivity.

There is a choice of whether to estimate behavior using direct data on the level of inputs (the primal or production function), or using data on relative prices (the dual or cost function). 4/ For this particular application--an analysis of output--the primal method is more directly

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1/ These data do not include Asian and colored workers, however blacks make up the vast majority of the nonwhite labor force. As noted by Knight (1988), these educational differences imply continued large income inequalities between whites and nonwhites under almost any scenario.

2/ A second, and more general, issue has to do with whether differences in nonwhite and white wages in South Africa should be analyzed in terms of market forces at all. Estimating a production function is only useful if the underlying assumption of market behavior is correct. Analyses of the South African labor market in Knight and McGrath ((1977) and (1987)) and Porter (1984) conclude that wage differentials are largely based on a combination of education, skills, and access to skilled jobs, rather than straight discrimination between workers in the same jobs.

3/ This can be seen as a second order approximation to an arbitrary production function.

4/ Much of the recent empirical work in production economics has concentrated on the dual formulation, since prices are exogenous to decisions; quantities of inputs, on the other hand, are endogenous, which creates econometric problems when estimating the primal (see Varian (1984), Ch 4 for a good account of the problems).

useful. The study therefore concentrates on results produced by this approach.

The level of production is defined by factor inputs plus technological progress. Formally,

$$Y_t = Y_t(K_t, W_t, B_t, t) \tag{3}$$

where Y, K, W, B and t represent real output, the capital stock, white labor, nonwhite labor and technological progress respectively. The translogarithmic production function for this problem is defined as,

$$\begin{aligned} \ln Y_t = {} & \ln\alpha_0 + \alpha_K \ln K_t + \alpha_W \ln W_t + \alpha_B \ln B_t + \alpha_T t \\ & + \tfrac{1}{2}\alpha_{KK} \ln K_t \ln K_t + \alpha_{KW} \ln K_t \ln W_t + \alpha_{KB} \ln K_t \ln B_t + \alpha_{KT} \ln K_t\, t \\ & + \alpha_{WK} \ln W_t \ln K_t + \tfrac{1}{2}\alpha_{WW} \ln W_t \ln W_t + \alpha_{WB} \ln W_t \ln B_t + \alpha_{LT} \ln L_t\, t \\ & + \alpha_{BK} \ln B_t \ln K_t + \alpha_{BW} \ln B_t \ln W_t + \tfrac{1}{2}\alpha_{BB} \ln B_t \ln B_t + \alpha_{BT} \ln B_t\, t \\ & + \alpha_{TK} t \ln K_t + \alpha_{TW} t \ln W_t + \alpha_{TB} t \ln B_t + \tfrac{1}{2}\alpha_{TT} t\, t. \end{aligned} \tag{4}$$

The restrictions on the coefficients imposed by theory are that for $i,j = K, W, B$, $\Sigma\alpha_i = 1$, $\alpha_{ij} = \alpha_{ji}$, $\alpha_{Ti} = \alpha_{iT}$, the sum over i $\Sigma\alpha_{ij} = 0$, and the sum over i $\Sigma\alpha_{Ti} = 0$.

The coefficients in the production function can be interpreted as follows. The α_{ij} $(i \neq j)$ terms represent relative substitutability of factors, the larger the value the more the factors are complements in production. The coefficients subscripted by T represent the effects of technological change, α_T is the constant rate of neutral technological progress, α_{TT} is an acceleration/deceleration term, while the α_{Ti}'s represent factor biases in technology; the larger the coefficient the more technological change boosts the productivity of that factor.

The parameters in equation (4) can be estimated using four equations, derived from differentiating with respect to K, L, B, and t. In a competitive market, the differential of output with respect to a factor of production is the price of that factor, which yields three equations in costs shares. In addition, by differentiating with respect to time, an equation representing the effects of technological progress can be derived. Specifically,

$$S_K = \alpha_K + \alpha_{KK} \ln K_t + \alpha_{KW} \ln W_t + \alpha_{KB} \ln B_t + \alpha_{KT}\, t, \tag{5A}$$

$$S_W = \alpha_W + \alpha_{WK} \ln K_t + \alpha_{WW} \ln W_t + \alpha_{WB} \ln B_t + \alpha_{WT}\, t, \tag{5B}$$

$$S_B = \alpha_B + \alpha_{BK} \ln K_t + \alpha_{BW} \ln W_t + \alpha_{BB} \ln B_t + \alpha_{WT}\, t, \tag{5C}$$

