SECTORAL PLANNING IN KENYA:
A PROPOSED MACROECONOMIC MODEL

By

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Synopsis

The structural equations for a multi-sector dynamic multisector growth models are formulated. The models, subsequent to its estimation and simulation, in intended as a long run planning instrument in guiding the Kenyan Government in monetary and final aspect of market regulation.

In ascertaining and attempting to influence the future course of economic development in Kenya the Ministry of Finance and Planning has recently embarked upon its third Five Year Plan. "Through an iterative process of interministerial consultation, the estimates of Government and private sector potential were then assimilated into a single, comprehensive plan. The views of individual Ministers on the final version of their own sector plans were then taken into account before the plan was published."

While such an informal planning mechanism might be sufficient for an underdeveloped economy it's applicability to a society desiring to achieve developed status is questionable, for comprehension of the complexity of economic interrelationships in a developed economy needs quantitative expression within some formal mechanism exposing these interrelationships in a systematic manner.

During the early years of Independence the decisions required to determine the allocation of government revenues within the diverse sectors of the economy was facilitated by the paucity of worthwhile projects. However this is hardly the situation at present as each ministry now has available a variety of projects many of which are potentially worthwhile.

An additional problem facing the Ministry of Finance and Planning is the assimilation of technology within the economy. While much technology in an underdeveloped country is borrowed from developed economies a dependence strictly upon this type of amorphous technological improvement would seem to imply being continually 'behind' the developed world. In order to achieve true development, e.g. parity with the developed world, it appears that some original research is required.

Economic theory has provided, within the twentieth century, quantitative techniques for evaluating alternative policy choices, known as macroeconomic models. It is clear that the government is not ignorant of these techniques -- for it is obvious that many of the recommendations made by the team of economists from the World Bank, these recommendations stemming from comparative static results of what is known as the World Bank Model, have been incorporated in the present Development Plan.

Proper choice of quantitative techniques for policy evaluation however should be a dynamic process incorporating the most recent theoretical apparatus; for continuing economic progress means the incorporation of ever more efficient techniques. This applies both to processes of government administration and planning as well as to the production of goods within the economy. Thus model formulation and selection by Government should be an ongoing process of constant revision and improvement.

The goal of this preliminary proposal is to present a theoretical outline of a macroeconomic model designed especially to determine optimal sectoral development; optimal in the sense of actually fulfilling the government's stated objectives concerning economic progress.

I Criteria of Model Selection

Ideally the Government would like to have exact knowledge of the economic relationships existing in the economy. Such knowledge however requires omnipotence, thus the problem of choosing suitable criteria for formulating and selecting a suitable model arises.

There exist three aspects to successful modeling and planning: I) Model formulation, II) Model Estimation and III) Model solution, simulation and projection. These three aspects must be empirically analyzed successively but analytically we can evaluate the methodology of each aspect of a model prior to actual construction. After this section this will be done for the proposed model.

In considering macroeconomic models a particular model is usually designed for a particular purpose; the explanation of a specific set of endogenous variables. Incorrect usage of a model results from predictions arising from *ad hoc* assumptions and mechanisms contained within the model. An example will elucidate the problem. The formulation of the World Bank Model was primarily intended to determine the financial requirements of the Kenyan economy, specifically the amount needed to finance the balance of payments' deficit. In order to make the model consistent price adjustment was formulated according to an ad hoc mechanism. Utilizing the model therefore to predict sectoral price changes would constitute an inappropriate analysis.

Of course the best criteria for judging a model is its performance in actual prediction. Accordingly that model should be chosen with a proven capability for explanatory power. Since this usually is not possible a priori a model should be rejected which proves to have poor prediction power ex post.

When constructing a macroeconomic model the specific formulation, where possible, should adhere to established economic theory. While it is possible that a model formulated according to bad or nonexistent theory might yield worthwhile predictions, it is not likely.

