NATIONAL INCOME MODEL FOR ZIMBABWE: A COMPARATIVE STATIC ANALYSIS

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Abstract:

Comparative statics is a very useful analytical tool in macroeconomic policy analysis. However, the mathematical technique has not significantly been applied in macroeconomic modelling in Zimbabwe. This paper develops and estimates a national income model for Zimbabwe over a twenty-four-year period (1975-1998) and derives various comparative static derivatives. Results show that government expenditure multiplier, which is equal to the export multiplier, is less than one, mainly reflecting high marginal propensities to tax and import, and the inflationary effect of fiscal expansion. Investment effect is small due to an insignificant interest rate coefficient and a relatively large marginal government recurrent budget. The paper also invokes uncertainty on relative prices and fears of credit squeeze associated with inflationary environments, which apparently balance out with any positive price incentive effect of inflation. Short-term effects of government expenditure or export increase on all withdrawals are greater than long-term effects due to restricted income multiplier, implying that high withdrawals are self-limiting in the long-term. Monetary expansion has insignificant effect on all endogenous variables. The paper makes several recommendations related to the structure of trade restrictions, domestic tax rates and efforts to enhance macroeconomic response capacity to monetary instruments.

Keywords: National income model, goods market, money market, comparative static derivatives, multiplier

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Introduction:

In a recently completed study on the ISLM model for Zimbabwe, the author provides an elaborate historical background on policy making in Zimbabwe (Mlambo, 2013, in press), which is currently reproduced succinctly. A Zimbabwean economy coming out of the liberation war of the 1970s was an economy of contrasts. It had sophisticated but war-damaged economic infrastructure as well as clear imbalances in distribution of income and means of production. Thus, immediately after independence in 1980, the espoused Growth with Equity policy tended to be fiscal-driven, and was also conceived in a socialistic ideological context. However, the rest of the 1980s witnessed the use of a combination of fiscal and monetary policies on an ad hoc basis until the dream of socialism was abandoned in the early 1990s for a more free market approach (the Economic Structural Adjustment Programme, ESAP). This was succeeded in the late 1990s (1997) by a chaotic indigenization programme mainly driven by the liberation war veterans, which saw the invasion of white-owned farms. This, together with several other factors such as involvement in the DRC war and payment of war veteran gratuities that were not unbudgeted for, precipitated an economic and political crisis which characterized the country from 1997 to 2009. In 2009, was ushered in the current dispensation of inclusive government and dollarization (use of the US$ in place of the Z$). Dollarization brought some stability to the economy; however, there has not been a clear macroeconomic policy due to the inevitable functional problems of a divided government made up of three different political parties.

Problem statement, objectives and significance of the study

Soludo (2002) concludes that macroeconomic policy modelling in Africa is still infant and that much of the work happens and remains in academic institutions rather than in policy institutions. He however, argues that it is impossible for policy to proceed without some kind of model, either implicit (in the head) or explicit (formal), and that the latter is to be preferred. In Zimbabwe, few macroeconomic studies that model both monetary and real sectors have been carried out. Single equation and partial equilibrium approaches still dominate the determination of qualitative and quantitative effects of policies. There is need to model policy effects on all key endogenous variables in both markets so as to predict policy outcomes with greater accuracy and detail.

Comparative statics has been used widely in economic discourse especially in applied studies. It has been applied in public finance in the analysis of tax incidences (for example, Seade, 1983; Stern, 1982; and Katz and Rosen, 1983), in the analyses of international trade policies (for example, Brander & Spencer, 1984; Dixit, 1984; Eaton & Grossman, 1983; and Krugman, 1984) and in industrial organization (for example, Dixit, 1980; Brander & Spencer, 1983; Bulow, Geanakoplos & Klemperer, 1983; Fudenberg & Tirole, 1984; and Eaton & Grossman, 1984) (All the references in this sentence are cited in Dixit, 1986, p.107). It has found elaborate application in analysis of prices and risk in asset markets, for example Rubinstein (1973), Gollier (2010), Sandmo (1977), and Hong & Stein (1999). However, in Zimbabwe this mathematical technique has not been significantly applied in the analysis of macroeconomic policy. The author is not aware of an attempt to estimate the national income model of Zimbabwe and its comparative statics.

This study seeks to estimate a national income model comprising the real sector (investment, savings, imports and tax functions) and the monetary sector (money demand function), over a 24-year period (1975 – 1998). From this estimation, primary comparative static derivatives are derived including multipliers related to exports, government expenditure and money supply, as well as interest rate responses to these exogenous variables. Using the primary comparative static derivatives several auxiliary comparative static derivatives are derived, representing structural responses of other key macroeconomic variables (including savings, investment, imports, tax revenue and demand for cash balances) to exogenous changes.

