STRUCTURAL PROBLEMS IN NAMIBIA'S SECTORAL AND SUB-SECTORAL PERFORMANCE DURING THE 1968-1992 YEARS[i]

V. HEINRICH S. AMAVILAH
PO BOX 38061
PHOENIX, AZ 85069 USA

WORKING PAPER No. 5

July 1999

A flexible production function analysis is addressed to Namibia's GDP data for the 1968-1992 period to test for evidence of structural problems in sectoral and sub-sectoral performance. The analysis found the primary sector to be characterized by constant returns to scale through the entire 25 years. The secondary sector experienced constant returns to scale pre-1980 and severe diseconomies post-1980, while the tertiary sector was marked by constant returns to scale pre-1980, and questionable increasing returns to scale post-1980. The changes imply structural problems inasmuch as factor productivities and the rate of technical change declined to zero or worse, and little support for domestic capital formation was found.

Key Phrases: structural problems and economic growth, transcendental production function, variable elasticity,

JEL Code: O47, O33, 055, 013, 014

0. Ground Zero - The Problem

This analysis explains how the shifts in Namibia's sectoral and sub-sectoral production from growth pre-1980 to decline and stagnation post-1980 occured. It puts forward the hypothesis that domestic resource inefficiencies in production account for the changes in the patterns of performance in Namibia's sectors and sub-sectors. It applies a variable elasticity of substitution production function by which the extent of structural problems can be inferred from scale, input, and substitution elasticities.

The analysis is important because the continued economic growth problems of many, mostly African, developing countries since the 1980s has renewed interest in the role of domestic factors (physical capital, labor, and land) and forces (enriched capital, labor, land, and technical progress) in determining economic growth rates. Partly in response to this interest, the World Bank (1989; 1991) has urged developing countries to open up their economies to international trade and investments, reform and privatize state-owned enterprises, and improve policy-making environments.[ii] How best to open up to trade and investment flows, and reform/privatize businesses in individual countries remain difficult questions to-date. However, it is often suggested that the growth path for developing countries, including those well-endowed with natural resources, lies in shifting from resource to innovation rents via the market mechanism of free trade. The

implication of this suggestion is that innovation rents, and therefore the rate of economic growth, can be increased by switching production and trade from primary commodities to manufactured goods.[iii]

How demonstrable this hypothesis can be as a model for developing countries like Namibia remains unclear. Clear is that attempts to illustrate the hypothesis have led to the debate among some economists about the costs and benefits of primary production and exports vis-a-vis secondary or higher production and trade. On the one hand, the "resource curse" theory maintains that primary resource (price or revenue) booms often lead to Dutch diseases of a sort, and exporting all or nearly all raw materials only worsens the terms of trade for the developing countries (Cordon, 1984; Auty, 1989, 1993; Davis, 1994, 1995). This theory concludes that averting Dutch diseases and adverse terms of trade requires some industrial policies and trade restrictions.

New growth theories, on the other hand, allege that too basic a comparative advantages in natural resources constrain the gains from trade for developing countries. Some new growth theorists recommend that developing countries, just like developed countries, can "create competitive advantages" through "managed" industrial and "strategic" trade policies (Borrus, Tyson, and Zysman, 1986). Others such as Krugman (1986, 1996) question the claims of industrial and trade policies in encouraging resource

abundant developing countries to bias their basic growth efforts against their natural comparative advantages [in the name of fostering competitiveness]. In this Krugmanian mind under global competition the efficiency gains from trade are potentially smaller than similar gains from the productivity of domestic resources (factors and forces), because it makes a big difference whether competitiveness in production and trade is about new ideas of trading old stuff, old ways of trading new products, or new ways of trading new products (Fagerberg, 1996).

As a developing part of South Africa until independence in 1990, and especially in the years before 1980, Namibia's economic growth was tied to private investment in the primary sector, with the trade surplus going to expand the domestic comparative advantages of other sectors. During this period real GDP (1980 = 100) more than tripled from US$503 million in 1970 to US$2.01 billion in 1980. Per capita GDP also rose to US$1,536 in 1980 from only US$495 ten years earlier. In fact, Namibia's GDP grew by three and one fifth percent between 1960 and 1980 with a large part of output growth coming from the primary sector, which represented over 50% of GDP and capital formation, and 79% of primary export earnings. Between 1970 and 1980 primary mineral exports grew by about five percent and accounted for 67.5% of primary production, while agricultural and fish commodities, which contributed 22.5% to primary production and 17% to the total value of exports, grew at a rate of only one percent.

Post-1980 as GDP declined to US$1.7 billion, and given a growing population, GDP per capita fell to US$1,020, and total exports also decreased by about one and one half percent (U.S. BOM, 1993). Even so, proponents of open markets continued to argue that with even freer trade Namibia's economy would find and settle into a growth path, and expand its secondary goods and tertiary services sectors. Hence, present day South African policy embraced the idea of biasing production and export incentives toward secondary industries. In Namibia's case secondary output as a share of GDP did increase. However, along the minimum expansion in the secondary sector two types of competition occurred. On the one hand, there was intra-sub-sectoral competition for scarce resources, which drew public investment away from manufacturing and in favor of the non-traded construction, water, and electric (CWE) industries. On the other hand, inter-sectoral competition for skilled labor benefited the tertiary sector. Consequently, real private gross domestic investment in fixed assets fell, and only a small fraction of what remained was invested in machinery and equipment. As it later turned out, the lack of investement in machinery and equipment had important implications for learning-by-doing and skill building, both essential for productivity and output growth (Arrow, 1962; Young, 1991; Hall and Jones, 1999).[iv]

Thus, the notable difference observed in Namibia's growth patterns pre-1980 as opposed to the post-1980 years suggests that prior to 1980 the surplus gains from trade appear to have been

invested in expanding primary production in traded goods sectors, but after 1980 trade gains went largely into the nontraded sectors, reducing the share of traded goods in GDP, such that, even as the rate of gross capital formation was 4.0% per year from 1985 onwards, a general weakness undercut the economy as evidenced by the average decline of 11.8% for the years 1970 to 1985. It would seem that after 1980 Namibia failed to convert short run comparative advantages in the primary (minerals) commodities into longer-run advantages in secondary goods markets. As often is the case in developing countries, policy-makers faulted the "comparative disadvantage" of primary resources for the failure.