Once a model has been formulated prior to application it is necessary to determine the quantitative values of the parameters of the model. This aspect of modeling, while extremely important, lies within the realm of econometrics. Proper selection of estimates is determined by use of statistics with desirable statistical properties; we eschew at present a discussion of this subject.

Until quite recently the third aspect of planning, that of model solution, simulation, and projection has been, to a large extent, the major determinant of the actual choice of a macroeconomic model.

Prior to recent advances in the theory of optimization methods for large-scale systems formulations capable of fulfilling the ultimate goal of such models, solution, simulation, and projection, were restricted to a single aggregate of production.[1] Multisector dynamic models remained strictly within the realm of theoretical growth literature; even here they were largely restricted to the analysis of two sector models.

Such a restriction however is no longer necessary as computer based approximization techniques are now available that simultaneously lead to optimal policies as well as eliciting comparative dynamic implications of changes in these policies.[2]

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1) The notable exception to this statement are Input-Output models which have been extensively utilized in the planning activities of command-type economies. Indeed the fundamental structure of such regimes requires such a technique for obtaining consistency in allocative instructions to the producing units. Unfortunately Input-Output models, inherently by their explicit formulation, have many drawbacks as viewed from a development context. Specifically (1) An Input-Output formulation eliminates the possibility of substitutability of factors in production. In the context of development for a less developed nation like Kenya an extremely relevant question is how best to adapt capital-intensive technology to a Kenyan labor-intensive economy. (2) The fixed coefficient production functions implied by an Input-Output formulation do not allow changes in the structure of the economy. Development however implies fundamental changes in the structural relationships of an economy. (3) In the context of a centrally planned economy the composition of production is determined by the decision of the planners with the concomittant implication that the relative evaluations of goods in production do not match the relative evaluations given by the public. In a market economy, such as Kenya, where individual needs count, a goal of planning should be satisfaction of these needs; thereby implying the equivalence between the aforementioned prices and the necessity to incorporate demand relationships.

2) It is noted here that the actual solution, e.g. the optimal policy, of the World Bank Model can be found through application of these same computer methods. This however has yet to be done; the present recommendations of this model stem from comparative static manipulations of the model which were not accomplished in accordance with any formal maximization objective. If this model is to be continued to be used by the Ministry of Finance and Planning finding the World Bank Model's solution, e.g. the optimal policy recommendations, would appear to be a useful exercise. Also recent international financial developments, most notably the formulation of the OPEC and the quadrupling of crude oil prices and worldwide inflation necessitate a reevaluation of this model due to the radical departure of anticipated import prices from the much higher realized prices which are still continuing to rise. For a theoretical analysis of possible computer simulation procedures see Robert James Whitacre, 'Policy Determination Through Simulation of Non-linear Econometric Models', IDS Working Paper No. 213.

II Formulation of the Model

The basic structure of the model is that of a multisector growth model. There are n + 1 sectors in the economy, n production sectors and government. The emphasis of the model is the determination of optimal sectoral planning both in terms of expenditure upon physical capital and expenditure on technology. To obtain this goal each productive sector of the economy is represented by a production function of the following form

$$(1) \qquad Y_{it} = A_1 \left(e^{\bar{\alpha}_{it}} + \sum_{k=1}^{t-1} \alpha_{ik} \tilde{T}_{ik}\right) K_{it}^{B_{1i}} L_{it}^{B_{2i}} \qquad i = 1, \ldots, n$$

$$(T) \qquad \tilde{T}_{it} = \Omega_{it} \left(\sum_{j=1}^{n} P_j G_j \right)$$

Output of the ith good in time t is given by Y_{it}. A_i is a constant which changes the units to those of output i. t stands for time. Therefore in terms of the model $\bar{\alpha}_i$ can be interpreted as autonomous technological progress in sector i. T_i stands for technological investment in sector i. In individual equations T_i should probably contain some amount representing investment in education lagged appropriately, e.g. human capital, initiated by the government. Thus the associated α_{ik} represent the impact of endogenous technological progress. It will probably be necessary to relate the α_{ik}, k= 1, ..., t - 1 in some way in order to facilitate estimation; e.g. a Koyck distributed lag or some such technique. K_{it} represents capital in industry i at time t and L_{it} represents labor. Equation (T) shows technological investment as some proportion of total government expenditures.