A study of this nature is useful in predicting the effects of macroeconomic policies before they are implemented, be they monetary or fiscal policies. Such ability to foresee the effect of choices on policy instruments makes policymaking effective and efficient. The study provides a quick way of viewing the effect of a specific policy on a whole array of economic variables or indicators. It also provides a means of testing several hypotheses; for example, answers can be provided regarding fiscal policy, monetary policy and the export-led growth hypothesis (for the export-led growth hypothesis see Ogbokor, 2005). The macroeconomic response parameters that are derived are useful in any further macroeconomic analysis.

The study, in deliberately avoiding the abnormal conditions that existed after 1998 up until 2009, seeks to establish baseline structural economic conditions against which the subsequent abnormal conditions during which the structure of the economy was severely altered or broken down may be compared. Being a representation of normal conditions just preceding a long recession, results are useful in attempts to re-establish normality.

The national income model:

While the policy maker is not always an economist, all economic models (for policymaking) should necessarily be based on economic theory to be sensible (Soludo, 2002, p.11). However, economics is characterized by competing views, and the policy maker should be aware of these views to make good policy choices. This observation by Soludo makes a strong case for keeping actual policy modelling simple by use of simple models – models that can be used to communicate to the policy maker. A more elaborate argument on keeping models simple is presented in Kuezenkamp & McAleer (1995) (cited in Mlambo, 2012, p.1).

Comparative statics is a way of comparing different equilibrium states (sets of equilibrium values of endogenous variables) as they change with changes in the values of exogenous variables and parameters (Chiang, 1984, p.127). Thus, comparative static analysis presupposes an initial equilibrium. The national income model in this paper, whose comparative statics we seek to analyse, is based on the national income model presented in Chiang (1984). Chiang abstracted from government expenditure and taxes which this paper incorporates in order to bring the model closer to practical reality. The model is split into two components: the goods market and the money market, both of which are assumed to have equilibrium outcomes. Several functions in this paper are identical to those in the ISLM model in Mlambo (2013, in press). Identical also are the study periods used so that the section on estimation approaches and data, as well as several regression results and their interpretations, are basically reproduced from the earlier work.

Goods market:

Investment function: $I = I(r) = I_0 + ir, \quad I_r (= i) < 0$ (1)

Savings function: $S = S(y,r) = S_0 + s_1 y + s_2 r, \quad 0 < S_y (= s_1) < 1, S_r (= s_2) > 0$ (2)

Import function: $M = M(y) = M_0 + my, \quad 0 < M_y (= m) < 1$ (3)

Tax function: $T = T(y) = T_0 + \tau y, \quad 0 < T_y (= \tau) < 0$ (4)

Exports: $X = X_0$ (5)

Government expenditure: $G = G_0$ (6)

Consumption function: $C = C_0 + cy_d$ (7)

National income identity: $y = C + I + G + X - M$ (8)

Equilibrium condition: $I(r) + X_0 + G_0 = S(y,r) + M(y) + T(y)$ (9)

In the above equations i, s_1, s_2, m, τ and c are constants; r, G_0 and X_0, which respectively denote interest rate, government expenditure and exports, are exogenously determined variables; I, S, M, T, y, y_d and C, which respectively denote investment, savings, imports, tax, national income, disposable income and private consumption, are endogenous variables (to the goods market model); and S_0, M_0, T_0 and C_0 are autonomous components (parameters) of the respective variables while I_0 is investment that is independent of interest rate. While both equations (8) and (9) are equilibrium conditions, for easy of exposition of the comparative statics of the model we use equation (9). However, inclusion of equation (8) in the above list of equations is meant to show that income is endogenous to the model. Likewise, equation (7) is only included to show that other endogenous variables in the model are consumption (which also appears in equation 8) and disposable income, though the equation is not used per se in the following comparative statistics.

Money market:

Money demand: $L(y,r) = L_0 + \varphi_1 y + \varphi_2 r, \quad \phi_1 > 0, \varphi_2 < 0$ (10)

Money supply: $M_s = M_{s0}$ (11)

Equilibrium condition: $L = M_s$ (12)

L denotes liquidity preference while M_s is money supply. In this model, endogenous variables include L and r (see Dornbusch & Fischer, 1981, p.97, in Mlambo, 2013, in press). Exogenous variables include M_{s0} and y.