1. Literature

This section first describes Namibia's economic sectors and sub-sectors, and then reviews some growth literature that seems relevant for the analysis.

1.1 Characteristics of Namibia' Economy, 1968-1992

Historically Namibia has relied for growth more on vent-for-surplus in the traded primary sector than on traded secondary goods sectors or non-traded goods and services sectors.

1.1.1 The Traded Primary Sector and Sub-Sectors

Basic to growth was the primary sector whose permanent endowment consists of land (agriculture, fishing, forestry, and mineral resources), and the short-run value of current capacities to produce, representing present net investment in mining and quarrying (**M&Q**) and in agriculture and fishing (**A&F**) sub-sectors. The M&Q sub-sector accounted for the largest share of primary production, and grew at an average rate of about four percent over the 1970-1980 decade, declined by four and three tenths percent through 1985, and stagnated to 1992 (Murray, 1993; World Bank, 1992b; Amavilah, 1996). Besides the fact that investment decisions were complicated by economic sanctions against Namibia, then a part of South Africa, the decline occurred despite that new technologies tended to lower mining costs and to permit high metal recovery rates.

Using this background lens, it would seem that the long-term benefits of new investments in offshore and marine diamond mining ventures since 1992 have yet to be realized (Chamber of Mines of Namibia, 1992; 1993; U.S. BOM, 1991; 1993). However, it is known that during the 1970s and early 1980s much of the growth in the gross revenue of M&Q came from uranium production and export. In subsequent years the sharp increase in uranium supply worldwide, and the decline in real yellowcake prices from US$51/lb in 1978 to about US$12/lb in 1992, reduced the effect on the economy that uranium production might have had. Consequently, as the international uranium market continues to adjust to the new

fundamentals of the nuclear power industry and the world economy, Namibia is bound to feel the pinch even more in the future (Johnson, 1990, Amavilah, 1994, 1995; Harris, 1984; Newcomb and Rieber, 1985). It is very unlikely that other minerals such as copper, zinc, lead, silver, gold, and semi-and precious stones would be able to make up the difference because they have been of little significance in terms of both production and export value (de Waal and Galloway, 1990; Hermann and Silfverstolpe, 1993; Amavilah, 1996; 1998).

The A&F sub-sector was responsible for the remainder of primary production. On average, agricultural production increased by only about one percent pre-1980 and declined by nearly nine percent post-1980. During the 1970s the fishing activity part of the A&F sub-sector performed poorly mainly because of overfishing in preceding years, but also because value-adding processes were limited to a few fish products for which a small residual market demand existed locally. In spite of its increased economic value in terms of employment and export volume in recent years, it would seem that the level of quasi-rents from A&F has remained subject to weather and the protectionist constraints of export markets.

1.1.2 The Traded Secondary Sector and Sub-Sectors

The secondary sector assets consist of the capital invested in traded processing and manufacturing, and the construction and

utility, industries. Construction and utility industries are nontraded, so that in this discussion the traded secondary sector is only material processing and manufacturing, which accounted for about seven percent of GDP over the 1968-1992 period. Besides the small size of the domestic market, competition from subsidized South African manufacturers and exporters restricted the growth of this sector (World Bank, 1992; Curry and Stoneman, 1993). The incentive packages offered either failed, or did not have sufficient time yet, to stimulate remarkable growth in the manufacturing industry. At any rate, manufacturing only expanded by about two percent over the 1970-1985 period (Curry and Stoneman, 1993; Ministry of Trade and Industry, 1993). This poor performance questions the notion that the manufacturing subsector could have acted as an engine of growth for Namibia during the period under this consideration.

1.1.3 The Non-Traded Sub-Sectors and Sector

The non-traded sector is the tertiary (services) sector, which among many consists of government, tourism, and money and banking. Nontraded sub-sectors include the non-traded secondary goods and services sub-sector composed of construction, water, and energy (CWE), industries. The construction part of the CWE sub-sector contributed only two percent to GDP over the 1968-1992 period, and its performance depended on government capital expenditures. Private construction (largely residential and some office

building) experienced some growth; however, over the 1970-1992 time period construction in Namibia declined by four and one third percent.

The growth of the CWE sub-sector was also constrained by the limited supply, and therefore the high price, of water which in 1992 was about US$0.50/$m^3$ compared to only US$0.06/$m^3$ in the United States in the same year. Since nuclear energy, for which Namibia produces the uranium feedstock, is undeveloped for obvious reasons, solar energy is harnessed and used to a very small degree only by larger mining companies for water-heating, and oil and coal are imported, the high cost of water also had broad implications for domestic hydro-power generation in particular and energy prices generally. It is not surprising, for example, that the average price of petrol (gasoline) in 1991 was an equivalent of US$2.50/gallon compared to US$1.20/gallon in the United States. Electricity cost US$0.05/kWhr in Namibia compared to three-tenth of one cent in the USA (van der Linden, 1993; Ministry of Mines and Energy, 1992; Murray, 1993; Investor, 1991; 1992, World Bank, 1992).

During the study period growth for the tertiary sector as a whole was positive except between 1978 and 1981, and between 1982 and 1984. However, tertiary sub-sectors grew at different rates during different time periods. For example, while tourism expanded, road infrastructure and the transport systems declined by one and a

half percent during the 1970-1980 decade (Weaver and Elliot, 1996; Murray, 1993, 1993; Investor, 1992, 1993; Thomas, 1978). In the finacial sub-sector of the tertiary sector variations in domestic price levels due to inflation over the years depended upon events in the Southern African Customs Union within the Common Monetary Area controlled by South Africa (Stone, 1992). For instance, interest rates in Namibia followed the upward trend of lending interest rates in South Africa, even though Namibia's economy was performing poorly compared to that of South Africa (Bank of Namibia, 1993). High interest rates in South Africa between 1980 and 1985 led to a delayed, but nonetheless sharp, rise in interest rates in Namibia, which induced high domestic household savings and reduced the rate of investment.[v] When South Africa lowered interest rates from 1986 to 1987, higher rates of inflation in Namibia than in South Africa ensued.