As depicted here the functional relationship between technology, capital and labor is given as a kind of Cobb-Douglas production function. Other alternatives clearly exist, e.g. CES, Box-Cox, or Generalized Production Functions (A. Zellner), but these generally require estimation of additional parameters. Where possible these other alternatives should be explored.

Of particular interest is an examination of whether or not financing in the various sectors should be geared towards firms of a particular type; small or large scale. This might be determined by use of a CES production function with a homogeneity parameter, called a Generalized Production Function, having the following form

$$(1) \qquad Y_{it} = A e^{\bar{\alpha}_{it} \sum_{t-1}^{t-1} \alpha_{ik} T_k} \left[A_{i1} (K_{it})^{h\partial} + A_{i2} (L_{it})^{h\partial} \right]^{1/\partial}$$

here h is the homogeneity parameter; possibly a function of average firm size.*

Aggregate Domestic Product is then the value of output in each productive sector weighted by price levels in the respective sectors and the value of government services.

Denoting the n + 1 vector of prices $\bar{P} = \begin{bmatrix} P \\ \cdot \\ \cdot \\ \cdot \\ P_n \\ P_{n+1} \end{bmatrix}$ and of product by $\bar{Y} = \begin{bmatrix} Y_1 \\ \cdot \\ \cdot \\ \cdot \\ Y_n \\ G \end{bmatrix}$

$$(2) \qquad \bar{P}\bar{Y} = \sum_{i=1}^{n} P_i Y_{it} + P_{n+1} G$$ 3., 4.

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* Some preliminary work in this area has been conducted by Leopold Mureithi of the Department of Economics, University of Nairobi.

3.) Since government services typically do not pass through the market most (if not all as I know of no exceptions) macroeconomic models, as well as accounting techniques, value these services at current factor cost concommittant with a treatment similar to consumption expenditures. Definitely this is misleading as the government in Kenya is one of the major purchasers of capital, both human and physical and it seems that technical expertise in rendering government services is one of the main differences between developed and underdeveloped countries. Thus some kind of production function should be ascribed to government as well. Procedurally part of this problem can be rectified by separating out all agencies which cover costs dealing with production of physical goods. This however does not solve the major problem since significant government expenditures deal with education, road construction, etc.; services which either do not pass through the market directly or receive a stream of returns spread over a significant period of time.

4.) A discussion of prices is temporarily eschewed until the monetary sector is considered.

In each sector domestic product plus imports, (M_i), minus exports, (E_i), represents gross product available for domestic utilization. In turn this amount is divided for use among the final users: household consumption (C_i), gross investment (I_i), and government expenditure (G_i).

(3)

$$C_i+I_i+G_i = Y_i+M_i-E_i \qquad i=1,\ldots,n$$

Note $\sum_{i}^{n} P_i G_i = P_{n+1} G$ by definition

Consumption demand by households depends upon relative prices and disposable income (DY)

(4) $$C_i=f_i(P_1,\ldots P_n, \overline{P}, DY) \qquad i=1,---,n$$

$$= a_i + \sum_j b_{ij} \frac{P_i}{\overline{P}} + cDY$$

It is noted here that this system of equations defines a system of demand equations which implicitly determines household savings (S_i). Perhaps some interest rate might be significant as this shows the relative tradeoff between present and future goods.