Comparative statics:

From (9) and (12) we have:

$$I(r) - S(y,r) - M(y) - T(y) + X_0 + G_0 = 0 \quad (9a)$$

$$L(y,r) - M_{s0} = 0 \quad (12a)$$

Totally differentiating (9a) and (12a) with respect to all endogenous variables (leaving out those acting as function symbols) and exogenous variables, and transferring all exogenous variable[1] terms to the RHS, we get:

$$(I_r - S_r)dr - (S_y + M_y + T_y)dy = -dX_0 - dG_0$$
$$L_r dr + L_y dy = dM_{s0}$$

Applying matrices to the above differentials give:

$$\begin{bmatrix} I_r - S_r & -(S_y + M_y + T_y) \\ L_r & L_y \end{bmatrix} \begin{bmatrix} \partial r \\ \partial y \end{bmatrix} = \begin{bmatrix} -\partial X_0 - \partial G_0 \\ \partial M_{s0} \end{bmatrix} \quad (13)$$

Denoting the lead matrix in (13) by J representing Jacobian matrix, the system in (13) can be solved using Cramer's rule to give:

[1] In this case the exogenous variables must be exogenous to both the real and money markets which means interest rate is not treated as exogenous.

$$\frac{\partial r}{\partial M_{s0}} = \frac{S_y + M_y + T_y}{|J|}, \qquad \frac{\partial r}{\partial X_0} = \frac{-L_y}{|J|}, \qquad \frac{\partial r}{\partial G_0} = \frac{-L_y}{|J|} \tag{14}$$

$$\frac{\partial y}{\partial M_{s0}} = \frac{I_r - S_r}{|J|}, \qquad \frac{\partial y}{\partial X_0} = \frac{L_r}{|J|}, \qquad \frac{\partial y}{\partial G_0} = \frac{L_r}{|J|} \tag{15}$$

where $|J| = L_y(I_r - S_r) + L_r(S_y + M_y + T_y)$

Equations (14) and (15) give the primary comparative static derivatives. Comparative static derivatives in (15) are multipliers. Using the primary comparative static derivatives, we can derive auxiliary comparative static derivatives (showing the effect of changes in the three exogenous variables on the equilibrium values of the rest of the endogenous variables).

Table 1: Various primary and secondary comparative static derivatives to be estimated

Primary Comparative Static derivatives	Auxiliary Comparative Static Derivatives				
	Savings	Imports	Taxes	Money demand	Investment
$\frac{\partial y}{\partial G_0}$	$\frac{\partial S}{\partial G_0} = S_y \frac{\partial y}{\partial G_0}$	$\frac{\partial M}{\partial G_0} = M_y \frac{\partial y}{\partial G_0}$	$\frac{\partial T}{\partial G_0} = T_y \frac{\partial y}{\partial G_0}$	$\frac{\partial L}{\partial G_0} = L_y \frac{\partial y}{\partial G_0}$	
$\frac{\partial r}{\partial G_0}$	$\frac{\partial S}{\partial G_0} = S_r \frac{\partial r}{\partial G_0}$			$\frac{\partial L}{\partial G_0} = L_r \frac{\partial r}{\partial G_0}$	$\frac{\partial I}{\partial G_0} = I_r \frac{\partial r}{\partial G_0}$

$\frac{\partial y}{\partial X_0}$	$\frac{\partial S}{\partial X_0} = S_y \frac{\partial y}{\partial X_0}$	$\frac{\partial M}{\partial X_0} = M_y \frac{\partial y}{\partial X_0}$	$\frac{\partial T}{\partial X_0} = T_y \frac{\partial y}{\partial X_0}$	$\frac{\partial L}{\partial X_0} = L_y \frac{\partial y}{\partial X_0}$	
$\frac{\partial r}{\partial X_0}$	$\frac{\partial S}{\partial X_0} = S_r \frac{\partial r}{\partial X_0}$			$\frac{\partial L}{\partial X_0} = L_r \frac{\partial r}{\partial X_0}$	$\frac{\partial I}{\partial X_0} = I_r \frac{\partial r}{\partial X_0}$
$\frac{\partial y}{\partial M_{s0}}$	$\frac{\partial S}{\partial M_{s0}} = S_y \frac{\partial y}{\partial M_{s0}}$	$\frac{\partial M}{\partial M_{s0}} = M_y \frac{\partial y}{\partial M_{s0}}$	$\frac{\partial T}{\partial M_{s0}} = T_y \frac{\partial y}{\partial M_{s0}}$	$\frac{\partial L}{\partial M_{s0}} = L_y \frac{\partial y}{\partial M_{s0}}$	
$\frac{\partial r}{\partial M_{s0}}$	$\frac{\partial S}{\partial M_{s0}} = S_r \frac{\partial r}{\partial M_{s0}}$			$\frac{\partial L}{\partial M_{s0}} = L_r \frac{\partial r}{\partial M_{s0}}$	$\frac{\partial I}{\partial M_{s0}} = I_r \frac{\partial r}{\partial M_{s0}}$

Table 1 shows how the auxiliary comparative static derivatives are derived from the primary comparative static derivatives in the extreme left column. It shows that savings and money demand (liquidity) are affected by each of the three exogenous variables through two channels – income and interest rate.