In a related area Sherbourne (1992) noted that Namibia's exchange rate during the period under this discussion was rarely overvalued. However, it is clear that when in 1985/1986 South Africa lowered the US$/Rand exchange rate to support gold production, the Rand depreciation also favored an increase in the gross value of Namibian mineral exports. As the gold price subsequently rose, Namibian mineral export value fell. Thus, along with the benefits such as access to developed regional and international financial institutions, the dependency of the Namibian financial system and monetary policy on South Africa

brought efficiency and distribution problems, including Namibia's lack of control over its macro-variables.

Most noticeable about the tertiary sector was that government more than doubled in size between 1970 and 1992. With government growth came along increased public spending, which essentially "crowded out" private investment, and provided one reason for both the World Bank (1992a) and UNIDO (1990) to urge Namibia to restrain and redirect public spending away from consumption and towards production. While the role of the public sector is of no special interest here, it does not hurt to note that a number of studies have argued that "market-friendly states" were responsible for the rapid economic growth of East Asian economies (World Bank, 1993; Park and Kwon, 1995; Huff, 1995; Lee, 1996). On the other hand, are those who say that the public sector via high taxes and other government actions often retards growth by warping work efforts, as well as distorting consumption, savings, and investment decisions, and even concealing weakness in the economy (Choi, 1983; Easterly and Rebelo, 1993; Collier and Gunning, 1999).[vi]

1.2 Some Relevant Growth Literature

Economic growth theory remains deficient in explaining the poor performance of developing countries. The Solow (1957) growth accounting and neo-Solow (Arrow, 1962) learning-by-doing growth models raised important questions about the causes of economic

growth, empirical measures of economic growth, and why growth rates differ across countries and even across regions within the same country (Denison, 1962; Young, 1991; Temple, 1999). However, subsequent research diverted attention from Solow's and Arrow's original concerns that capital and labor accounted for a smaller than expected share of growth to exploring, almost exclusively, the unexplained residual share of growth, with emphasis on various adjustments on labor for quality as in Romer (1989), Mankiw, Romer and Weil (1992), Barro (1991, 1994), and Barro and Sala i Martin (1995).

Earlier still Abramovitz (1979), Denison (1962), Kendrick (1961), Jorgenson and Griliches (1967, 1972), Kaldor (1966), and many others, tried to build bridges between Solow's original questions and the efforts of contemporary students of the residual (technical change). However, for a while new researchers either refused to cross any of these bridges, or those who dared crossing often dropped the baton. Only recently did post-Solows bring back into focus Solow's original questions by endogenizing labor, capital and technical change (Lucas 1988, 1993; Grossman and Helpman, 1991; Romer, 1990, 1993, 1994; Gould and Ruffin,1995). By this time, however, half of the original cause was already lost, and the new cause serves policy well mainly in developed countries.

Clearly the new growth models have provided the needed CPR to

economic growth theory by knocking down unclear and/or unrealistic parts of older models. But just as clearly, even the new growth models have failed to provide generalizations of enduring soundness (Solow, 1994; Pack, 1994). As a result there has emerged a presumption that how the developing countries got into the growth mess is less important than how they can get out. While the presumption is not all unreasonable, it does stifle the thought that how poor performance occurs is just as important for understanding as how growth can be stimulated. Unfornately, a thick layer of cross-sectional analyses continues to conceal this fact. For instance, Ghura and Hadjimichael's (1996) modification of Mankiw, Romer and Weil (1992) to examine the economic growth of a number of sub-Saharan African developing countries over the 1981-1992 period failed to test the endogenous aspects of the proposed model. Even though the general finding of the paper turned out to be that private capital is more important to growth than the other factors examined, the results of the paper lacked prescriptive enthusiasm which policy makers desparately need to take action. Hence, individual African developing countries must have felt scolded into in-action.

Arifovic, Bullard, and Duffy (1997) proposed an innovative model of the economic transition from stagnation to growth through an adaptive learning process. On the one hand, the model adds to the understanding of how economies shift from poor to good performance; on the other hand it, too, is silent about how so

many developing countries have shifted from growth to decline and stagnation. Do countries learn mainly from their own mistakes, in which case poor performance is a necessary and sufficient condition for growth? Or do they learn mainly from other countries, such that their own mistakes are inconsequential to future growth? It would seem that analysis of poor performance is just as important as that of good performance.

Finally, conventional production theory is mostly based on the assumption of decreasing scale elasticities (Ringstad, 1974). Yet, production analysis almost always prefers Cobb-Douglas, translog, and/or CES functional forms, all of which enjoy the advantages, as well as suffer the disadvantages, of *a priori* restrictions with respect to returns to scale, and elasticities. These restrictive shapes of the production function seems umappreciative of Hicks' (1966) insight that given low rates of technical progress various elasticities tend to negative. It also ignores what would seem obvious, and that is that such forms are special cases of **trans**cendental functions (Halter, Carter, and Hocking, 1957).[vii] Flexible trans-forms have been used in the past to explain shifts in US manufacturing output, and postwar Soviet bloc, and Japanese, industrial growth and decline (Lovell 1968, 1973; Mundalak, 1964; Baraim, 1994; cf. Revenkar, 1971). Thus, trans-forms seem suitable for the analysis of the shifts from growth to decline and stagnation experienced by Namibia's sectors and sub-sectors during the 1968-1992 period.

2. Analytical Framework

2.1 Key Definitions

Let Namibia's real GDP (Y) over time be the sum of primary (Y_1), secondary (Y_2), and tertiary (Y_3) values-added, i.e.,

$$Y \equiv Y_1 + Y_2 + Y_3, \qquad (1a)$$

Further designate the values-added of M&Q, A&F, manufacturing, and CWE as Y_{11}, Y_{12}, Y_{21}, and Y_{22}, respectively, such that

$$Y \equiv Y_{11} + Y_{12} + Y_{21} + Y_{22} + Y_3, \qquad (1b)$$

where $Y_{11} + Y_{12} = Y_1$ is total primary sector value-added, and $Y_{21} + Y_{22} = Y_2$ is total secondary sector, and $Y_1 + Y_{21}$ are values-added from the traded sectors and sub-sectors.[viii]