$$PD_t = \alpha_T + \alpha_{TK} \ln K_t + \alpha_{TW} \ln W_t + \alpha_{TB} \ln B_t + \alpha_{TT} t, \qquad (5D)$$

where S_K, S_W, and S_B represent the shares of capital, white labor and nonwhite labor in costs respectively. PD is a measure of productivity described below Since $S_K + S_W + S_B = 1$, it is only necessary to estimate two of the three equations. This feature also imposes many of the coefficient restrictions derived from theory. Assuming that the first two equations are estimated with the fourth, the only cross equation restriction that have to be imposed are $\alpha_{WK} = \alpha_{KW}$, $\alpha_{Ti} = \alpha_{iT}$, and the sum of α_{Ti} over i = K,W,B is zero.

The series PD_t, which represents the level of productivity growth, is equal to,

$$PD_t = \Delta \ln Y_t - (S_{Kt}+S_{Kt-1})\Delta \ln K_t/2$$

$$- (S_{Wt}+S_{Wt-1})\Delta \ln W_t/2 - (S_{Bt}+S_{Bt-1})\Delta \ln B_t/2. \qquad (6)$$

The interpretation is straightforward. It is the change in output minus the factor-share-weighted increase in factor inputs. 1/

The dual can be estimated using the translog price function, which has a very similar form to the production function. Essentially the estimation is identical, except that quantities are replaced by prices on the right-hand side of equations (5A-D and 6). 2/

V. Results

Data were collected on the capital stock, nominal output, and employment and renumeration by racial division for the nonprimary and mining sectors of the economy. 3/ The nonprimary capital stock was multiplied by the rate of capacity utilization (in manufacturing, the only available series) to get the effective level of capital. In terms of the aggregates used above, the white labor force and costs were defined as corresponding to whites in the data, while nonwhite labor and costs are defined as the sum of data referring to Asians, coloreds, and blacks. Cost shares were calculated by taking these data and dividing by output. Real wages were computed by

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1/ The values for K, L and B in equation (5D) should also be an average of t and t-1.

2/ Unfortunately there is no direct correspondence between the parameters in the production and cost functions. Hence it is not possible to make direct inferences between the two sets of coefficients. For more details on the dual function see Jorgenson (1983).

3/ The employment and renumeration series comes from the quarterly employment survey, which cover most of the formal sector of the economy. The output and capital stock data, which come from the national accounts were adjusted for differences in coverage.

dividing costs by employment and output prices. The data cover the period 1972-1987, for the nonprimary sector and 1972-1984 for mining, which were the longest periods for which consistent data could be obtained.

Table 4 shows the results from estimating equations (5A-D) simultaneously using three stage least squares. 1/ The first column shows the coefficients for the nonprimary sector, the second column the results for the mining sector. 2/ Standard errors are reported for those coefficients directly estimated, the others being inferred from the restrictions implied by theory. For the nonprimary sector the coefficients are generally significant at conventional levels, with the exception of the term representing technological progress (α_T). All the α_{ij} coefficients are negative, which indicates that the factors are substitutes in the production process. 3/ The rate of Hicks neutral technological progress is very small (0.09 percent) and imprecisely estimated (the acceleration term (α_{TT}) was excluded since it was insignificant). This may reflect inefficiencies in the economy brought about by structural impediments and capital deepening resulting from low real interest rates. The terms measuring factor biases indicate that nonwhite labor has been becoming more productive over time (α_{TB} is positive and significant); as noted above, this can be interpreted as a gradual lifting of restrictions on the nonwhite labor force. 4/

For the mining sector the α_{ij} coefficients indicate that nonwhite labor and capital are highly substitutable, while the opposite is true for white labor and capital. Technological progress is negative in this sector, starting at -9 percent in 1972 but increasing at a rate of 1/2 percent per annum (coefficients α_T and α_{TT}), which implies that technological progress is approximately zero by the early 1990s. The negative rate of productivity growth estimated for this sector presumably reflects the decline in the average ore grade as higher grade ores have been depleted. The technological bias terms were excluded since they produced unsatisfactory results.

The complementary elasticities of substitution between the factors of production are shown below the coefficient estimates. In both cases they indicate that capital is very substitutable with both types of labor, while

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1/ As noted above, inputs are not necessarily exogenous, hence instrumental variables were used; the instruments being a constant, a time trend, current factor prices and the first lag of factor quantities. Standard errors are shown in parentheses.