Estimation approaches and data:

The model we seek to estimate comprises equations (1) to (4) of the goods market on the one hand, and equation (10) of the money market on the other hand. Simultaneous equation approaches are used. For identification status of the equations we use the rank order condition, which states that for an equation to be identified, the number of excluded exogenous variables should be greater than or equal to the number of included endogenous variables less one. Using this condition we find that equations (1) to (4) are overidentified, while equation (10) is exactly identified. However, equation (1) is exclusively a function of an exogenous variable, therefore Ordinary Least Squares (OLS) can be used directly to estimate it. For equations (2) to (4) we use the Two Stage Least Squares (2SLS) method and for equation (10) we use the Indirect Least Squares (ILS) method.

For the 2SLS in each of equations (2) to (4), we first regress each endogenous explanatory variable against all predetermined variables in the goods market system, use the estimated coefficients to obtain an estimate for the endogenous explanatory variable, which estimate is used as an instrumental variable. In all cases of final econometric estimation, since the data used are time-series and plots of residuals show clear patterns, results are corrected for autocorrelation using the Cochrane-Orcutt method. All final interpretations and further mathematical computations use the corrected versions of estimates.

The study makes use of a wide range of secondary data, including national income, gross fixed capital formation (gross investment), gross savings, imports, exports, government expenditure, tax revenue, money supply, and nominal interest rate. The data are time-series and annual, and they cover the years 1975 to 1998. All the data are nominal, and with the exception of interest rates which are in percentages, all data are in Z$million. Sources of data include the Central Statistical Office (various Quarterly Digest of Statistics, Statistical Yearbooks and the Compendium of Statistics 2000) and the Reserve Bank of Zimbabwe (Quarterly Economic and Statistical Reviews). Exact sources are detailed below.

National income figures are obtained from Reserve Bank of Zimbabwe (1999) and Central Statistical Office (2000b). Investment figures (which are Gross Fixed Capital Formation) are obtained from Reserve Bank of Zimbabwe (1999) and Central Statistical Office (1986 and 2000b). Savings figures are obtained from Central Statistical Office (1986, 1996 and 2002). Exports and Imports refer to goods and services only (the current account) and data sources include Central Statistical Office (1986, 1991 and 2000b). Government expenditure figures are totals of government expenditure including maturing debt (1975-1979) or net lending (1980-1986). Figures for 1975-1986 are given for year ending June 30, while those for 1997-1998 are computed sums of the respective monthly figures. Sources of data for government expenditure include Reserve Bank of Zimbabwe (1980, 1998 and 1999). Money supply definition used is M2 and all data are from Central Statistical Office (1981, 1986, 1991, 1993a, 1996 and 2000b). Interest rates are averages of the principal money market rates obtained from Central Statistical Office (1986, 1993b and 2000b). Tax figures are sums of direct and indirect taxes (1977-1985, 1993-1998) and sums of taxes on income, profits, goods, services and miscellaneous taxes

(1986-1987, 1990-1992). Miscellaneous taxes are assumed to be either direct or indirect taxes. Tax figures for 1975-1976 and 1988-1989 are not available and are estimated by multiplying respective government expenditure figures by the average ratio of tax to government expenditure for the years for which tax figures are available (rest of the years), which ratio is 0.71. Available tax figures are from Central Statistical Office (1987, 1989 and 2000a).