Moreover, measure domestic capital (K_i) inputs (including energy and materials) in the primary (K_1), secondary (K_2), and tertiary (K_3) sectors in millions of Namibia Dollars (N$), and express labor ($L_i$) inputs as the number of workers employed: L_1 for the

primary, L_{11} for M&Q, L_{12} for A&F, L_2 for the secondary, L_{21} for manufacturing, L_{22} for the CWE, and L_3 for the tertiary (sub)sectors. Then aggregate resources are:[ix]

$$K \equiv K_1 + K_2 + K_3; L \equiv L_1 + L_2 + L_3, \tag{1c}$$

and sectoral and sub-sectoral resource constraints are:

$$K_1 \equiv K_{11} + K_{12}; L_1 \equiv L_{11} + L_{12}$$

$$K_2 \equiv K_{21} + K_{22}; L_2 \equiv L_{21} + L_{22} \tag{1d}$$

$$K_3 \equiv K_{31} + K_{32}; L_3 \equiv L_{31} + L_{32},$$

where $(K_1 + K_{21})$ and $(L_1 + L_{21})$ are total capital and labor inputs in the traded sectors, and $(K_{22} + K_3)$ and $(L_{22} + L_3)$ are total capital and labor inputs in the nontraded sectors.[x]

2.2 General Production Function

Next consider a production theory in which any value-added (Y_i) over time is a general function of the state of technology (A_i), labor (L_i), and capital (K_i) inputs as:

$$Y_i = F(A_i, L_i, K_i). \tag{2a}$$

Let the state of technology (A_i) evolve as

$$A_i = A_{i0} e^{\delta_i T}, \tag{2b}$$

where A_{i0} is the initial state of technology for the ith sector or sub-sector, and T is a time dummy variable common to all sectors and sub-sectors. Neoclassically speaking, the rate of technical change (δ_i) between year T = 0 and year T = N, would be

$$e^{\delta_i T} = f(L_i, K_i, T = N)/(f(L_i, K_i, T = 0)). \quad (2c)$$

In other words, holding L_i and K_i constant, δ_i represents the increases in sectoral and sub-sectoral outputs due to technical change from year O to year N. Hence, inasmuch as (2b) mixes technological (A_i) and technical (implied by T) changes, it can be read as Abramovitz's (1979) "measure of our ignorance" (see Choi, 1983, Chap. 3).

2.3 Assumptions and the Specific Form of Production

Assume that

(a) sectoral and sub-sectoral values-added are additive (although in the simplistic sense that apples + oranges + error = fruits);

(b) each sector and sub-sector uses inputs specific to it, i.e., there are no interactions (cross-inputs) among sectors and sub-sectors;

(c) competition among sectors and sub-sectors is reasonably market-driven so that factor and product prices are given;

(d) labor is the numeraire in each sector and sub-sector;

(e) the production function is twice-differentiable; and

(f) *a priori* restrictions on the production form such as constant returns to scale are not required, but permissible.

Then, instead of the restrictive functional forms such as Cobb-Douglas, translog, and/or CES, we can write the value-added of the ith sector or sub-sector (Y_i) as the following transcendental function of capital (K_i), labor (L_i), and some measure of technical change (A_i):

$$Y_i = [(A_{i0} e^{\delta_i T} L_i^{\alpha_i} K_i^{\beta_i})(e^{\alpha_i' L_i + \beta_i' K_i})] e^{\mu_i}, \qquad (3)$$

where **e** is the natural logarithmic base, δ_i is the rate of technical change, α_i and β_i are partial coefficients of L_i and K_i respectively, α_i' and β_i' are trans-parameters measuring the variability of α_i and β_i in response to changes in production scale and input substitution (complementarity), and $\mu_i \sim N[0 = E(\mu_i), \sigma^2 = E(\mu_i^2)]$ is the random error term.

It follows that if α_i' and β_i' are zero, (3) is Cobb-Douglas. For nonzero trans-parameters the Cobb-Douglas special case is rejected because in that case (3) is nonlinear and characterized by variable marginal products, short-run input elasticities, and marginal rates of technical substitution (Halter, Carter, and Hocking, 1957, Hicks, 1966, Baraim, 1994, Amavilah, 1996). Even so, (3) can still be estimated by conventional regression methods because its natural logarithmic version is linear in the

parameters, where for $a_{i0} = \ln A_{i0}$,

$$\ln Y_i = a_{i0} + \delta_i T + \alpha_i \ln L_i + \beta_i \ln K_i + \alpha_{i'} L_i + \beta_{i'} K_i + \mu_i. \quad (4)$$

Thus, differentiating (4) with respect to time yields the rate of growth of sectoral and sub-sectoral values-added as

$$\dot{Y}_i = \delta_i + [\alpha_i + (\alpha_{i'} \dot{L}_i)\dot{L}_i] + [\beta_i + \quad (5)$$

where

$$\dot{Y}_i = (dY_i/dT)/Y_i, \dot{L}_{it} = (dL_i/dT)/L_i, \dot{K}_i = (dK_i/dT)/K_i, \delta_i = dA_i/dT/A_i.$$

Going back to (3), treating labor as a numeraire, and taking the logs of both sides gives

$$\ln y_i = b_{i0} + \beta_i \ln k_i + \beta' k_i, \quad (6)$$

where $y_i = Y_i/L_i$ is average labor productivity, and $k_i = K_i/L_i$ is capital-labor ratio.[xi] Thus, the rate of growth of labor productivity is,

$$\dot{y}_i = \delta_i + \beta_i + (\beta_{i'} \dot{k}_i)\dot{k}_i$$
$$= \delta_i + \xi_{k_i} \dot{k}_i. \quad (7)$$

In this estimation superior sectors and sub-sectors are identified by their high and significant marginal productivities and the rates of technical change.

The results of (4)-(7) are Hicks-neutral, but only if $\alpha_i' = 0$ and $\beta_i' = 0$. For any nonzero α_i' and β_i', ξ_i are variable. In that case scale elasticities are:

$$\varepsilon_i = \sum_i^N \xi_i. \tag{8}$$

The rates of technical progress associated with (5) and (7) become

$$\delta_i = \dot{y}_i - \xi_{\dot{L}_i} \dot{L}_i - \xi_{\dot{K}_i} \dot{K}_i = \dot{y}_i - \varepsilon_i;$$

$$\delta_i = \dot{y}_i - \xi_{\dot{k}_i} \dot{k}_i = \dot{y}_i - \varepsilon_{\dot{k}_i}.$$

