

**OCCASIONAL PAPERS SERIES No. 2**

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## ON OSSREA'S OCCASIONAL PAPERS SERIES

This paper represents the first instalment in the series of **Occasional Papers** which the Organization for Social Science Research in Eastern Africa(OSSREA) is launching.

For a number of years now the Organization has been running research competitions on both general social science themes and gender issues. Winners of these competitions are required to present their research findings in the form of final reports. These reports, because they tend to be bulky, do not lend themselves to easy and wide circulation. However, since some of them are of good enough quality to deserve wider readership, it was felt that an opportunity should be given to the authors to condense their reports to a size appropriate for occasional papers. This is how the present paper originated. Its author was a winner of the Second OSSREA Social Science Research Competition.

However, we do not intend the research competitions to be our only source of occasional papers. We would therefore like to appeal to all social scientists in the region and those elsewhere doing research on it to contribute to the series. OSSREA undertakes to ensure as wide a circulation of the papers as possible.

Eshetu Chole

Executive Secretary

# THE SPECIFICATION AND ESTIMATION OF A MACROECONOMETRIC MODEL OF BOTSWANA

## 1. INTRODUCTION

This paper presents a macroeconomic model of Botswana. The model is specified to capture the supply side of the Botswana's economy and is based on the concepts of the two-gap models as specified by Chenery et al (1962). The special feature of the model is that it incorporates the elements of the Dutch Disease which characterizes this small open economy on account of the predominance of mining and more specially diamond production which has transformed the economy from a low income one at the time of independence twenty five years ago to a middle income economy today. The model endeavours to show the kind of structural change that has accompanied the spectacular growth of the economy. It is categorized into nine blocks and, in order to capture the effects of the Dutch Disease on the economy, output, labour and capital inputs blocks are modelled at the sectoral level.

The model has been estimated using annual data for the period 1966-1986 for the seven blocks excluding those in respect of money and trade. The former blocks are estimated using annual data for the years 1976-1988. Three techniques of estimation have been applied; namely, the ordinary least squares (OLS), the two-stage least squares (2SLS) and the maximum likelihood (ML) technique. The model consists of 72 behavioural equations and 97 definitional equations.

The model is of significant interest in that Botswana is one of the very few countries in Sub-Saharan Africa whose economies have not been adversely affected by the very poor economic performance of the past two decades. Botswana's economy has fared very well through all the numerous shocks it encountered since the mid-1970s.

The paper describes briefly, in the second section, Botswana's economy. The third section discusses the rationale behind the choice of macroeconomic theory that has been applied for the estimation of the model. The fourth section gives in tabular form a block-by-block specification, and the fifth gives the description of model performance.\* Included also is a flow chart indicating the linkage between blocks.

## 2. SUMMARY OF THE MAIN FEATURES OF BOTSWANA'S ECONOMY

The main features of Botswana's economy may be summarised as:

- The mining sector's dominance as an engine of growth:- Moyo (1983) asserts that the mineral-led growth has led to the development of an enclave sector with few linkages with the rest of the economy except via tax revenues. On the other hand, Nanunu and Nchindo (1983) hail it as the engine of growth of the country's economy.

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\* Appendices containing an alphabetical list of variables and all of the equations in the model have been excluded from the present paper. Interested readers may obtain copies of these appendices by writing to OSSREA or to the author.

- Openness: for a large part of the post independence period the proportion of imports to GDP had by far exceeded that in respect of exports. Botswana is perhaps the only country in the SADCC region with minimum import restrictions.

- The significance of foreign savings (net inflows) in financing trade deficits.

- The significant role of foreign direct investment and the accompanying substantial outflows of profits and dividends. But the net outflows have not resulted in a drain of foreign exchange in view of the fact that the foreign investment had been channelled into the export sector of the economy.

- The insignificant contribution of the agricultural sector. At the time of independence this sector contributed more than fifty percent of the GDP. At present, it accounts for less than five percent of GDP.

- The limited capacity of the mining and other growth sectors to absorb labour. The mining sector, as in other countries, operates with a high degree of capital intensity. Although it contributes more than fifty percent of GDP, it employs less than ten percent of the labour force in the formal sectors.

- On the monetary side, a rapid growth of commercial bank deposits over the years has not been matched by the growth of commercial bank lending, leading to a steady build up of excess liquidity in the commercial banks (Bank of Botswana Annual Report 1988). This has led to a situation where commercial banks have become increasingly reluctant to accept interest-bearing deposits from the public.

Among the latest measures to remedy the position in the financial market, the Bank of Botswana has introduced a number of policy measures designed to stimulate the demand for domestic credit by reducing the cost of borrowing. The Bank has undertaken to provide assurance of a minimum rate of return to all depositors who seek to place funds in interest-bearing accounts. The institution is also in the process of bringing interest rates gradually to levels which are consistent with the working of the market (making interest rates higher than the rate of inflation).