Corresponding to each productive sector an investment function will be required. Since the Kenyan economy is primarily a market economy it is reasonable to suppose that firms act in their own self interest; that individual enterprises are profit maximizers. Also since market demand information is difficult to obtain it seems plausible to presuppose that firms are price takers. Therefore firms will act to satisfy the criteria necessary for profit maximization, namely they will attempt to equate marginal value of the factor product with marginal factor cost; where the relevant price is that anticipated: P_i^*.

Marginal value of factor product is given by

$$\frac{\partial}{\partial K_i}(P_i^1 Y_i) = \frac{B_{1i} P_i^* Y_i}{K_i}$$

Let r_i be the interest rate in sector i; then

$$\frac{B_{1i}P_i{*}Y_i = r_i}{K_i} = r_i \qquad i - 1,\ldots,n$$

This implies desired capital stock is given by

$$(5) \qquad K_i^* = \frac{B_{1i}Pi{*}Y_i}{r_i} \qquad i= 1,\ldots,n.$$

Assuming that depreciation is a constant fraction of existing capital stock and that adjustment to the new equilibrium level of capital stock is proportional to the gap between desired and anticipated capital at the end of the period we have

$$(6) \qquad I_{it}^P - \lambda_i [K_{it}^* - (1-\delta)K_{i,t-1}]; \; i=1,\ldots,n$$

5.

Here I_{it}^P is private investment at time period t in sector i. Correspondingly let I_{it}^G be government investment and $I_{i,t}^F$ be foreign investment. Then definitionally we have

$$(7) \qquad I_{it} = I_{it}^P + I_{it}^G + I_{it}^F; \; i=1,\ldots,n$$

Finally capital stock in the present period is the capital stock left from the previous period plus total investment

$$K_{it} = I_{it} + (1-\delta_i)\, K_{i,t-1}; i=1,---,n$$

The various interest rates persisting in the different industries will clearly be related. In a perfect capital market, due to competition, they should all be equal except for compensating risk differentials. Thus we might expect these n different rates to be related through n - 1 equations.

In a real capital market, such as exists in Kenya, deviations from a perfect capital market are quite substantial. Transactions costs in individual loans are of considerable importance in situations where firm size is rather small; a characteristic of most Kenyan industry. Also since the capital market is highly regulated by the government both through its own lending institutions, strict regulation of banking practices, and also through its financing and/or regulation of major projects (the Nairobi Airport, the oil pipeline from Mombasa to Nairobi, etc.) and industries (the East African Power and Lighting Co., Ltd., etc.), the exact relationship between interest rates is fairly well obscured. Thus now the relationship between interest rates should be included in a proper sectoral planning model is open to some controversy; specifically should the hypothesized interest rate relationships be the result of some equilibrium growth path of the economy or should they be incorporated prior to model solution? The present construction of the model follows this first path: satisfaction of static equilibrium conditions in lending markets is deemed a result of proper government action. Determination of existing compensating interest rate differentials in a functioning market economy can therefore only be determined ex post to the determination and allocation of production.

IMPORTS AND EXPORTS

Since aggregates are being considered it is possible (indeed likely) that at any prevailing sectoral price level both imports and exports will occur. Considering an aggregate equation for net imports (or net exports) fails to take account of specialized sectoral tariff charges which differentiate between imports and exports. Also differential shipping costs per dollar or volume unit can be expected between imports and exports. Finally when considering imports and exports there is a definite price problem involved, as domestic prices and international market prices can differ widely for many reasons.

Differentiation between imports and exports will facilitate examination of specialized taxation. An example might be an investigation of the aggregate benefits (or more likely costs) of the recently introduced ten percent tariff on imported machinery.

When considering imports it is useful to think of such items as demand for foreign goods by the domestic economic agents; consumers, firms, households, and government. It would seem illegitimate to expect parameter estimates for a domestic sector demand to be identical with the same foreign sector demand as the specific goods involved are normally quite different; most imported goods are not produced in the domestic Kenyan economy.