Both (8) and (9) are variable unless $\alpha_i' = 0$ and $\beta_i' = 0$ in which case elasticities are neoclassical. Note from (5) that

$$\delta_i^* = \delta_i + \alpha_{i'} + \beta_{i'} = \dot{y} + (\alpha_{i'} \dot{L}i)\dot{L}_i + (\beta_{i'} \dot{K}i)\dot{K}_i, \tag{10a}$$

and from (7)

$$\delta_i^* = \delta_i + \beta_i = \dot{y}_i - (\beta_i \dot{k}_i)\dot{k}_i. \tag{10b}$$

The state of technology underlying (10a) and (10b) above would be

$$A_i = A_{i0} e^{\delta_i T + \alpha_i L_i + \beta_i K_i}. \tag{10c}$$

3. Model Realizations

Equations (4) and (6) were estimated for Nmaibia's three sectors (primary, secondary, and tertiary), and four subsectors (M&Q, A&F, manufacturing, and CWE). Output growth rates were then calculated as actual and estimated $\ln Y_{i,t} - \ln Y_{i,t+j}$, where $t < t+j$, and labor productivities as $\ln y_{i,t} - \ln y_{i,t+j}$. Estimations produced reasonable results, and we turn to those shortly.

3.1 Value-Added Regression Findings

3.1.1 Primary Sector and Sub-sectors

For the primary sector $\beta_1 > 0$ was not statistically significant, while $\alpha_1 < 0$ was significant. In the M&Q and A&F subsectors α_{11}, β_{11}, and β_{12} were all negative and $\alpha_{12} > 0$. The models explained over 95%

Figure 1

of variations in the levels of sectoral and sub-sectoral values-added. Nonetheless, the results conclude that severe diseconomies characterized the primary sector as well as its two sub-sectors. At all levles of the primary sector low exogenous rates of technical change were significant determinants of values-added. See **Figure 1**.

3.1.2 Secondary Sector and Sub-Sectors

Although $\alpha_2 < 0$ and $\delta_2 < 0$ were constant, the value-added of the secondary sector was transcendental in K_2, i.e., $\beta_2 > 0$ and $\beta'_2 < 0$ (**Figure 2**). Hence, $\xi_{K2} = 0.2974 - 0.0004K_2$ was positive only through 1974 when it changed sign to negative. Given that $\alpha_2 < 0$, $0 < \varepsilon_2 = -0.125 + \xi_{K2} = 0.1724 - 0.0004K_2 < 1$ through 1971, and $\varepsilon_2 < 0$ thereafter. The elasticity of substitution was negative throughout this period. A reasonable conclusion is that K_2 and T were responsible for the minimum output growth that occurred in the secondary sector during these years. However, pre-1980 growth did little to offset the diseconomies this sector experienced post-1980.

In manufacturing K_{21}, L_{21}, and T significantly determined output. However, $\alpha_{21} < 0$ while $\xi_{K21} = 0.5909 - 0.0054K_{21}$, and $\varepsilon_{21} = -0.112 + \xi_{K21} = 0.4789 - 0.054K_{21}$, both suggested negative substitution possibilities. On average, technical change explained about two percent of the observed variations in the manufacturing product.

Moreover, production in the CWE sub-sector was fully transcendental

Figure 2

in form, with $\xi_{K22} = 0.3083 - 0.00003K_{22}$, $\xi_{L22} = 0.3948 - 0.0008L_{22}$, and $\varepsilon_{22} = \xi_{L22} + \xi_{K22} > 0$. Even so, ξ_{K22}, ξ_{L22}, and ε_{22} were positive only through 1975, 1972, and 1971, respectively. Substitution elasticity turned out to be a constant approximately equal to unity, consistent with the conventional production function assumption. The explanatory power for the secondary sector and its sub-sectors was over 99%, with significant multiple correlation among the log and exponential variables on the one hand, and with the time dummy variable on the other as one would expect.

3.1.3 Tertiary Sector

For the tertiary sector, $\xi_{L3} = 0.0727 - 0.0005L_3$, $\xi_{K3} = 0.0753 - \beta'_3K_3$, and $\varepsilon_3 = \xi_{L3} + \xi_{K3}$ - all being positive through 1977, 1976, and 1977, respectively. Substitution elasticity equalled unity throughout the years.

3.2 Productivity Regression Results

3.2.1 Primary Sector and Sub-Sectors

For the primary sector the results show that increases in k_1 contributed significantly to the growth of y_1. Within the primary sector a change of ten percent in k_{11} and k_{12} was accompanied by significant rises of about one and one fifth percent, and in k12 by an increase of three and one fifth percent in the labor

Figure 3

productivities of the two sub-sectors. The effects of technical change represented only a small improvement in the productivity of the primary sector. Thus, one can conclude that the growth problems of the primary sector were low factor productivities and rates of technical change.

3.2.2 Secondary Sector and Sub-Sectors

More than half of the changes in the productivity of the secondary sector were explained by k_2, $\exp(k_2)$, and T. Productivity rose by one and one third percent for each 10% increase in k_2. In manufacturing, technical change had a significant and positive impact on labor productivity, but a statistically insignificant fall of up to seven percent in manufacturing productivity resulted from a 10% increase in k_{21}. Labor productivity in the CWE subsector tended to rise by about three percent as a result of a change in k_{22} and technical change, and to fall with a change in $\exp(k_{22})$, such that the coefficients of both k_{22} and $\exp(k_{22})$ ratios were insignificant.

3.2.3 Tertiary Sector

Preliminary estimations of productivity in the tertiary sector gave a negative sign on the coefficient of k_3. Attempts to correct the wrong sign of the k_3 parameter, including overlooking $\exp(k_3)$ and technical change, concluded that changing k_3 by ten percent

increased labor productivity by more than one percent nonsignificantly.

4. Observations and Implications

The statistical problems regarding parameter signs and significance are understandable given multiple correlations between logged and exponential variables. However, econometric adjustments such as removing variables do not improve the results. The large constant terms observed for each sector and subsector suggest missing variables. One would suspect foreign capital inflows, for example, have had separate and different influences on the M&Q and manufacturing sub-sectors.[xii]

Given these statistical problems the high R^2 and the absence of technical change simply imply erratic growth. Also, the absence of significant trends in the growth rates of values-added suggests that the rents arising pre-1980 dispate post-1980 as the minerals sub-sector that initially led other sectors and subsectors contracted. Only the CWE subsector seems to have grown, but that may have been due to double-counting new, or extensions to, mines as additional value-added to construction. In addition, extra water and power used by new mines and mine extensions appear to have been recorded as output for the CWE sub-sector rather than as inputs. If so, growth for this sub-sector was simply an "agglomeration effect".[xiii]

Table 1

Although the secondary and tertiary sectors did not follow the growth of the primary sector growth in a significant way pre-1980, when the minerals sub-sector declined post-1980, all other sectors declined as well. Thus, the importance alleged for the manufacturing sub-sector simply was not there! Instead, the economy suffered from widespread technical inefficiencies.