### 3. THE RELEVANCE TO BOTSWANA OF RECENT DEVELOPMENTS IN MACROECONOMIC THEORY AND ON THE CHOICE OF A SUITABLE MACROECONOMIC THEORY

#### *(i) Keynesian Theory*

How relevant is Keynesian theory (and its modifications) for Botswana? It is understood that the incomes and employment policy has been rectified so as to give employers much freedom in the determination of their employees' wages and salaries. This positive course of action will apparently significantly affect the distribution of labour between sectors and industries and the overall future level of employment in the country. During the period under consideration, however, wages in Botswana were not determined by the interplay of supply and demand in the labour market, but rather by the committee responsible for the implementation of the incomes and employment policy on the basis of, among other things, uniformity with similar jobs in the public service, productivity, working conditions and so on. Furthermore, the incomes and employment policy limited the role of the trade union movement as a collective bargainer over wage levels. More important is the fact that Botswana's economy is characterised by the existence of the Dutch Disease on account of the predominance of the mining sector in the economy. The Dutch Disease operates as follows: part of the mining (diamond) revenue is spent on non-traded goods (e.g. construction and services) which leads to a real appreciation ( a rise in the relative prices of non-traded goods in terms of the traded goods) (Wijnbergen, 1984). This appreciation draws resources out of the non-mining traded sectors (e.g. the movement of labour from agriculture to construction, government and general services sectors) into the non-traded sectors (Corden and Neary, 1982). It seems unlikely to us that in this case, the government, through fiscal policies (using the income tax and government expenditure) can completely influence aggregate demand and unemployment, among other things. Moreover, with three quarters of the population residing in the rural areas, outside the cash economy and leading a subsistence type of life, it is doubtful whether aggregate demand plays a decisive role in determining the level of real output.

As far as unemployment is concerned, in Botswana's context structural unemployment is illustrated by the absolute decline of the agricultural sector and a growth in the mining and public sectors, which might have resulted in some workers losing their jobs in the formal sector (Tumkaya, 1983). It has, however, been noted that the level of education has been the main determining factor in that those with no education and training, on giving up agriculture, have not been able to find employment in the growth sectors. On the other hand, those with education and training and who have been willing to take up new jobs have been more successful in adjusting to changing economic conditions. Consequently, unemployment among the uneducated persons who have given up traditional farming is not absolutely due to the failure of the economy to generate enough jobs. Account has to be taken of the mismatch between their skills and the new job requirements (Mhozya, 1987).

Unemployment and more particularly under-employment in Botswana are therefore mostly among the rural population involved in traditional agriculture (tradeable goods). In this situation it is highly doubtful whether Keynesian conditions fully apply to this small open economy. For if

it did, devaluing the currency and expanding the money supply (all other things being equal) would stimulate employment. Employment would be increased in the nontradeable sectors, for example, by expanding nominal demand, leading to lower real wages through exchange rate depreciation.

*(ii) The Rational Expectations Hypothesis*

As for the notion of rational expectations in relation to the Botswana's situation, the question is whether economic developments and performance are systematic. Botswana maintains a stable government with stable economic policies and philosophy. In spite of this situation there are several factors which diminish the relevance (with respect to the theory under consideration) of the relationship between private agents' reactions and systematic government course of action.

It has been observed that, in a broad sense, rational expectations theory can be regarded as operating within the same framework as Keynesian theory, whereby the maintained criterion is that of an optimizing government that seeks to adopt any policy it considers best. Both theories make use of the concept of authority (government or central bank). Under both theories the system operates as follows: the government acts on the private sector and the private sector reacts through the price and wages. The entire concept of rational expectations, it is argued, deals with one-way causation, and indeed whether the government can 'trick' the private sector into adopting a behaviour that it would not entertain if it had full information and utilized all that information. Like the Keynesian theory (or relative modifications) rational expectations theory does not undertake to evaluate the motives of government, or the influence of the private agents on government outside the working of the market (e.g. through lobbying, etc.) (Corden, 1987).

From the salaries and wages point of view the newly rectified version of the incomes and employment policy will eliminate the current reactions and interactions between the private agents and the government. According to the revised policy, private agents will be free in determining the levels of wages of their employees. There are, however, still many fields in which the reactions of private agents affect government decisions in Botswana. To mention a few, the customs revenue represents one of the major sources of government revenue. The amount accruing to Botswana is a result of a series of negotiations between all the member states of the Southern African Customs Union. Mineral revenue, which constitutes the major component of government revenue, is determined through long-term contracts with the mining companies in the country. In summary, a significant portion of the government revenue upon which most of the government overall expenditure is based is not free from the influence of the private agents. There is a two-way causation in the relation between government and private agents.