Therefore for each sector

(8) $$M_{it} = \bar{\alpha} + \sum_{j=1}^{n} \bar{\bar{a}}_{ij} \, \bar{\bar{b}}_{ij} \, \frac{P_j}{\bar{P}} + C_i \overline{PY} \qquad i = 1, \ldots, n.$$

Here $\bar{\bar{a}}_j$ is the coefficient associated with price and $\bar{b}_j$ is one plus the import duty.

Since Kenya is a small part of the world market in the goods which it exports, export demand will essentially be very elastic; deviations from perfect elasticity primarily being determined by differential shipping costs to foreign ports. This argument implies that demand by foreigners for individual goods available for export will depend only upon that goods price in relationship to international price $(\hat{P}_j)$, and not upon other domestic prices; thus

(9) $$E_{it} = E_i + k_D X_i + y_i \left(\frac{Z_i P_{it}}{\bar{P} \; \bar{Y}} - \hat{P}_j \right) ; \; i=1,\ldots,n.$$

Here y_i is the coefficient and Z_i is export duty or subsidy.

MONEY MARKETS

Money markets are, in the long run, believed to operate according to the quantity theory of money; modified however for those markets primarily influenced by international market prices or government regulation. Overall price level changes consist of two separate components. Those induced by domestic monetary policy and that induced via the change in price of imported goods.

Looking at the Input-Output Table for Kenya in the year 1967 the vast bulk of imported goods lies in capital investment goods and petroleum. In these areas it would seem reasonable to take prices in the domestic market as dependent upon international market prices. Also some deflator should be contained in the investment equations reflecting the cost fof capital equipment. Adequate incorporation of this latter fact into the model has yet to be accomplished

Since money markets are highly concentrated in Kenya, being almost exclusively based in Nairobi, price level changes induced by money stock changes can be expected to be consummated in a short amount of time. Empirically this seems to be the case for the domestic Kenyan economy.[6]

Our basic money equation

(10) $$MV = \overline{PY} = \sum_{i=1}^{n} P_i Y_i + P_n + 1G$$

Let the last m productive sectors be those whose price levels are determined on international markets, then

$$MV = \sum_{i=1}^{n-m} P_i Y_i + \sum_{j=k-m+1}^{n} Y_j \overline{P}_j + P_{n+1} G$$

Consider each of the n - m prices determined domestically. It is assumed that prices change according to the following type of mechanism:

6.) (details of WB estimates)

$$\text{(11)} \quad \Delta P_{jt} = \sum_{\tilde{t}=1}^{t} \Delta M_{\tilde{t}} \, \tilde{m}_{\tilde{t}j} (P^*_{jt} - P_{jt-1}) \qquad j = 1, \ldots, n-m$$

$\tilde{m}_{\tilde{t}}$ would then be the impact of monetary policy in period $\tilde{t}$ upon period t.[7]

The formulation in equations (11) allows different sectors to adjust at different rates to changes in monetary policy.[8] Changes in sectoral price levels might depend intrinsically upon sectoral interest rates also as, possibly, a low marginal return would relate directly to a low price due to production considerations. If empirically equations (11) were statistically similar for all sectors then inflation per se would not be bad (except possibly to investment expectations due to aggregate price changes) for the economy as change in the money stock would induce proportionate changes in sectoral price levels while relative prices would be determined by demand.

7.) Several variations on a plausible money market probably need to be tested. The basic problem is price determination in a multi-sector economy through time; a topic rather sparsely covered in the literature. Suggestions here would prove most helpful; particularly those in quantified form (that is, mathematical statements).

8.) The basic problem with inflation is that different prices adjust at different relative rates and not directly in proportion to aggregate price level changes. Thus in adjusting from one price level to another if the velocity of money remains constant, or is secularly increasing or decreasing, a too slow a rate of increase in one price necessarily entails too great an increase in another. The system of equations in (10) and (11) implies an entirely different mode of adjustment. Here money supply increases can change both the price levels and the velocity of money. This is a significantly different hypothesis than the first one postulated above; that requiring a constant or secularly changing velocity. If the velocity of money were a necessarily constraints or changing uniformly this would place side constraints on equations (11); however the exact nature such constraints should take in such an alternative specification is somewhat difficult to ascertain.