Over the 25 years the structural changes characterizing values-added and productivities in Namibia were not accompanied by either consistent growth or significant technical change. The M&Q sub-sector appears to have performed better than other sectors and sub-sectors pre-1980. Yet, not all sectors and sub-sectors followed this sub-sector up its short-lived growth path. The manufacturing sub-sector did slightly better post-1980 than pre-1980. However, its performance did not aid growth in other sectors and subsectors. Instead, intra-subsectoral competition for scarce resources within the secondary sector favored the nontraded CWE sub-sector, while inter-sectoral competition leaned toward the tertiary sector, which bloated without significant increases in its own productivity or the productivities of other sectors and sub-sectors. Thus, the higher sectoral and sub-sectoral marginal products post-1980 only confirm that K/L ratios declined (see **Table 1**).

The low to negative output, scale, and substitution elasticities imply the absence of both endogenous growth and exogenous

technical change. In particular, negative output elasticities with respect to

Figure 4

inputs (see **Figure 4a-f**) suggest falling average products and negative marginal products. According to conventional production theory, positive average products and negative marginal products would indicate suboptimal resource utilization (allocative inefficiency). However, three things were going on here that suggest production inefficiency instead of allocative inefficiency. First, the existence of a small skilled labor force and strong unskilled labor unions meant a high cost of laying off workers. Second, labor employment needed to increase for political reasons, leading to low labor productivities even for the most efficient firm in terms of resource allocation. Third, existing techniques of production in M&Q and manufacturing, for example, were well-known which limited the scope for embodied technical progress. Given the capital intensities of these subsectors, and limited technical change, increased labor employment only reduced K/L ratios.

5. Conclusions

The results conclude that at the very best Namibia's technologies were characterized by constant returns to scale in the early years, but that diseconomies set in after 1980 as the attempt to shift away from emphasis on the primary sector resulted in decreased factor productivities. One may infer that the rather significant change in Namibia's fortune after 1980 evidences serious technical inefficiencies. Prior to 1980 capital formation

in the traded goods sector fostered economic growth, but with the policy of shifting away from resource rents toward manufacturing rents coming into force post-1980, public investment rose and private investment diminished. Hence, one sees both increasing capital in the secondary sector after 1980 and the turnabout in economic growth accompanying a change in output and investment away from traded to non-traded goods and services industries. Since the financing after 1980 was largely through capital transfers, rather than trade surplus, a purchasing power transfers-in (and so of opposite sign from) the free cash flows of the pre-1980 decades in which trade surpluses dominated capital accumulation. The net result was an economy that performed below expectations after 1980 as confirmed by the many low and negative output elasticities of both capital and labor as well as low rates of technical change (**Figure 4c-f**).

While such anomalies can be the result of data problems, insomuch as they support the appearance of technical inefficiencies, they suggest the importance of domestic resources (factors and forces) in economic growth. Therefore, the results counsel Namibia to improve factor productivities, if stimulating economic growth is the goal, and to encourage technical progress in order to sustain economic growth. Given the current input productivities, Namibia cannot realistically expect "miraculous" growth in the short run. In that respect the World Bank's and UNIDO's recommendations for reducing the size and growth of the public component of the

tertiary sector are on target. Speculations for stimulating growth via a shift to manufacturing, however, are both doubtful and undemonstrated.

The hypothesis that accelerated growth can be obtained by shifting to innovation rents requires knowledge of which Namibian industries actually hold out a promise for higher rents and have at least comparative advantages. First, one may suggest downstreaming industries which evidence comparative advantages. A further strategy may be to encourage sectoral and sub-sectoral integration of Namibia with its neighbor (South Africa), which has potential for high growth in the long-run. For decades the two economies were virtually one. With South Africa projected to grow fastest among African states, Namibia may already be better positioned than other African countries to take advantage of its proximity to South Africa in order to strengthen its domestic savings and investment functions. These functions are essential for industrial growth and change, along with technology transfer. The savings and investment functions require some minimum domestic resource capacity (surplus), which currently only the primary sector can provide. To weaken this sector, even with the good intention of expanding manufacturing production and industrialization, is to postpone economic growth well into the future.

References

Abramowitz, M. (1979)Rapid growth potential and its realization: The experience of capitalist economies in the postwar period. In E. Malinvaud (ed.) Economic Growth and Resources. New York: St Martin's Press.

Amavilah, V.H.S. (1996) Resources, Technology, and Mineral trade in the Economic Growth of Namibia. PhD dissertation. University of Arizona.

Amavilah, VHS (1996) The Performance of Small Mines in Namibia and the Region. Development Southern Africa, 13(1): 31-46

Amavilah, VHS (1993) The Political Economy of Export Processing Zones (EZPs) in Developing Countries. Natural Resources Forum 17(4): 273-287.

Amavilah, V.H.S. and Newcomb, Richard T. (1996) The Impacts of Changing Resources and Strategic Trade Policies on Namibian Sustainable Growth: 1968-1992", Working Paper No 93, Department of Agricultural and Resource Economics, University of Arizona.

Amavilah, V.H.S (1994) The Influence of Oil and Coal Prices on World Uranium Demand. OPEC Review XVIII(4): 489-508.

Amavilah, V.H.S. (1995) The Capitalist World Aggregate Supply and Demand Model for Natural Uranium. Energy Economics 17(3): 211-220.

Amavilah, V.H.S. (1998) Cross-Sectional Profitability of Namibian Formal Small-Scale Mining Firms. Small Business Economics 11(1):57-73.

Amavilah, VHS. (1998) German Aid and Trade Versus Namibian GDP and Labor Productivity. Applied Economics 30(?):689-695.

Arrow, K.J. 1962) The economic implications of learning by doing, Review of Economic Studies 29: 155-73.

Auty, Richard M. (1993) Sustaining Development in Mineral Economies: The Resource Curse Thesis London: Routledge.