Furthermore, about eighty percent of Botswana's imports originate from the Republic of South Africa(RSA) and consequently a larger proportion of Botswana's inflation is imported from that country. Moreover, the value of the Pula is pegged to a basket of the currencies of Botswana's main trading partners, including among others, the RSA's Rand, the USA Dollar and the Special Drawing Rights (SDR). Due to the high degree of import dependence on the relevant country, the Rand accounts for seventy-five percent of the value of the basket. This means that fiscal policy in the RSA is likely to affect Botswana's relative prices of labour, capital and goods

through its effects on employment creation, on business profits and on consumer prices. Thus, the forms of support offered to RSA farmers by the RSA government will affect the prices and availability of imported goods in Botswana. Monetary policy in the RSA will affect interest rates and exchange rates which will influence imports prices in Botswana again. The RSA's wages and employment policy will influence industrial cost, migration and remittance in Botswana (Love, 1989).

The foregoing particulars confirm the fact that private agents (including external factors) do influence Botswana government actions and policies directly. The direction of causation is two-way. Government policies certainly affect the behaviour of private agents, but at the same time, private agents also affect the governments's course of action as well as policies. This implies that the macroeconomic situation of Botswana is outside the scope of rational expectations theory.

### *(iii) The Neo-Ricardian Theorem*

Although the Botswana government has not recorded a deficit in the last ten years, money markets are not yet well developed in the country, and therefore government deficits would be usually money-financed. In the case of money-financed deficits, it is held that the neo-Ricardian effects would not be expected if the rise in money supply neither increases inflation nor causes current account deficit, but just boosts output in a Keynesian sense. If inflation is expected, the expectation that the real value of money holdings will depreciate will lead to higher savings. The balance on current account in Botswana has been positive since 1983 on account of the favourable terms of trade. Moreover, the rise in money supply does not determine or explain the behaviour of the current account deficits in the case under consideration. Of the three causes or sources of inflation in regard to Botswana's situation, facts available suggest that cost-push inflation contributes most significantly to the overall price increases in view of the fact that price developments in Botswana are, to a large extent, linked to those in the RSA. This is because the country's imports come predominantly from the latter country, where inflation has been soaring high in recent years. The amount of inflation due to increases in money supply in Botswana is relatively small. Moreover, as already stated, it is highly doubtful whether Keynesian effects are relevant in Botswana's context, although it cannot be denied that Botswana's fiscal policies can create certain expectations at home and abroad, which may have (early) effects on the exchange rate, private savings, private investment and other factors, including the external balance. It is therefore doubtful whether the neo-Ricardian situation prevails in the case of Botswana.

### *(iv) Supply-Side Models And Sectoral Income Effects*

Supply-side economics deals with the study of factors and policies influencing and affecting the real economy as distinct from the nominal economy, that is, the physical characteristics of economic agents, and their response to variations in real (relative) prices as distinct from nominal prices, (Corden, 1987). Supply-Side models give an allowance for a 'rational' behaviour and appear to be consistent with the Botswana situation. These models have been used successfully in a number of developing countries, including Tanzania (Lipumba et al, 1988).



They also allow for negative supply shocks to produce both increases in unemployment and decreases in real wages while at the same time setting wages independently of nominal demand shocks but responsive to real shocks.

It has been observed that some shock, whether nominal or real in origin, temporary or not, may be favourable, causing real wages to rise and that these real wages may not fall when the relevant shocks are reversed. This position cannot be ruled out in the case of Botswana. One example is a temporary decrease of the price of diamonds in the world market.

This situation cannot be modelled under, say, the rational expectations hypothesis. For, according to the relevant theory, if it were known that the shock was anticipated to last for a long time, rational expectations hypothesis would require the wage negotiators (trade unions) to lower their demands in the light of the new information.

The Dutch Disease theory, whose main concern is in the sectoral real income effects and the overall macroeconomic consequences of a sectoral real income boom, falls under supply-side economics. The Dutch Disease theory, as discussed earlier, adequately explains Botswana's contemporary economic situation. The uniform characteristics of all Dutch Disease models is the emphasis they place on real income and output effects on the various sectors of the economy (Corden, 1987). The foregoing details indicate that supply-side modelling is the most suitable procedure in the macroeconometric model specification and estimation for Botswana.

#### 4. BLOCK STRUCTURE AND PRINCIPAL FEATURES

A summary of the specification of the model is given in tabular form in Table 1, which shows, among other things, the block structure of the model and the principal endogenous variables which are relevant to Botswana's economic situation.

The specification incorporates the elements of supply-side economics by including supply constraints in respect of the various endogenous variables. The specification also incorporates the country's exogenous policy scenarios such as the incomes and wages policy.