Table 2: National Income (Y), Investment (I), Savings (S), Imports (M, Exports (X), Government Expenditure (G), Tax Revenue (T), Money Supply (M_2) and Interest Rate (r)

Year	Y	I	S	M	X	G	T	M2	r
1975	1,953	468	437	613	590	518	368	441	5.13
1976	2,108	427	394	533	617	577	410	518	4.78
1977	2,150	379	338	558	610	754	508	552	4.53
1978	2,317	341	292	593	675	848	503	626	4.61
1979	2,769	395	264	803	798	945	542	710	4.65
1980	3,394	528	382	1,146	1,043	1,050	699	952	4.80
1981	4,318	830	578	1,442	1,117	1,284	1,044	1,035	11.67
1982	5,003	1,039	552	1,450	1,141	1,681	1,416	1,236	9.82
1983	6,058	1,238	314	1,544	1,338	2,247	1,738	1,270	11.57
1984	6,209	1,185	1,110	1,673	1,708	2,627	1,911	1,553	9.35
1985	8,876	1,299	1,251	2,002	2,020	2,923	2,117	1,619	9.44
1986	10,045	1,559	1,884	2,230	2,492	3,308	2,246	1,838	10.20
1987	10,875	1,804	1,755	2,383	2,690	4,053	2,637	2,064	9.78
1988	13,718	2,197	2,849	2,873	3,350	4,681	3,324	2,562	10.10
1989	17,062	2,452	2,632	3,803	4,087	5,676	4,030	3,140	9.59
1990	20,787	3,913	3,369	4,899	4,915	6,446	4,637	3,803	10.50
1991	28,644	6,097	4,746	8,048	7,075	8,356	5,917	4,687	21.90
1992	32,985	7,690	3,676	12,548	9,364	11,073	8,315	5,611	28.14
1993	40,877	10,021	6,701	13,784	13,050	13,408	9,093	9,081	22.75
1994	53,754	11,879	15,148	20,509	19,431	15,811	11,507	12,203	22.97
1995	58,969	14,996	13,908	25,216	23,562	21,814	13,572	16,116	25.30
1996	81,837	19,245	14,744	30,747	30,910	26,024	16,746	19,979	17.94
1997	97,111	20,509	11,177	45,535	38,375	38,127	27,545	37,514	26.07
1998	126,567	23,931	26,424	64,812	62,332	48,852	40,543	43,133	32.20

ILS approach for estimation of money demand function:

$$M_{s0} = L_0 + \varphi_1 y + \varphi_2 r$$

$$r = -\frac{L_0}{\varphi_2} - \frac{\varphi_1}{\varphi_2} y + \frac{1}{\varphi_2}(M_{s0})$$

$$r = \alpha_0 + \alpha_1 y + \alpha_2 M_{s0} \qquad (16)$$

where $\alpha_0 = -\frac{L_0}{\varphi_2}$, $\alpha_1 = -\frac{\varphi_1}{\varphi_2}$, $\alpha_2 = \frac{1}{\varphi_2}$.

Once equation (16) is estimated (by OLS) we can then obtain the values of the structural parameters in the demand function from the reduced form coefficients as follows:

$$L_0 = -\alpha_0 \varphi_2, \quad \varphi_1 = -\alpha_1 \varphi_2, \quad \varphi_2 = \frac{1}{\alpha_2}$$

Results:

Investment function:

Version not corrected for autocorrelation

$I = -4{,}315 + 726.0200r, \quad r^2 = 0.74$

$(1{,}475.3715) \quad (91.9595) \quad df = 22$

$t = (-2.925) \quad (7.895) \quad F_{1,22} = 62.33$

Version corrected for autocorrelation

$$I = 3{,}208{,}316 \quad +15.4689r$$
$$(908{,}518.08) \quad (66.3136) \qquad (17)$$
$$t = (3.531) \quad (0.233)$$

In the uncorrected version, the investment function has a negative constant and a positive coefficient, both of which are significant. However, in the corrected version, while the constant becomes positive but remains significant, the OLS estimate of the coefficient of interest rate remains positive but becomes insignificant, with computed t value (= 0.233) far less than 2. The positive sign of the coefficient is inconsistent with economic theory, which states that investment is negatively related to interest rate. However, the insignificance of the coefficient and the significant high positive constant show that there are other exogenous factors making up the constant, probably high investment share of FDI. Investment in Zimbabwe over the period of study had little to do with interest rate. Other detailed studies on investment in Zimbabwe have also concluded that empirical relationships are not consistent with the neoclassical hypothesis that private investment is negatively related to the cost of capital (interest included) (Dzawanda, 1994), while others have obtained results consistent with theory but insignificant (Dailami and Walton, 1989).

Studies on investment elsewhere also obtained results inconsistent with the neoclassical hypothesis. Chetty (2007) analysed the relationship between investment and interest rate in a situation where investment is characterized by irreversibility and uncertainty in terms of payoffs. He found that in such situation there are two costs that are influenced by interest rate changes, namely, the direct cost of capital and the cost of holding up investment in order to get necessary information. He found the result to be a back-ward bending investment function. He explains that if interest rate is rising from a low level the cost of delay rises too, so that investments are undertaken instead of being delayed. Sandmo (1971) asserts that the neoclassical hypothesis holds in the short run, but in the long run the relationship between investment and interest rate is unstable. Jenkins (1998) concludes that investment in Zimbabwe is constrained by availability of finance (and not interest rates).