2/ Adding a first order autogressive process produces similar coefficient estimates. Since the coefficient in this process was insigificant the results are not repeated.

3/ If these coefficients were zero the production function is Cobb Douglas, with elasticities of substitution of one. The negative coefficients indicate that the elasticities of substitution are above unity.

4/ Terreblanche and Nattrass (1990 p.15) characterize the period after 1973 as one of steady liberalization in the labor sphere.

Table 4. South Africa: Estimated Production Function Coefficients

Sector	Nonprimary	Mining
α_W	.33 (.01)	.12 (.01)
α_B	.15 (.01)	.16 (.01)
α_K	.52	.72
α_{WW}	.12 (.05)	.09 (.09)
α_{BB}	.13 (.03)	-.08 (.06)
α_K	.11	.01
α_{WB}	-.07 (.03)	.00 (.09)
α_{WK}	-.05	-.09
α_{BK}	-.06	.05
α_T	.0009 (.0035)	-.092 (.027)
α_{TT}		.005 (.003)
α_{TW}	-.0030 (.0011)	
α_{TB}	.0035 (.0010)	
α_{TK}	-.0005	
Elasticities of Complementarity		
WB	-1.2	-3.4
WK	-10.0	-24.8
BK	-11.3	-29.1

Notes: Standard errors are given in parentheses for estimated coefficients. The sample period was 1972-87 for the nonprimary sector and 1972-86 for the mining sector. The elasticities of complementarity measure how the ratio of inputs i and j respond to a change in the relative price of i and j, assuming other quantities to be fixed.

the substitutability between the types of labor themselves is considerably lower. This feature of the production functions is important for the simulation results.

VI. The Implications for Future Growth

These production functions were combined to form a supply side model of the formal sector of the South African economy, in order to investigate future growth possibilities for the economy. In Table 5 two central projections are reported using the estimated production functions. 1/ The first assumes that South Africa continues to be denied access to international saving; in this case the capital stock is assumed to grow at one percent per annum (the average level since 1985), while the white labor force is projected to grow by 0.8 percent per annum, and nonwhite real wages at 2 percent per annum. In the second simulation, it is assumed that South Africa regains access to international capital, and that as a consequence the rate of investment rises to 26 percent per annum, the rate achieved in the early 1980s. This implies that the rate of growth of the capital stock rises to 3 percent per annum.

The first three rows in Table 5 show the growth rate (averaged over the five years period that was used for the simulations) of real output, nonwhite employment and white real wages in the formal sector of the economy. The next three rows show the change in the percentage of nominal output accruing to nonwhite labor, white labor and capital; for example, the figure of 0.3 in the first column indicates that the ratio of nonwhite labor income to output rises by 0.3 percentage points per annum. 2/

The first simulation illustrates the problems that would follow from continued low growth of the capital stock in an environment of rising expectations. Output growth is sluggish (1 1/4 percent per annum over the period), with the result that nonwhite employment growth is less than 1 percent per annum, well below the increase in the nonwhite labor force, while white wages fall at almost 1 percent per annum in real terms. The failure of nonwhite employment to keep up with the rise in the labor force implies a rising trend of nonwhite unemployment; regressions using past data indicate that every 1 percent fall in the ratio of nonwhite formal sector employment to the labor force leads to a 1/2 percent rise in the black unemployment rate. On this basis, the low growth in nonwhite employment projected under this scenario would lead to a secular rise in black

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1/ The simulations assumed that both black and white real wages moved in tandem in the two sectors. For the capital stock, however, the two sectors were projected separately. This was done because the location of capital between the two sectors turned out to be unrealistically sensitive to price movements.

2/ It is estimated that in 1989 both white and nonwhite labor received about 25 percent of output, and capital the remaining 50 percent.

Table 5. South Africa: Medium-Term Scenarios

(In percent)

	Central Cases		High Growth
	Continued Capital Constraints	Lifted Capital Constraints	Capital Growth Rebound
	Capital Stock Growth		
	1 Percent	3 Percent	4 Percent
Growth of:			
Output	1.1	2.8	3.6
Nonwhite employment	0.6	3.2	4.5
White wages	-0.7	-0.2	0.1
Change of share of output:			
Nonwhite labor	0.3	0.6	0.7
White labor	-0.3	-0.6	-0.8
Capital	0.0	0.0	0.1
Assumptions			
Growth of:			
Capital	1	3	4
Nonwhite real wages	2	2	2
White employment	0.8	0.8	0.8

Notes: Results indicate average growth over a five-year period.

unemployment of almost 1 percent per annum. However, despite this, the ratio of nonwhite labor costs to output rises by 0.3 of a percentage point per annum because of relatively fast growth of nonwhite real wages. Similarly, although whites continue to enjoy virtually full employment, their share falls at a similar ratio, reflecting persistent declines in their real wages.