Table 1

##### BLOCK STRUCTURE AND STRUCTURAL RELATIONSHIPS

No. of Block	Block Name	Structural Equation	Explanatory Variables	Form of Equation	To be Estimated as	Viable Estimation Technique
1	Output 1	Agriculture	rainfall, labour, capital, time	nonlinear (logarithmic)	simultan.	ML/nonlinear 3SLS,

						nonlinear 2SLS
		2 Manufacturing	labour capital GDP share	Ditto	Ditto	Ditto
		3 Mining	labour, capital	"	"	"
		4 Utilities	rainfall, labour capital	"	"	"
		5 Construction	labour, capital	"	"	"
		6 Trade & Hotels	labour, capital	"	"	"
		7 Transport	labour, capital	"	"	"
		8 Financial institu.	labour, capital	"	"	"
		9 Social & Pers. svc	labour, capital	"	"	"
		10 General Gvt.	labour, capital	"	"	"
2	LABOUR	11 Man-hours agriculture	output, time	Nonlinear (logarithmic )	Simultan.	ML/nonlinear r 2SLS  Nonlinear 3SLS
		12 Man-hours utilities	output, capital	"	"	"
		13 Man-hours transport	output, capital	"	"	"
		14 Man-hours Government	output, capital	"	"	"
		15 Man-hours Social Sv	output, capital	"	"	"

	16	Man-hours mining	output, capital wages rate	"	"	"
	17	Man-hours manufac	output, capital wages rate	"	"	"
	18	Man-hours construct.	output, capital wages rate	"	"	"
	19	Man-hours trade	output, capital wages rate	"	"	"
	20	Man-hours financial	output, capital wages rate	"	"	"
	21	Formal employment	GDP, GDP , lagged endogenous, lagged capital, time	logarithmic	single	OLS/ML
	22	Traditional agr. & informal employment	GDP, GDP , lagged endogenous, time	"	"	"
3	CONSUMPTION (on GDP)					
	23	Durables and nondurables	disposable income, lagged consum., credit terms	logarithmic	single	OLS/ML
	24	Service consumption	disposable income, lagged consumption			
4	INVESTMENT-FIXED Investment					
	25	Agriculture	output, relative price of capital, time and	Non-linear	simultaneous equation	ML/2SLS

			lagged endogenous			
	26	Manufacturing	"	"	"	ML/Nonlinear 2SL Nonlinear 3SLS
	27	Mining	"	"		"
	28	Utilities	"	"	"	"
	29	Construction		"	"	"
	30	Trade	output, relative price of capital time and lagged , endogenous	nonlinear	simultaneous equation	ML/Nonlinear 2SL Nonlinear 3SLS
	31	Transport		"	"	
	32	Financial institutions	"	"	"	
	33	Social & Pers. Svc.	"	"	"	
	34	Government	"	"	"	
	35	Inventory investment	GDP, time, lagged endogenous	logarithmic	single	OLS/ML
5	THE GOVERNMENT SECTOR					
	36	Customs revenue	lagged imports, time	linear	"	"
	37	Taxes revenue	non-traditional agri. GDP, time	"	"	"

	38	Rent, royal ties and dividends revenue	long term interest rate, public sector lending to private sector, Mining GDP, time	"	"	"
	39	Govt. debt	govern. borrowing, debt servicing, net lending to parastatals interest received	"	"	"
6	PRICES					
	40	Consumer price index	import price index exchange rate lagged endogenous, money stock, labour productivity, lagged import price index, lagged exchange rate, lagged labour productivity	logarithmic	"	"
	41	GDP Deflator-National	labour productivity, import price index, lagged endogenous, real exchange rate	logarithmic	single	OLS/ML
	42	Agric. GDP deflator	import price index, lagged import price index, sectoral	"	"	"

			labour productivity			
		43 Mining deflator	import price index, National GDP deflator	"	"	"
		44 Manufacturing deflator	import price index, National GDP deflator	"	"	"
		45 Utilities deflator	sectoral average wages, sectoral labour productivity	"	"	"
		46 Construction deflator	import price index, lagged import price index, sectoral labour productivity	"	"	"
		47 Commerce deflator	sectoral average wages, labour productivity, import price index	"	"	"
		48 Transport deflator	import price index, lagged index, sectoral import price labour productivity, sectoral average wages	"	"	"
		49 Finance deflator	sectoral average wages, sectoral labour productivity, lagged sectoral	"	"	"

			labour productivity, import price index			
		50 Services deflator	sectoral average wages, sectoral labour productivity, lagged sectoral labour productivity, import price index	"	"	"
		51 General Gvt. deflator	import price index sectoral labour productivity, sectoral lagged labour productivity, sectoral average wages	"	"	"
		52 Fixed formation capital deflator	import price index, price deflators of agri., mining, manufacturing, utilities, transport and finance	"	"	"
7	MONETARY SECTOR			"	"	"
		53 Demand for money	average interest rate, GDP, CPI.	"	"	"
		54 Total deposits	GDP, relative interest rate of deposits, availability of bank facilities,	"	"	"