Here in equations (11) P_{jt} is the solution of these equations given disposable income and the current price level. Prices however, for institutional (e.g. government price controls) as well as operational market reasons, cannot adjust instantaneously to a new equilibrium position in a single time period; thus the necessity of some disequilibrium price adjustment mechanism such as equations (11).

If however empirically equations (11) are statistically different for different sectors then an inflationary or deflationary monetary policy (particularly one with accelerating or decelerating changes in the money supply) will induce changes in relative prices which are not dictated by consumer preferences; thus contituting a harmful effect upon the economy as a consumer sovereignty and therefore societal welfare is being negated by monetary policy.

GOVERNMENT REVENUES AND EXPENDITURE

Let D_i equal the government deficit in the ith sector and T_i be the tax in quantity terms then

$$G_i = T_i + D_i \qquad \forall_i = 1, \ldots, n$$

and overall monetary deficit is defined to be

$$\overline{P}\,\overline{D} = \sum_{i=1}^{n} P_i D_i .$$

Taxes in each sector depend upon the incidence of sales, import, and export taxes plus a percentage of income taxes arising from that sector

$$P_i T_i = E_i P_i Y_i + b_i M_i P_i + \delta_i \hat{P}_i E_i + \psi_{1i} + \psi_{2i} \overline{P}\,\overline{Y}$$

Here f the last two terms are income tax and E_i represents the sales tax applicable to sector i. Also it might pay to add in corporate profts taxes, wage taxes, etc. if these prove to be important.

LABOR MARKETS

In establishing the relevant equations relating to labor supply and demand in the Kenyan economy in terms of a multisector model some major conceptual problems arise due to the inherent skill structure of the labor force. Most productive industries require a spectrum of skilled, semi-skilled, and unskilled workers; albeit to varying degrees. The Kenyan labor force however has very many unskilled workers, some semi-skilled workers and a very small component of skilled and professional workers. The net result is many industries face bottlenecks in production from the available labor supply. The obvious solution, that of specifying several different types of labor to enter the production function, has the drawback that data is not easily obtainable, if were it would be highly correlated over time, and in addition would greatly complicate the model. Also very few empirical comparisons could be made with studies of other countries to check validity of estimated coefficients.

Another added problem when considering the Kenyan economy is the existence of minimum wage legislation. The problem arises as clearly these laws are not followed by all sectors of the economy; thereby resulting in a varying scale of wages paid for essentially the same service offered. Analyzing the influence of this phenomenon on production will arise from the comparative statics of this model.

Sectoral labor supplies are presumed to depend both upon the wage rate, both nominal and real, and potential labor force population. Denoting by Q all able bodied workers we have

$$L_i^s = m_{1i} + m_{2i}w_i + m_{3i}w_i/\overline{P}\ \overline{Y} + n_iQ$$

If the coefficients m_{1i} prove significant some money illusion is present.

Since firms are profit maximizers they equate the value of the marginal factor product to the wage:

$$\frac{\partial}{\partial L^D}(P_iY_i) = \frac{B_{2i}P_iY_i}{L_i^D}$$

which implies

$$\frac{B_{2i}\,P_iY_i}{L_i^D} = \frac{w_i}{\overline{PY}}.$$

Solving for labor demand

$$L_i^D = \frac{B_2P_iY_i\overline{PY}}{w_i} \qquad i = 1,\ldots,n$$

Equilibrium in labor markets requires

$$L_i^D = L_i^S \qquad i = 1,\ldots,n.$$

MISCELLANEOUS EQUATIONS

Personal consumption plus personal savings is necessarily personal disposable income. Also personal savings must necessarily equal investment funds attributable to the consuming sector.

$$C_i+S_i = DY_i \qquad\qquad i = 1,\ldots,n$$

It is useful when considering savings and investment as being principally determined by business and government. First investment takes place and then the remainder of national income is left for consumption Of course in a discrete model encompassing a time span of an entire year between stages this consecutive nature of investment, then consumption, will appear to occur simultaneously.