Bank of Namibia (1992) Annual Report Windhoek: Bank of Namibia.

Bank of Namibia (1993) Namibia: 1990 to 1992 Balance of Payments Publication No. BOPA1 Windhoek: Bank of Namibia.

Baraim, E.I. (1994) Homogeneous and Nonhomogeneous Production Functions: Theory and Applications Brookfield, US: Avebury.

Barro, Robert, and Sala i Martin, Xavier (1991) Convergence across States and Regions, Brookings Papers on Economic Activity, 1:

107-82.

Borrus, Michael, Laura D'Andrea Tyson, and John Zysman (1986) Creating Advantage: Home government policy strategy in international trade of in the semiconductor industry. In Paul R. Krugman (Ed) Strategic Trade Policy and New International Economics. Cambridge (MA): MIT Press.

Chamber of Mines of Namibia (1992) Mining in Namibia Windhoek: Chamber of Mines of Namibia.

Chamber of Mines of Namibia (1993) 1991/1992 13th/14th Annual Report Windhoek: Chamber of Mines of Namibia.

Choi, Kwang (1983) Theories of Comparative Economic Growth. Ames: Iowa State University Press.

Collier, Paul and Jan Willem Gunning (1999) Explaining African economic performance, Journal of Economic Literature, XXXVII(1): 64-111

Curry, Steve, and Stoneman, Colin (1993) 'Problems of industrial development and market integration in Namibia," Journal of Southern African Studies 19 (1): 40-51.

Davidson, Russel, and MacKinnon, James G. (1993) Estimation Inference in Econometrics New York: Oxford University Press, Chap.11.

Davis, Graham (1994) South African Managed Trade Policy: The Wasting of a Mineral Endowment Westport: Praeger.

Davis, Graham (1995) Learning to love the Dutch disease: Evidence from the mineral economies World Development 23 (10): 1769-1779.

Easterly, W. and S. Rebelo (1993) Fiscal policy and economic growth: An empirical investigation. Journal of Monetary Economics, 32: 417-458.

Economist Intelligence Unit (EIU) (Various) Namibia Country Reports, and Country Profiles London: Business International. London.

Fagerberg, J. (1996) Technology and competitiveness. Oxford Review of Economic Policy, 12(3): 39-51.

Greene, William H. (1990) Econometric Analysis. New York: Macmillan Publishing Company.

Grossman, Gene M., and Helpman, Elhanan (1991) Innovation and Growth in the Global Economy Cambridge (Mass): The MIT Press.

Grossman, Gene M. and Helpman, Elhanan (1994) Endogenous innovation in the theory of growth' Journal of Economic Perspectives 8(1): 23-44.

Hall, Robert and Charles I Jones (1999) Why do some countries produce so much output per worker than others? Quarterly Journal of Economics, 114(1): 83-116.

Halter, A.N., et. al. (1957) A Note on the Transcendantal Production Function, Journal of Farm Economics, 966- 974.

Harris, D.P. (1984) Mineral Resource Appraisal Oxford: Clarendon Press. Chapters 1, 2, 4.5, 9.3, 12.7, and 13.9.

Hermann, Gabriella, and Silfverstolpe, A. (1993) The Role and Prospects of the Namibian Mining Industry, Minor Field Study Series No. 38, Lund: Nationalekonomiska Instituionen vid Lunds Universitet.

Hicks, J.R. (1966) The Theory of Wages, New York: St. Martin's Press.

Huff, (1995) Development state, government, and Singapore's economic development since 1960, World Development, 23(8): 1421-1438.

Intriligator, Michael D. (1978) Econometric Models, Techniques, and Applications. Englewood Cliffs, NJ: Prentice-Hall, Inc.

The Investor (1992, 1993) Investment (Promotion) Centre of the MTI, Nos.1, 2, and 3.

Johnson, C. (1990) Economic leaching at Rossing Uranium Limited, Journal of South African Mining and Metallurgy 90(6): 141-147.

Jones, Charles I (1997) Convergence Revisited. Journal of Economic Growth, Vol. 2, No. 2, pp.131-153.

Jorgenson, Dale W. and Zvi Griliches (1967) Explanation of productivity change. Review of Economic Studies, 34, pp.249-282.

Kaldor, Nick (1966) Causes of the Slow Rate of Growth in the United Kingdom: An Inaugural Lecture. London: Cambridge University Press.

Kendrick, J.W. (1979) Productivity trends and the recent slowdown: Historical perspective, causal factors, and policy options. In W. Fellner (Ed) Contemporary Economic Problems. Washington, D.C: American Enterprise Institute.

Krugman, Paul R. (1986) Strategic trade Policy and New International Economics. Cambridge (MA): MIT Press.

Krugman, Paul R. (1996) Pop Internationalism Cambridge (Mass): The MIT Press.

Krugman, Paul R. (1994) Competitiveness: a dangerous obsession, Foreign Affairs 73 (2): 28-44.

Landau, Ralph (1991) Technology and Economics. National Academy of Engineering. Washington, D.C: National Academy Press.

Lee, Jong-Wha (1996) Government Intervetions and P
oductivty growth. Journal of Economic Growth. Vol. 1, No. 3, pp. 391-414.

Leister, G.M.E.(1972) Public finance in SWA, 1945/46 to 1969/70 South African Journal of Economics 40(1): 1-32.

Lucas, R.E.,Jr. (1988) On the mechanics of economic development Journal of Monetary Economics 22(): 3- 42.

Lucas, R.E., Jr. (1993) Making a miracle Econometrica 61(2): 251-272.

Mankiw, N. Gregory, Romer, David, and Weil, David N. (1992), A contribution to the empirics of economic growth, Quarterly Journal of Economics 107(): 407-437.

Ministry of Mines and Energy (1993) Investment Profiles in Namibia Windhoek.

Ministry of Trade and Industry (1992; 1993), Namibia Trade Directory: An Overview of Namibian Trade and Industry 1991-1992; 1992-93, Windhoek: Advantages Promotions.

Ministry of Trade and Industry (1993) Special Incentives for Manufacturing Enterprises, Windhoek: MTI.

Murray, Roger (1992) Namibia Through the 1990's: Turning Rich Resources into Growth, Economic Prospects Series. Special Report No. M211. London: Economist Intelligence Unit.