			lagged endogenous				
		55	Excess Reserves	demand for credit, risk of lending money, rates of interest on loans, easiness of obtaining funds from central banks, lagged endogenous	"	"	"
		56	Domestic credit	commercial banks liquidity, gvt. cash balance	"	"	"
8.	EXTERNAL TRADE						
		57	Producer price of beef	export price of beef, exchange rate, BMC margin, CPI	"	"	ML/OLS
		58	Producer price copper	export price of copper, exchange rate BCL margin	"	"	OLS/ML
		59	Producer price of nickel	export price of nickel, exchange rate <u>BCL margin</u>	"	"	"
		60	Diamond production	labour, capital, time	logarithmic	single	OLS/ML
		61	Copper-Nickel	labour, capital,	"	"	"
		62	Beef production	rainfall, lagged price of beef, lagged index of prices of arable	"	"	"



			agricultural products				
		63	Imports of consumer goods	distribution of income, total private and govt. consumption index of production of food, lagged export index	"	"	"
		64	Imports of intermediate goods	GDP, lagged real exports, foreign transfers, net inflows	"	"	"
		65	Imports of capital goods	fixed capital formation time	"	"	"
9	INCOMES, TAXES AND WAGES						
		66	Urban household income	non-traditional agr. GDP, time, lagged endogenous	Linear		
		67	Rural household income	traditional agri. GDP time, lagged endogenous	"	"	"
		68	Gross surplus of public corporations	gross public corporations product, public corporation, labour time	"	"	"
		69	Private corporate profits	gross private sector product, private sector labour income,	"	"	"

			unemployment			
	70	Personal taxes	lagged personal income tax, total personal income minus government transfer payments, contribution to pension schemes	"	"	"
	71	Corporate taxes	government corporate tax rate, corporate profits	"	"	"
	72	Pensions	the tax rate of contribution of pension scheme, total local employees wage bill	"	"	"
	73	Gratuities	the gratuity rate,  total expatriates' wage bill	"	"	"

## 5. RESULTS OF MODEL FITTINGS

### *(i) Presentation of the Results of Model Fittings*

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The following statistics are presented for the estimated equation: ( $R^2$ ) coefficient of multiple determination adjusted for degrees of freedom; (F) F statistics together with the position regarding its significance; (DW) Durbin-Watson statistics. We present in parentheses under the respective coefficients the t-ratios for the estimated regression coefficients. For those equations which include the lagged endogenous variable among the predetermined variables as well as

those which are characterised by the presence of autocorrelation, we apply two forms of modified maximum likelihood (Cachrane and Hildreth) estimation techniques and include in the table of results for the relevant cases, the coefficient for the estimated lagged disturbance  $U_{t-1}$  with the respective estimate of  $\rho$ , the autocorrelation parameter. We also show, for each estimated equation, the relative estimation method.

The coefficients are given to four decimal places, other statistics (t,F,DW, $R^2$ ,p) are given to three places and, in accordance with normal practice, the level of significance for each t-ratio for the estimated regression coefficients is indicated.

The estimated equations are the results of numerous trials regarding the optimal form of the functions as well as the variables that give as a group the most desirable qualities of a satisfactory model fitting.

In order to allow for a thorough study of the effects of the Dutch Disease on the various sectors of the economy, the same variables have been retained in respect of the fitted equations for Blocks 1,2 and 4. Unless otherwise rejected due to the presence of autocorrelation, corresponding equations in these three blocks have been estimated jointly using two-stage least-squares (2SLS).

#### *(ii) Model Performance*

##### BLOCK 1

Eight out of ten fitted regressions have the value of  $R^2$  in the region of 0.9. The utilities equation's  $R^2$  is 0.789 and construction bears the lowest value of  $R^2$  of 0.542. The value of the "F" statistics is significant at five percent level of significance and the value of the DW 'd' statistic indicates the absence of autocorrelation in each one of the ten fitted regressions. From the statistical and econometric point of view, therefore, all the fitted regressions provide good fits to the situations (data) under analysis.

All the fitted equations in respect of the block under consideration satisfy the economic criteria except the one in respect of agriculture. That is to say, the evidence that emerges from the empirical equations is compatible with the model specifications which are based on economic theory for the situation under consideration.

As for the agriculture-fitted regression the coefficients corresponding to rain and fixed capital formation do not satisfy the economic criterion. The valid explanation for this situation is the presence of the Dutch Disease which is discussed in the previous section. Thus the results show that there has been disinvestment in the agricultural sector. The results also confirm the inadequacy of rainfall in Botswana's agricultural production. That is, the average rainfall during the post-independence period has not been high enough to support adequate agricultural production (*ceteris paribus*). This means that to raise arable agriculture to the level that can sustain meaningful economic development the country must adopt, in suitable areas, irrigation systems. Relying on rain-fed agriculture is one of the major factors responsible for poor agricultural output.

It is also important to note at this juncture that values of coefficients corresponding to the variable fixed capital formation differ significantly between sectors. This situation supports the rejection of the hypothesis of a uniform production process justifying one production function for the entire economy. The production characteristics vary from sector to sector, and sectoral production functions help to capture these differences.