Savings function:

Version not corrected for autocorrelation

$$\begin{array}{lllll} S = -363 + & 0.1813y + & 24.1447r, & R^2 = 0.88 \\ & (1{,}072.0247) & (0.0281) \quad (110.2808) & df = 21 \\ t = & (-0.339) & (6.451) \quad (0.219) & F_{2,21} = 79.84 \end{array}$$

Version corrected for autocorrelation

$$\begin{array}{lllll} S = -437 + & 0.1795y + & 32.1101r, \\ & (1{,}100.7101) & (0.0280) \quad (110.9607) \\ t = & (-0.397) & (6.405) \quad (0.289) \end{array} \qquad (18)$$

The critical t and F values at 5% level of significance are 2.080 and 3.47 respectively. All the estimates in the savings function, including the constant term have signs consistent with theory (a negative vertical intercept, a marginal propensity to save between 0 and 1, and a positive interest rate coefficient) in both the uncorrected and corrected versions. However, in both regressions the interest rate coefficient is not significant while that of income is significant. This shows that agents mainly increase their savings as a response to increased incomes rather than to increased interest rates. In other words, agents save mainly for security of their money rather than to gain interest. Note that income enters as gross, not disposable, because Government also saves from its tax revenue. A negative autonomous savings figure shows that at zero income the public will be dissaving.

Import function:

Version not corrected for autocorrelation

$$\begin{array}{lllll} M_t = -2{,}439 & + 0.4829Y_t, & r^2 = 0.99 \\ (416.0205) & (0.0098) & df = 22 \\ t = (-5.864) & (49.232) & F_{1,22} = 2{,}423.82 \end{array}$$

Version corrected for autocorrelation

$$\begin{array}{lll} M_t = -4{,}208 & + 0.5194 Y_t & \\ \quad (1{,}543.7351) & (0.0170) & (19) \\ t = \quad (-2.726) & (30.534) & \end{array}$$

The uncorrected version of the import function shows that it is consistent with economic theory. Both the individual estimates and the model as a whole are significant at 5%, and the model shows a very high explanatory power of 99%. The estimates remain significant in the corrected version. The estimate of the marginal propensity to import (corrected version) is 0.52, showing that when national income increases by one million dollars, imports increase by 0.52 million dollars.

Taxation function:

Version not corrected for autocorrelation

$$\begin{array}{llll} T_t = -889 & + 0.2862 Y_t, & r^2 = 0.98 & \\ \quad (320.6716) & (0.0076) & df = 22 & \\ t = \quad (-2.771) & (37.851) & F_{1,22} = 1{,}432.71 & \end{array}$$

Version corrected for autocorrelation

$$\begin{array}{lll} T_t = -834{,}221 & + 0.3607 Y_t & \\ \quad (577{,}104.16) & (0.0195) & (20) \\ t = \quad (-1.446) & (18.486) & \end{array}$$

The uncorrected version of the taxation function is consistent with economic theory which states that there is a positive income tax rate since the main source of government revenue is tax. The model as a whole also shows a good fit and overall significance at 5% with the coefficient of

determination and computed F value of 98% and 1,432.70 (>4.30) respectively. All estimates are significant at 5%. The estimates remain significant after correction for autocorrelation. Using the corrected version, the results show that the marginal income tax rate over the period was 36%. The negative autonomous tax indicates that when income is zero the government, instead of taxing its citizens, pays them.

Money demand function:

We first estimate equation (16), the reduced-form equation, by OLS correcting it for autocorrelation which gives equation (21). Using the reduced-form estimates we derive the structural parameter estimates.

Regression results for reduced-form equation not corrected for autocorrelation

$$\begin{array}{lllll} r = 7 & + & 0.0005\,y - 0.0008\left(M_{s0}\right), & R^2 = 0.77 \\ & (1.2545) & (0.0001) \quad (0.0003) & df = 21 \\ t = & (5.394) & (3.977) \quad (-2.190) & F_{2,21} = 34.94 \end{array}$$

Regression results for reduced-form equation corrected for autocorrelation

$$\begin{array}{lll} r = 10 + & 0.0001\,y + 0.0003\left(M_{s0}\right) & \\ (3.4614) & (0.0001) \quad (0.0003) & \\ t = (3.003) & (0.531) \quad (1.025) & \end{array} \qquad (21)$$

Using the corrected version of the results we find that:

$$\varphi_2 = 3{,}333.3333, \quad \varphi_0 = -33{,}333.333, \quad \varphi_1 = -0.3333$$

Therefore, the money demand function is given by:

$$L = -33{,}333.333 - 0.3333Y_t + 3{,}333.3333r_t \quad (22)$$

The money demand function is not consistent with theory as the coefficient of r is positive and that of Y is negative.