In the second simulation, where the growth rate of the capital stock is raised to 3 percent per annum, output and nonwhite employment would expand by slightly under and slightly over 3 percent per annum respectively. The increase in nonwhite employment is sharply higher at 3.2 percent per annum, somewhat above the growth in the labor force, implying a gradual fall in nonwhite unemployment over the period. White real wages continue to show a decline, but not as large as in scenario 1; this reflects the high elasticity of substitution between white labor and capital. The percentage of output accruing to nonwhite labor expands at a rate of 0.6 percent per annum, twice the rate in scenario 1, indicative of a faster closing of income differentials between white and nonwhite populations.

A third simulation is also reported. In this the capital stock grows at 4 percent per annum, broadly the rate at which it expanded in the 1970s and early 1980s. This implies an investment output ratio of around 30 percent of GDP, implying either a substantial recovery of national saving or capital inflows of the order of 6 percent per annum. In this scenario, output growth exceeds 3 1/2 percent, and nonwhite employment expands by 4 1/2 percent per annum, well above the growth in the labor force, and white real wages rise slightly.

Comparing the scenarios, it is apparent that the rise in the capital stock is particularly beneficial for nonwhite employment; each percentage rise in the growth of the capital stock produces an increase of over one percent in nonwhite employment growth at the assumed growth in nonwhite wages, while white real wages rise by 1/4 percent. As a result the share of output accruing to nonwhite labor rises with the growth rate of the capital stock.

In Table 6 the sensitivity of the results to changes in the assumptions are analyzed. Two changes are considered; raising the growth in nonwhite real wages from 2 percent to 2 1/2 percent, and doubling the growth of the white labor force from 0.8 percent per annum to 1.6 percent per annum. The former looks at the sensitivity of the results to the level of nonwhite aspirations, while the later experiment explores the idea that the white labor force actually represents skilled workers, and that with the erosion of inflexibilities in the labor market the "effective" white, or skilled, labor force will expand.

The results reveal that nonwhite employment (and output growth) are extremely sensitive to nonwhite real wages. A half a percent rise in nonwhite real wages leads to a 3 percent fall in the growth of nonwhite

Table 6. South Africa: Medium-Term Scenarios--
Results Based on Alternative Assumptions

	Capital Stock Growth	
	1 Percent	3 Percent
	Continued Capital Constraints	Lifted Capital Constraints
	(Nonwhite real wage growth of 2.5 percent)	
Growth of:		
Output	0.2	2.1
Nonwhite employment	-3.9	0.1
White real wages	-0.5	0.0
Change in share of output:		
Nonwhite labor	-0.4	0.1
White labor	0.0	-0.4
Capital	0.4	0.3
	(White employment growth of 1.6 percent)	
Growth of:		
Output	1.3	2.9
Nonwhite employment	0.3	3.0
White real wages	-0.9	-0.4
Change in share of output:		
Nonwhite labor	0.2	0.5
White labor	-0.2	-0.5
Capital	0.0	0.0

Notes: Other assumptions are as in Table 4. The results indicate average growth rates over five years.

employment. This reflects the high elasticity of substitution between nonwhite labor and other factors of production. 1/ Turning to the second experiment, a rise in the rate of growth of the white labor force has relatively small effects, raising the growth rate slightly, lowering nonwhite employment and white real wages, and leaving total employment largely unchanged.

Table 7 reports simulations showing the rate of increase in nonwhite real wages required to achieve a 3 percent growth of nonwhite employment, the level required to keep employment growing at the same rate as the labor force. This can be seen as an estimate of the level at which nonwhite real wages can rise without a secular rise in unemployment. In the low growth scenario this implies real wage growth of 1 1/2 percent, as opposed to 2 percent in the high growth case. Interestingly, the differential between white and nonwhite wage growth is largely unaffected by the rate of growth of the capital stock.

Table 8 shows the actual data for the pre-sanctions period (1981-1984), and post sanctions (1985-88) are reported in order to compare the projections from the model with the recent experience of South Africa. The data for 1981-84 broadly conform to the results in Table 5 in which the growth of the capital stock was set at 4 percent per annum, although the growth of nonwhite employment is slightly lower than predicted. The 1985-88 data can be compared with the low growth scenario reported in Table 5; again the results are broadly similar. The projections produced by the model appear broadly in line with the historical experience.