Expected prices in the next time period are the price in the old time period plus a weighted average of recent price changes.

$$P^*_{it} = k_{it} + P_{it-1} + \sum_{\tau=1}^{t-1} S_{i\tau}\,(P_{i\tau} - P_{i\tau-1}); \qquad i = 1,\ldots,n.$$

Also

$$\overline{P}\,\overline{D}\,\overline{Y} = \overline{PY} - \overline{P}\,\overline{T} + \overline{P}\,\overline{M}\cdot\overline{P}\,\overline{E}$$

Summary of Structural Equations

(1) $Y_{it} = A_{ie}(\bar{\alpha}_{it} + \sum_{k=1}^{t-1} \tilde{\alpha}_{ik} T_{ik}) K_{it}^{B_{1i}} L_{it}^{B_{2i}}$; $i = 1,\ldots,n$

$\tilde{T}_{it} = \tilde{\alpha}_{it} (\sum_{j=1}^{n} P_j G_j)$ = $i, = 1,\ldots,n$

(2) $C_i + I_{it} + G_i = Y_{it} + M_i - E_i$; $i = 1,\ldots,n$

(3) $C_i = f_i (P_1,\ldots,P_n, \bar{P}, DY)$; $i=1,\ldots,n$

(4) $K_i^* = \underline{B_{1i} P_i^* Y_i}$; $i = 1,\ldots,n$

(5) $I_{it}^{P} = ^{r_i} \lambda_i [K_{it}^* - (1-\delta)K_{i,t-1}]$; $i = 1,\ldots,n.$

(6) $I_{it} = I_{it}^{P} + I_{it}^{G} + I_{it}^{F}$; $i=1,\ldots,n.$

(7) $K_{it} = I_{it} + (1-\delta_i) K_{i,t-1}$; $i = 1,\ldots,n$;

(8) $M_{it} = \bar{a}_i + \sum_{j=1}^{n} \underset{aij}{=} \underset{bij}{=} \frac{P_i}{\bar{P}_\Lambda} + C_i \overline{PY}$; $i = 1,\ldots,n.$

(9) $E_{it} = X_i + y_i \left(\frac{Z_i P_{it}}{\overline{PY}} - \frac{P_i}{\overline{PY}} \right)$; $i = 1, \ldots, n.$

(10) $MV = \overline{PY} = \sum_{i=1}^{n} P_i Y_i + P_{n+1} G = \sum_{i=1}^{n-m} P_i Y_i + \sum_{j=n-m+1}^{n} \tilde{P}_j Y_j + P_{n+1} G.$

(11) $\Delta P_{it} = \sum_{\tilde{t}=1}^{t} \Delta M_t \tilde{m}_{ti} (P_{it}^* - P_{it-1})$; $i=1,\ldots,n$

(12) $G_i = T_i + D_i$; $i = 1,\ldots,n.$

(13) $P_i' = E_i P_i Y_i + b_i M_i P_i + \delta_i \tilde{P}_i E_i + \psi_{i1} + \psi_{i2} \overline{PY}$ $i = 1, \ldots, n.$

(14) $L_i^S = m_{1i} + m_{2i} w_i + m_{3i} \frac{w_i}{\overline{PY}} + n_i Q$; $i = 1,\ldots,n.$