## BLOCK 2

### Labour Inputs (Man-hours)

From the statistical and econometric criteria point of view the ten fitted regressions for labour inputs give satisfactory fits.

Eight out of the ten fitted regressions satisfy the criteria demanded by economic theory regarding the signs of the coefficients as well as relative significances as narrated in the previous section. Two sectors have negative and significant output coefficients. These are agriculture and trade. A negative and significant output regression coefficient for agriculture is brought about by the Dutch Disease, which has resulted in the drain of resources from agriculture to sectors producing non-traded goods and partly due to the fact that agricultural employment in Botswana, like in most countries in Sub-Saharan Africa, is essentially residual where those not employed in the formal sector remain (Lipumba et al, 1988). Therefore, as output in agriculture slumped, employment (in the traditional farming sub-sector) continued increasing and productivity declined. The negative output coefficient in the trade equation requires further study both from the accuracy of data point of view and that of the economic situation.

In almost each one of the ten fitted equations under discussion, the lagged endogenous variable coefficient is statistically significant (at five percent level of significance), confirming the conventional partial-adjustment behaviour of labour inputs to output. This situation is an indirect indication of the relevance of the hypothesis that factor intensities are revealed by employment behaviour in Botswana's state of production. That is, the observed changes in measured labour inputs are proportional to the desired changes. Although the variable  $Q/w$  is not statistically significant in most equations, its "t" values are fairly high in several equations. This variable measures the ratio of the price of capital to the wage rate. The price of capital changes with import prices (inflation). For the period under consideration, nominal wages in Botswana were a policy variable as explained in the previous sections. They depended on, among other things, the levels at which the government fixed public servants' wages. A sudden rise in this coefficient implies that the government was failing to raise wages in lien with the price of capital. A fall in the ratio implies that the government was raising money wages faster than the price of capital and consequently inflation. A constant ratio implies that wages and inflation underwent changes at the same rate. A significant ratio implies that the desired inputs of labour were being chosen so as to minimise the cost of producing expected output in a long-run equilibrium. The fairly significant values of the relevant ratio in Botswana's labour inputs fitted regressions imply that the requirement of cost minimization, i.e., that the ratio of marginal products of labour be equated to the ratio of price of capital to wage rate, was almost satisfied.

The revised wages and employment policy is meant to do away with government intervention in the labour market and subsequently to bring about efficiency in manpower allocation. The consequences of this course of action are that wages in the labour market would be determined by the supply and the demand for labour in the country. In this case the desired inputs of labour and capital would be presumed to be chosen so as to minimize the cost of producing expected output in long-run equilibrium (Hickman et al, 1976). Assuming that there is no monopsony in factor markets, then cost minimization would require that the ratio of marginal products of labour and capital be equated to the ratio of their expected prices. In the short-run it would be possible to test this axiom using the relevant estimated production, labour and investment functions.

The results also indicate that output is statistically significant in all the fitted regressions except in agriculture and trade, in which it appears with wrong arithmetic signs for reasons already discussed.

### Employment

The two fitted regressions satisfy both the econometric criteria and those required by economic theory. The output elasticity of formal employment is equal to 3.8314. This value is relatively higher than those established by Lipumba et al for Tanzania. Apparently, in Botswana employment levels in the formal sectors have kept pace with output levels. The elasticity with respect to fixed capital formation is also fairly high - in the region of 0.9. However, the fact that this value is less than one implies that a proportional increase in fixed capital formation would be accompanied by a relatively lower proportional increase in formal employment.

Unemployment is one of the major problems in Botswana. Employment projections in the current National Development Plan (NDP 6) are based on the following assumptions:

- That the average employment coefficient in a sector, that is to say, the amount of labour required to produce a given amount of output, does not diminish. For if this were to occur, it would decrease the sector's demand for labour.
- That there is no significant substitution of capital for labour.
- That the cost of labour relative to the cost of other production inputs remains constant.

The fitted regression for formal employment provides evidence for the validity of the first assumption. As for the second assumption concerning the issue of substitution, Mhozya (1987) establishes the elasticity of substitution between any pairs of inputs in the entire Botswana economy to be around 1.467, implying a fairly significant substitution of capital for labour. Computations of the relevant factor from our output functions in this study confirm the relevant value and support the hypothesis that production processes are becoming more and more capital intensive.

Regarding the employment function of traditional agriculture and the informal sectors, the results indicate that the best fit regression is of an autoregressive nature. Previous period level of

employment in the relevant sector determines the level of employment in the current period (*ceteris paribus*) and output produced does not explain the amount of labour hired to a large extent.