The results from the model indicate that future growth and employment prospects for the South African economy depend to a large extent on success in regaining access to foreign saving and increasing investment. Without access to foreign saving and an associated strengthening of domestic confidence, the economy will probably continue to stagnate, and be unable to create enough jobs to avoid a secular rise in nonwhite unemployment and falls in nonwhite real wages. The restoration of access to foreign capital (involving both the lifting of financial sanctions and resolution of political uncertainty) could, on the other hand, lead to significantly higher economic growth, improved employment generation, and an accelerated reduction in income disparities.

1/ Unfortunately, the results from estimating the dual cost function do not find the same high level of substitutability. Indeed, they show rather low elasticities of substitution. Hence this feature of the model is not robust to alternative estimation techniques. However, the results from estimating the dual were unsatisfactory in other ways.

Table 7. South Africa: Medium-Term Scenarios--Adequate Nonwhite Employment Growth

	Capital Stock Growth	
	1 Percent	3 Percent
	Continued Capital Constraints	Lifted Capital Constraints
	(Nonwhite employment growth of 3 percent)	
Growth of:		
Output	1.6	2.7
Nonwhite real wages	1.6	2.0
White real wages	-0.8	-0.2
Change in share of output:		
Nonwhite labor	0.7	0.5
White labor	-0.5	-0.6
Capital	-0.2	0.1
Assumptions:		
Growth of:		
Capital stocks	1	3
Nonwhite employment	3	3
White employment	0.8	0.8

Table 8. South Africa: Historical Performance
(Growth Compared with Previous Four Year Average)

	Pre-Sanctions 1981-84	Post-Sanctions 1985-88
Growth of:		
Output	3.4	1.0
Nonwhite employment	1.9	0.2
White real wage	0.4	-0.7
Nonwhite real wage	1.6	2.0
White employment	1.5	0.3
Capital stock	4.7	2.3

Notes: All data refer to the nonprimary sector of the economy.

Table 9. South Africa: The Effect of Financial Sanctions--Increasing the Growth Rate of the Capital Stock by 2 Percent

	Nonwhite Employment Endogenous	Nonwhite Real Wages Endogenous
Change in growth of:		
output	1.63	1.09
Nonwhite employment	2.74	.na
Nonwhite real wages	.na	0.36
White real wages	0.53	0.64
Change in share of output:		
Nonwhite labor	0.3	-0.2
White labor	-0.3	0.0
Capital	0.0	0.2

Notes: The data represent averages over five years.

VII. The Effect of Financial Sanctions in the 1980s

The model can also be used to look at the effects of financial sanctions which have already occurred. Since 1985 South Africa has been effectively excluded from international capital markets. As a result the large capital inflows of the early 1980s became large outflows in the second half of the decade (the average current account surplus from 1985-1989 was 3 percent of GDP).

The effect of financial sanctions is modeled in a similar way to the previous section. In their absence it is assumed that domestic investment ratio would have been maintained at the levels of 1980-84, implying a rate of growth of the capital stock of 3 percent, instead to the 1 percent actually experienced. 1/ Hence the effect of sanctions can be estimated by looking at the effect of raising the rate of growth of the capital stock by 2 percent per annum.

The results from this exercise are shown in Table 9. The first column shows the results if it is assumed that black real wages are unaffected by economic conditions. Sanctions are estimated to have lowered output growth by over 1 1/2 percent per annum. The effect on nonwhite employment is larger, with growth being lowered by 2 3/4 percent, while real wages for white labor is estimated to have been reduced by 1/2 percent per annum. On these calculations the main effect of sanctions has been to decrease nonwhite employment. These effects can also be seen in implied decline in the proportion of output going to nonwhite labor.

These results assume that nonwhite real wages are unaffected by economic conditions, so that while white real wages are flexible, for nonwhite labor it is employment which adjusts. An alternative is to assume that nonwhite employment is fixed and nonwhite wages adjust. The results of this experiment are also shown in Table 9. In this case output growth falls by only 1 percent, since there is no reduction in nonwhite employment. White real wages fall by 0.64 percent per annum, and nonwhite wages by 0.36 percent; hence on this calculation the effect of sanctions fall largely on the white population, as illustrated by the movements in the share of income accruing to white labor and capital.