Table 3: Estimates of parameters

I_0	3,208,316	I_r	15.4689	L_y	-0.3333
S_0	-437	S_y	0.1795	L_r	3,333.3333
M_0	-4,208	S_r	32.1101		
T_0	-834,221	M_y	0.5194		
L_0	-33,333	T_y	0.3607		

Table 4: Estimates of comparative static derivatives

WRT	Income	Int. rate	Savings		Imports	Taxes	Liquidity		Investment
			Savings (via y)	Savings (via r)			Mon.Dema (via y)	Mon.Dema (via r)	
G_0	0.9423	0.0001	0.1691	0.0032	0.4894	0.3399	-0.3141	0.3333	0.0015
X_0	0.9423	0.0001	0.1691	0.0032	0.4894	0.3399	-0.3141	0.3333	0.0015
M_{s0}	-0.0047	0.0003	-0.0008	0.0096	-0.0024	-0.0017	0.0016	1	0.0046

Using the estimates in Table 3, the Jacobian determinant is equal to 3,537.5465. Table 4 shows estimates of all the various comparative static derivatives. Each figure in Table 4 shows the eventual effect of change in the exogenous variable (respective variable in the extreme left column) on the equilibrium value of the endogenous variable (respective variable in the first or second row) after the necessary period of adjustment. **WRT** denotes 'with respect to' (exogenous variables in the first column).

Further interpretation and discussion:

The following points are noted from the results in Table 4 regarding the effects of changing government expenditure, exports and money supply.

Government expenditure and exports:

We note from Table 4 that the comparative static derivatives with respect to government expenditure and exports are identical in all cases, hence we discuss them simultaneously.

a) Income: An increase in government expenditure (or exports) of Z$1 million increases equilibrium income by Z$942,300 (that is, by less than the initial increase). A multiplier of 0.9423 is small given that the increases are theoretically expected to trigger a series of expenditures in the local economy which should result in more than the initial change. A number of factors may explain this result. The claim on the effectiveness of fiscal policy is premised on the Keynesian proposition that expansionary fiscal policy can effectively result in increased domestic aggregate demand, hence real output and employment (Nevile, 1983, in Maxwell, 1987). However, a high import propensity implies that the increase in government expenditure does not significantly influence domestic aggregate demand as it is diverted to foreign markets. High tax rates have also had dampening effect on the multiplier. A marginal tax rate above 30% is high by international and regional standards. Another factor is inflation. Every expansionary demand management policy results in some inflation, and if prices are very flexible (see Nevile, 1983, in Maxwell, 1987) this can absorb a greater part of the expenditure increase without any meaningful effect on real output, as prices adjust quickly to clear the market.

b) Investment: An increase in government expenditure (or exports) leads to an increase in equilibrium investment, but the increase is insignificant. It requires government expenditure (or exports) to increase by Z$667 million to increase investment by Z$1 million. This apparently reflects the fact that investment in Zimbabwe is mainly driven by foreign capital, and a greater part of government expenditure is recurrent. However,

there are other alternative explanations. As Nevile (1983) (in Maxwell, 1987, p.103) explains, the inflationary environment that may be produced by expansionary fiscal policy creates uncertainty regarding changes in relative prices, which adversely affects investment. It also negatively affects savings by producing fears of credit squeeze, thus increasing liquidity reducing investment in the process. While inflation itself may be a positive price incentive for business investment, apparently in Zimbabwe, the small effect of expansionary policy on investment indicates that the negative effects of inflation outweigh the positive price incentive. However, it is not plausible to explain the smallness of the investment effect by crowding out (see Nevile, 1983, in Maxwell, 1987) given the very low levels of investment and capital stocks and the fact that the classical assumption of a negative relationship between interest rate and investment does not hold in Zimbabwe.