Murray, Roger (1993) Mineral Investment in Namibia, London: Mining Journal Research Services.

Newcomb, Richard T. and Michael Rieber (1985) The economics of coal and nuclear energy, in Economics of the Mineral Industries, 4th ed., William A. Vogely (ed.),New York: American Institute of Mining, Metallurgical, and Petroleum Engineers,Inc. Chapter 4.11, pp. 417-481.

Paul, CJ and Don Siegel (1999) Scale economies and industry agglomeration externalities: A dynamic cost function approach,

American Economic Review, 89(1): 272-290.

Romer, Paul M. (1990) Endogenous technological change, Journal of Political Economy 98(5): S71-S102.

Romer, Paul M. (1993) Idea-gaps and object-gaps in economic development, Journal of Monetary Economics 32(3): 543- 573.

Romer, P.M. (1994) The origins of endogenous growth, Journal of Economic Perspectives 8(1): 3-22.

Sherbourne, Robin (1992) The Social Dimensions of Monetary Currency, and Credit Policy in Namibia, Working Paper No. 16, Windhoek: Namibia Economic Policy Research Unit (July).

Solow, R.M. (1957) Technical change and the aggregate production function, Review of Economics and Statistics 39: 2-320.

Solow, Robert M. (1994) Perspectives on growth theory, Journal of EconomicPerspectives 8(1): 45-54.

Stone, Simon (1993) The Consumer Price Index and Inflation in Namibia, Working Paper No. 37, Windhoek: Namibia Economic Policy Research Unit (April).

Temple, Jonathan (1999)The new growth evidence, Journal of Economic Literature, XXXVII(1): 112-156.

Temple, Jonathan and Paul A. Johnson (1998) Social capability and economic growth, Quarterly Journal of Economics, 113(3): 965-90.

Thomas, W.H. (1978) Economic Development in Namibia. Bonn: Kaiser.

UNIDO (United Nations Industrial Development Organization) (1990) Namibia: Industrial Development at Independence, Industrial Development Review Series, New York: UN.

van der Linden, E. (1993) Namibia's Energy Sector: A Country Review. Working Paper No. 33. Windhoek: Namibia Economic Policy Research Unit (February).

White, H., 1980, A heteroskedasticity-consistent covariance matrix estimation and a direct test for heteroskedasticity, Econometrica 48: 817-838.

World Bank (1992a) Namibia: Poverty Alleviation with Sustainable Growth, Washington, D.C.: The World Bank.

World Bank (1992b) Strategy for African Mining. Mining Unit, Industry, and Energy Division. World Bank Technical Paper No. 181. Africa Technical Departmrnt Series. Washington, D.C.

World Bank (1989) Sub-Saharan Africa: From Crisis to Sustainable Growth. Washington, D.C.: World Bank.

World Bank (1991) World Development Report. New York: Oxford University Press.

World Bank (1993) The East Asian Miracles: Economic Growth and Public Policy Washington D.C.: The World Bank.

Notes

i. Consultant, Resource and Engineering Economics (e-mail: vhs@ziplip.com) and Adjunct Professor, Glendale College, 6000 W. Olive Avenue, Glendale, AZ 85302 USA. This paper draws upon my dissertation completed at the University of Arizona. I am deeply indebted to my advisor, Richard T. Newcomb, for his guidance, and to DeVerle Harris, Michael Rieber, Donald Heckerman, and Ronald Oaxaca for their insightful support. An early draft of this paper was published in the 1997 Proceedings of the Mineral Economics and Management Society. For that version I gratefully appreciate the assistance by Professors Henry McCarl, DeVerle Harris, and Gary Campbell. Any remaining errors are mine alone.

ii. The Journal of Economic Perspectives, 13(3) (Summer): 3-114, carries five symposium papers on "slow growth in Africa" by noted growth economists.

.i.. This up-dated version of Adam Smith's "vent-for surplus" doctrine is used to gue for extensions of open and free trade agreements. For example, among Canada, xico and the United States, the North American Free Trade Agreement (NAFTA) hopes t imulate the transition from current reliance on home goods exports dominated by source commodities and imported manufactures to the expansion of exports from high- owth regional industrial sectors. In Mexico's case, the leverage of opening its sources to export as a start toward a transition is appealing.

'.. Temple and Johnson (1998) refer to "social infrastructure" as "social .pability".

. Paul Collier and Jan Gunning (1999) give an excellent account of the implications r African economic performance of financial repression and similar problems.

... A recent review of the growth literature by Temple (1999) touches upon these sues and is highly recommended.

.i.. A function f is algebraic (non-transcendental) in an interval I if $f^k(x) \equiv f(x)$ is transcendental (non-algebraic) if it is not algebraic in I. The prefix "trans-" used with reference to this function and its derivatives.

.ii.. In this analysis the terms "output", "product", and "value-added" are used terchangeably.

:.. The Namibia Dollar (N$) came into circulation in September 1993. It is "pegged" par to the South African Rand (R).

. It would have been useful to separate the components of the tertiary sector that
e private from those that are public. No separate data for L_3 and K_3 were readily
ailable.

... For the ith sector or sub-sector the measure of technological efficiency $b_{i0} = A_{i0} + \ln e^{\alpha'} + \delta_i = a_{i0} - \alpha' + \delta_i \leq a_{i0} \Leftrightarrow \alpha' = 0$ and $\delta_i = 0$.

.i.. Temple (1999) discusses data and measurement problems which often afflict
stimations of this type. The unexpected negative elasticities may also indicate that
.) the data suffered from problems such as multicollinearity(ii) the functional form
inappropriate, or (iii) production is inefficient. The high correlations between
e logged and exponential variables support the presence of multicollinearity, and
e intensive approach reported below was taken for that reason among others. With
spect to the functional forms, questions arose about the extent to which the
pearance of fixed coefficients in the primary sector was due to rigidities in the
y the labor force works and about whether or not the true functions describing
mibia's production were political functions rather than feasible economic and/or
gineering functions. If rigidity is the issue, then negative elasticities, though
desirable, are part of traditional theory; if political functions, leaving the
stimates as they are is preferable.While his counsel is well taken, sometimes it is
tter to do something than not to, as long as the limitations are taken into account

.ii.. Paul and Siegel (1999) propose a production function augmented by external
.riables which in its dual form permits separation of agglomeration effects from the
nventional scale effects due to internal inputs.