1/ This simulation assumes that in the absence of financial sanctions, external capital inflows to South Africa would revert to their pre-1985 levels. It must of course be recognized that it is highly probable that with the changed conditions in the international capital market, capital flows to South Africa might not revert to their former levels in the event that sanctions were lifted.

VIII. Conclusions

This paper estimates the impact of the financial sanctions imposed on the South African economy in 1985 using a three factor production function; the factors of production being capital, skilled (white) labor, and unskilled (nonwhite) labor. The results indicate that financial sanctions had a major impact on South African economic growth. A 1 percent rise in the rate of growth of the capital stock is estimated to lead to a 1.5 percent increase in the growth of nonwhite employment and a 0.3 percent rise in the growth of white real wages. As a result, output growth increases by 0.8 percent per annum. Sanctions, by excluding access to foreign saving, probably lowered the growth of the capital stock from 3 percent per annum (the growth rate implied by the investment ratio just before the imposition of sanctions) to 1 percent per annum, the growth in the capital stock achieved since 1985.

Continued slow growth of the capital stock is projected to result in inadequate growth in output and nonwhite employment, leading to a secular rise in nonwhite unemployment over the medium term, and falling white real wages; this represents a continuation of the unsatisfactory performance over the last few years. The higher rate of growth in the capital stock implies a faster expansion of real output, nonwhite employment growth which is above that of the nonwhite labor force, and a smaller decline in white real wages. These estimates imply that the majority of the benefits from faster growth in the capital stock come in the form of nonwhite employment, rather than white wages or the return to capital. Similar conclusions emerge when the model is used to estimate the costs of sanctions in the late 1980s. The slowdown in the growth of the capital stock is estimated to have caused a reduction of 1 1/2 percent in real output growth, 2 3/4 percent per annum in nonwhite employment and 1/2 percent per annum in the real wage of the white labor force.

Bibliography

Findlay, R. and M. Lundahl "Racial Discrimination, Dualistic Labor Markets and Foreign Investment", Journal of Development Economics (1987).

Hofmeyr, J "Black Wages: the Post-War Experience" in The Political Economy of South Africa ed N. Nattrass and E. Ardington, Oxford University Press (Cape Town 1990).

Iyengar, M. and R. Porter, "South Africa Without Apartheid: Estimates from General Equilibrium Simulations", Journal of International Development, Vol 2:1, (1990).

Jorgenson, D. "Econometric Methods for Modeling Producer Price Behavior", Handbook of Econometrics Volume 3, North Holland, 1983.

Knight, J. "A Theory of Income Distribution in South Africa", Oxford Bulletin of Statistics, Vol 27:4 (1964).

Knight, J. "The Nature of Unemployment in South Africa", South African Journal of Economics, Vol 50:1 (1982).

Knight J. "A Comparative Analysis of South Africa as a Semi-Industrialised Developing Country", Journal of Modern African Studies, 26:3 (1988).

Knight, J. and M. McGrath "An Analysis of Racial Wage Discrimination in South Africa", Oxford Bulletin of Economics and Statistics, Vol 39:4, (1977).

Knight, J. and M. McGrath "The Erosion of Apartheid in the South African Labour Market: Measures and Mechanisms", Discussion Paper No. 35, Institute of Economics and Statistics, September 1987.

Lewis, W. "Economic Development with Unlimited Supplies of Labour", Manchester School of Economics, Vol 22 (1954).

Lundahl, M. "The Rational of Apartheid", American Economic Review, Vol 72:5, (1982).

McGrath, M. "Economic Growth, Income Distribution and Social Change" in The Political Economy of South Africa ed N. Nattrass and E. Ardington, Oxford University Press (Cape Town 1990).

Porter, R. "A Model of a South African-Type Economy", American Economic Review, 68:5 (1978).

Porter, R. "Apartheid, the Job Ladder, and the Evolutionary Hypothesis: Empirical Evidence from South African Manufacturing 1960-87", Economic Development and Cultural Change, (1984).

Sadie, J. "A Reconstruction and Projection of Demographic Movements in the RSA and TVBC Countries", Bureau of Market Research, University of South Africa, (1988).

Terreblanche, S. and N. Nattrass "A Periodization of the Political Economy since 1910" in The Political Economy of South Africa ed N. Nattrass and E. Ardington, Oxford University Press (Cape Town 1990).

Varian, H. Microeconomic Analysis Second Edition, W. W. Norton and Co., 1984.