c) Savings, imports and taxes: Savings are affected by all the exogenous variables (including government expenditure) through two channels, namely income and interest rate. Therefore, the total comparative static derivative of savings with respect to any of the three exogenous variables is given by the sum of the two channel effects. The sum for government expenditure (or exports) is 0.1723 million dollars for every 1 million dollar increase. Note that the marginal propensity to save (short-run effect) is greater than the eventual adjustment in the equilibrium level of savings (long-run effect). This apparently reflects the limited multiplier effect of government expenditure (or exports) on income alluded to in point (a), the negative effect of inflation on real interest rates and fears of credit squeeze alluded to in (b). For the same reasons of restricted multiplier given on savings, the marginal propensities to import and to tax are greater than the eventual change in equilibrium imports and tax levels (for imports the propensity and equilibrium change are 0.5194 and 0.4894 respectively; and for taxes 0.3607 and 0.3399 respectively).

d) Interest rate and liquidity: The qualitative effect of an increase in government expenditure (or exports) on interest rate is positive. However, the effect is quantitatively insignificant since a Z$1 million increase in government expenditure (or exports) only increases

equilibrium interest rate by 0.0001% meaning that to increase interest by 1% an increase in government expenditure (or exports) of Z$10 billion is required. This reflects the low sensitivity of interest rate to changes in income of 0.0001. Increase in government expenditure or exports also results in slight increase in liquidity preference (0.0192).

Money supply:

In general, an increase in money supply does not significantly change equilibrium values of most endogenous variables, with all comparative static derivatives with respect to money supply having very small magnitudes. The only exception is money demand which increases by about the same amount (for achievement of money market equilibrium). The following specific details are noted:

a) Income, interest rate and investment: Expansionary monetary policy is theoretically expected to cause interest rates to fall, which should cause investment to increase and eventually income to increase. However, Table 4 shows that the impact of money supply expansion on income is negative. Given the results in the corrected version of equation (21) are inconsistent with theory and insignificant, it is plausible to assume that money supply expansion has no significant effect on interest rates. However, increase in money supply, like an expansionary fiscal policy causes inflation (quantity theory of money), which creates uncertainty in relative prices, hence negatively affects investment. Nevertheless, the net effect on investment is almost zero due to the balancing effect of the positive price incentive and the slightly positive effect on investment from the increased availability of credit in the short-term.

b) Savings, imports and taxes: Equilibrium savings respond positively but insignificantly to money supply expansion. Money supply expansion has a negative effect on savings through negative effect on income, and a positive effect on savings through the abnormal though insignificant positive money supply – interest rate relationship. The net effect is slightly positive. The negative effect of money supply on imports and taxes directly trace from the negative impact of money supply on income.

c) Liquidity: The necessity of equilibrium demands that after adjustment to a money supply shock money demand change must match the initial increase in money supply. Thus, money demand increases by approximately Z$1 million following a Z$1 million increase in money supply.

Conclusion:

Government expenditure and exports have identical effects (both qualitative and quantitative) on all endogenous variables in both the goods market and the money market. Thus, given the inflationary effects of government expenditure increase, efforts to promote exports (which are likely to be less inflationary) should receive more emphasis ahead of fiscal expansion. The multiplier effect of fiscal expansion or exogenous export increase is less than unit, albeit positive, despite a very high marginal propensity to consume. The paper has explored several possible reasons including high tax rates, large marginal propensity to import and the inflationary effect of fiscal expansion. This suggests the need to shift trade restrictions from an emphasis on tariff to non-tariff barriers and to reduce rates of domestic tax (direct and indirect). The short-term effect is to reduce government revenue hence the ability to continue fiscal expansion on the basis of government revenue, which suggests the need to debt-finance the expansion. Quantitative barriers to trade can also elicit reactions from trading partners and sour relations with multilateral lenders. However, in the long term this is expected to enhance the multiplier effects of fiscal expansion.

Fiscal expansion or export increase have insignificant effect on investment partly because of the insignificance of the interest rate coefficient and partly because government expenditure is largely recurrent. The paper has also alluded to Neville (1983, in Maxwell, 1987) who argues that the inflationary environment created by expansionary fiscal policy has both negative effects (uncertainty in relative prices and credit squeeze) and positive effects (positive price incentive) on investment, which may balance out. It has also been argued that, in the context of Zimbabwe, crowding-out explanation is not significantly relevant. The short-term (immediate) effect of government expenditure or export increase on all withdrawals (savings, imports and taxes) is

greater than the long-term effect due to the restricted multiplier effect on income. This implies that high rates of withdrawals are self-limiting in the long run.

The impact of monetary expansion on all endogenous variables in both markets is insignificant. Besides the insignificance of the impact on income, it is also qualitatively negative. The paper argues that this reflects the negative effect of resultant inflation. Thus tinkering with money supply is only likely to be inflationary. However, efforts to bring the large informal sector into the mainstream formal sector could improve the level of monetization of the economy and the response to money supply as a policy instrument.

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