(15) $L_i^D = \frac{B_2 P_i Y_i \overline{PY}}{w_i}$; $i = 1,\ldots,n.$

(16) $L_i^D = L_i^S$; $i = 1,\ldots,n.$

(17) $C_i + S_i = DY_i$; $1, \ldots, n$

(18) $P^*_{it} = aki + P_{it-1} + \sum_{\hat{t}-1}^{t-1} s_{i\tilde{t}} (P_{i\tilde{t}} - P_{i\tilde{t}-1})$; $i = 1,\ldots,n$

(19) $\overline{PT} = \sum_{i=1}^{n} P_i T_i.$

Comments Upon Structural Form

It is useful to compare the model presented with the corresponding Keynesian static model: indeed a static view of this model can be given the normal Keynesian interpretation.[9] The static equilibrium state of the model, if there were only one sector, is the standard textbook model of an economy having an import-export sector, a monetary sector, a productive sector, a money market, and a labor market. The static linkage between the monetary sector and the productive sector in such a one sector model would arise via the labor market should money illusion be present within the population. The full static model, where there are n different sectors, n presumably greater than one, while interpretable as a straightforward generalization of the normal Keynesian model, possesses the same basic type of linkage between the monetary sector and the productive sectors, that is money illusion via the various labor markets. However the overall effect such linkages would have upon the equilibrium values of the endogenous variables would depend upon the pattern of production within the economy as determined via the overall productive processes. Different degrees of money illusion in the different labor markets implies a differential impact of changes in monetary policy upon the growth rates of sectoral production.

The full dynamic model contains many more linkages between the productive sectors and the monetary sector. Specifically even when there is no money illusion present investment in each sector depends upon anticipated prices, which in turn influences production. Anticipated prices however influence actual prices via the price adjustment equation (11). The complete model also embodies such fundamental concepts as technological change, additions to capital, and foreign trade, all within the context of a multisector growth model. As formulated there are 17_n+2 equations

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9 This cannot be said for either of the two extant models of the Kenyan economy: The World Bank Model and the Slater-Walsham model, although this latter model can be given the usual static Linear Programming interpretation.

in the model. The following variables can be considered as endogenous:

Y_{it}	$i=1,\ldots,n$
K_{it}	$i = 1,\ldots,n$
L^{D}_{it}	$i = 1,\ldots,n$
C_{it}	$i = 1,\ldots,n$
I_{it}	$i = 1,\ldots,n$
M_{it}	$i = 1,\ldots,n$
E_{it}	$i = 1,\ldots,n$
K^{*}_{it}	$i = 1,\ldots,n$
t^{*}_{i}	$i = 1,\ldots,n$
I^{P}_{it}	$i = 1,\ldots,n$
L^{S}_{it}	$i = 1,\ldots,n$
w_{i}	$i = 1,\ldots,n$
DY_{i}	$i = 1,\ldots,n$
S_{i}	$i = 1,\ldots,n$
P^{*}_{it}	$i = 1,\ldots,n$
P_{it}	$i = 1,\ldots,n$
V	
$\hat{T}_{i}$	$i \quad i=1,\ldots,n$
T_{i}	$i = 1,\ldots,n$
$\overline{PT}$	

The following variables and coefficients can be considered as exogenous:[10]

$$\Omega_{it},\ \bar{a}_i,\ \bar{\bar{a}}_{ij},\ \bar{\bar{b}}_{ij},^{+}\ c_i,\ x_i,\ y_i,\ z_i,\ \psi_{i1},\ \psi_{i2},\ G_i,\ I_i^G,\ M.$$

The following coefficients are considered as constants or parameters not affectable by policy: All predetermined variables.

$$A_i,\ \bar{\alpha}_i,\ \alpha_{ik},\ \beta_{1i},\ \beta_{2i},\ \lambda_i,\ \delta_i,\ \tilde{m}_{\tilde{t}i},\ m_{1i},\ m_{2i},\ m_{3i},\ n_i,\ k_i,\ s_{\tilde{i}t},\ I_{it}^F,\ Q.$$

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10. A distinction is made here between exogenous variables, those controllable by government fiat, and parameters.

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