### BLOCK 3 CONSUMPTION (ON GDP)

The two fitted regressions under this block satisfy all the statistical, econometric and economic theory criteria. The marginal propensity to consume is 0.5731. This value is relatively lower than those which have been established by Limpumba et al in the case of Tanzania. This coefficient is even lower for service consumption. These values, however, are relatively very high when compared to those of developed countries, (Hickman et al, 1976). The values are typical of medium-income countries. The results thus support the hypothesis that as incomes increase the marginal propensity to consume falls. Botswana is today a middle-income country.

### BLOCK 4 FIXED INVESTMENT

All the ten fitted equations satisfy the statistical and econometric criteria. In the agriculture and utilities, fitted regressions output coefficients bear wrong arithmetic signs. These are apparently not statistically significant.

The estimated coefficients in respect of factor on GDP vary significantly between 0.9512 (for construction) and 0.0975 (for manufacturing). This suggests lack of uniformity in the characteristics of fixed investment between sectors in the country in as far as the output explanatory variable is concerned. Furthermore, in almost all the ten equations the lagged endogenous variable coefficient is statistically significant with the value being around 0.5. This means that the partial Adjustment behaviour is relevant to Botswana.

### BLOCK 5 GOVERNMENT SECTOR

All the three equations representing the main sources of government revenue satisfy the statistical, econometric and economic theory criteria. All the marginal values estimated in the three equations are statistically significant (at 0.1 percent level of significance). The fact that the import marginal value is statistically significant implies that the customs revenue sharing formula is effective in the process of apportioning customs revenues in as far as Botswana is concerned.

The marginal rate of non-traditional GDP with respect to tax revenue agrees in value with those that have been established in other developing countries (the Tanzanian value, for example, is equal to 0.1361). Mining revenue contributes significantly to government revenue originating from rent, royalties and dividends. This is reflected in the value of its marginal rate, which is higher than those with respect to imports and non-traditional agriculture GDP. It is well-known that the long-term interest rate affects dividends received by government on its shareholdings in mining companies. Factors of significance to government revenue are the Shashe project and the diamond mines administered by Debswana (Lewis et al, 1983). The estimated coefficient in respect of the long-term interest rate variable unfortunately bears a negative sign which is also

statistically significant. This is probably due to, among other things, the stagnation in interest rates.

## BLOCK 6 PRICES AND SECTORAL LABOUR PRODUCTIVITY

Money supply does not appear in the best fit equation of the Consumer Price Index(CPI) implying that inflation in Botswana is to a large extent due to rises in the prices of imported goods and also due to the country's labour productivity. The estimated elasticities of import prices for the current year are 0.5522 and 0.8732 in respect of the CPI and the GDP, respectively. For the past year the value is 0.3059 in respect of the CPI, confirming the fact that import prices have very strong effects on overall Botswana prices. The fact that the current year import price coefficient is statistically significant in both the CPI and GDP equations implies that domestic prices respond effectively and instantaneously to imported inflation (within one year). Furthermore, as in the Tanzanian case (Limpumba, 1988), these results confirm the fact that the incomes policy on wages and salaries has succeeded in controlling inflation transmission via wages. The wage variable was tried and found to be statistically quite insignificant. There is also the absence of stickiness in almost all the equations except the agriculture deflator. This means that the responses to input prices and labour productivity changes for the nine sectors, excluding agriculture, are immediate.

On the other hand, unemployment has continued increasing in recent years. The incomes Policy, it appears, has not allowed for the smooth creation of additional jobs in the country. This is due to the fact that the policy uses government wages and salaries as a yardstick and basis for the determination of wages and salaries of all workers, including those in parastatals and semi-Government institutions. Government wages and salaries, however, may not be in line with the required levels as dictated by the demand and supply of labour in the market. It appears that for Botswana, where most of the inflation originates from without, an incomes policy simply brings about distortion in the equilibrium between the demand and supply of labour, resulting in unemployment.

## BLOCK 7 MONETARY SECTOR

The links between money and prices in the model are shown in Fig. 1. The specifications and relative results of Block 6 show that the main determinants of prices are the import prices which reflect the prices of inputs and the labour productivities. Real money balances, do not appear in the expenditure functions of Blocks 3 and 4. As already mentioned, financial markets are not yet well-established in Botswana. For economies with well-established financial markets, the demand and supply of money determine the money stock and interest rates. Interest rates affect real expenditures in the consumption sectors and influence output and employment through the multiplier process. Labour demand directly affects money wages and, consequently, average unit costs and prices. At the same time, production levels influence prices via capacity utilization and the unit costs. It appears that this neat flow of causation is not relevant in the case of Botswana (just as it does not apply in most other countries operating without well-established financial markets).

The results represent the best fit empirical functions in respect of currency in circulation and total deposits respectively. In the case of currency in circulation, GDP turns out to be the most statistically significant variable. The average interest rates variable is also fairly significant. The level of prices variable is apparently weak in explaining the endogenous variable under consideration (currency in circulation). The value of the adjustment coefficient (one minus the coefficient of the lagged endogenous variable) is in the region of 0.64, and from the point of view of fulfilling the statistical, econometric and economic theory criteria, the fitted equation is quite satisfactory. The fitted equation for total deposits contains three explanatory variables. In this fitted equation also GDP is the most important explanatory variable.

Commercial banks, being profit-maximizing enterprises, would not opt for incurring the opportunity costs of holding excess cash. In the past, this has been the case in Botswana. The main reasons have been lack of demand for credit by borrowers, the high risk of lending money to some sectors, and the level of interest rates on the various types of loans. These facts are confirmed by the results of the fitted regression for excess reserves in which none of the above mentioned factors is statistically significant (neither at 0.1 level of significance nor at 5 percent level). Interest rates also determine the level of credit to the public by commercial banks. The results indicate that the rate of interest on loans is the most significant variable in this regard. The rates of interest have recently been changed to be in line with the position in the money market, in which case they (interest rates) are bound to remain significant in this regard in future.

## BLOCK 8 EXTERNAL TRADE

### Producer Prices

Botswana's major exports are made up of beef and mineral products. Of the mineral products, diamonds account for about 75 percent to total export value. The BCL company which carries out the mining of copper-nickel at Selibe-Phikwe has not done very well (EIU, The Economist Intelligent Unit Annual Supplement, 1984). In the early years of production it was besieged by a succession of technical problems. This was followed by low metal prices due to world recession. These factors have caused the mine to operate at a loss and to accumulate significant and large arrears in debt payments to the principal shareholders. This explains why the variable representing BCL margins has a negative sign and is apparently not statistically significant.

The foreign exchange variable represents in this case the number of U.S. dollars per Pula. This means that the lower the value of the exchange rate the higher the number of Pulas per dollar. This explains why this variable carries a negative sign in the fitted regressions. Data for the export price of beef were difficult to come by. Records were obtained for a number of years and the rest were interpolated and extrapolated, and hence the poor performance of the variable in the equation describing producer price of beef. The consumer price index is nevertheless the most important determining factor for the relevant price.

### PRODUCTION OF EXPORT COMMODITIES

The results indicate that beef production responds positively to own price increases. However, it does not respond to the price of the seemingly competing agricultural products. Statistics indicate



that throughout the pre-independence period beef has enjoyed better price relative to arable agricultural products prices.

As for the metals, the results show very high and statistically significant labour coefficients. The inclusion of the time trend in the equations reduces the capital coefficient to almost nil and statistically insignificant. The capital coefficients in the omitted variable equations (when the time variable is excluded) are, however, relatively high and statistically significant. The positive and significant time trend reflects, for diamonds, the spectacular increase in production in the early eighties due to the opening of Jwaneng mine.

## IMPORTS

Botswana is one of the few countries in Africa which operate with an open economy. There are almost no restrictions on foreign exchange for the amount of goods one can import in the country, subject only to the rules and regulations of the Common Customs Union. Imports of consumer goods are therefore not constrained by the supply of foreign exchange (a situation which is relevant in most other SADCC countries).

Foreign exchange obtained from the previous years' exports would therefore, normally, be expected not to be crucial in determining the level of imports of consumer goods in the current year in this case. This situation is confirmed by the insignificance of the relevant variable in the equation representing imports of consumer goods. As expected, the coefficient with respect to the index of food production is very high (0.83). Botswana is not food-sufficient and in the last decade had to import a significant proportion of its food-stuff requirements due to the recurrence of droughts.

The results also indicate that elasticities on the demand variables are either trivial or low. The variable GDP does not appear in the best-fit equations and the elasticity in respect of fixed capital formation in the equation for imports of capital goods is only 0.33.

## BLOCK 9 INCOMES, TAXES AND WAGES

The results of the equation representing urban household personal income indicate that this factor is best explained or modelled using an equation of an autoregressive nature. The coefficient with respect to real non-traditional agriculture GDP is not statistically significant. It means that personal income that accrues to a particular household in the current year is determined, to a large extent, by the previous years' earned income.

In the rural household income equation, however, traditional agriculture GDP significantly determines the level of personal income. This is probably due to the fact that in rural Botswana (just as in most rural parts of any developing country) agriculture is the major source of income.

In urban areas, however, the majority of citizens supplement their incomes by conducting businesses outside their regular employment in rural areas, and some of this income is of traditional agriculture in kind (e.g. cattle-post).

In the private corporate profits equation, the unemployment rate is included to capture the possible decline in the corporate share of private output usually observed during business contractions. This factor has a very high and statistically significant elasticity in the relevant equation signifying the extent of effects of unemployment on the overall private corporate profits brought about by the Dutch Disease.

The results also indicate that personal taxes are best modelled by an autoregressive type of a relation in which the previous period level of taxes determines the current period level of personal taxes. As for corporate taxes the government corporate tax rate is the main determining factor, as expected.

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