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AN ECONOMETRIC APPROACH USING THE REPUBLIC OF KENYA

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STRUCTURAL CHANGE IN A LOW-INCOME COUNTRY:

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A thesis submitted to the Graduate School of the University of Wisconsin in partial fulfillment of the requirements for the degree of Doctor of Philosophy

BY

Neal Peter Cohen

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STRUCTURAL CHANGE IN A LOW-INCOME COUNTRY

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I

INTRODUCTION

This thesis creates a macro-economic model of Kenya. It makes three specific contributions to the literature on low-income countries. A model (1) of Kenya which allows for, and analyzes the extent and nature of structural change; (2) of a low-income country which utilized instrumental estimates, thus not assuming zero error term correlations between equations; and (3) that assists in the analysis of the Kenya Second Economic Development Plan.

Over the past decade economists have become more knowledgable concerning statistical and mathematical tools, and their limits. While often these tools are incorrectly utilized or the results improperly interpreted, they can provide much useful information. They can assist in rational decision making so that desired objectives are more fully achieved. Here, some of these tools are used to analyze the Second Five Year Plan. Such a model could have assisted the planners in making more accurate decisions concerning the direction of the economy and developing problems. It further demonstrates the impact of some of the policy options open to the government. It must be rather cautious in this area since there are always policy implementation problems. The tools of value here are available on the micro-economic level, some being roughly comparable to those here utilized.

By utilizing some of the tools of economics a better comprehension of their limits, and their potential value can be achieved.

There has been extensive discussions in the economic development literature concerning the measurement and/or need for structural change in order for developed to be accelerated. The question of whether change is good or needed is not addressed here. The concern is rather in measuring the form of the change, and its extent. In order for the discussions on the need for change to have analytical content there must be some agreement on what is meant by structural change, and some of the implications of such change. By addressing this question and providing answers for one country that has undergone some structural change, albeit non-major, a base for comparison is established. A comparison of the results presented here, with those derived for other countries, can yield a better understanding of the impact and necessity of such changes. The issue of structural change is of considerable importance in many low-income countries. More extensive and accurate information should help in the making of correct decisions.

After the model is specified sensitivity tests are performed to determine key relationships and analyze the impact on parameter magnitude changes on forecasts. Thus the problems of misspecification can be avoided, or at least comprehended before the model is utilized for development plan analysis. By sensitivity analysis and an analysis of the assumptions of the Development Plan the possible problems of misspecification can be limited as well as the impact of changing structural relationships.

It is demonstrated that using information that was available to the planning agency at the time of the writing of the Plan that a forecast of the Kenya economy for 1974 would have been more accurate (in light of data received covering through 1971) had the model been utilized. This is an admittedly limited forecast, with only the major variables considered. These are still crucial elements, from the estimate of their values many other values in the Plan were derived.

It is unfortunate that so many planners, officials, and citizens have a fear of the tools of the statistician, mathematician or econometrician. The tools can be used to assist rational decision making. This thesis is a movement along the path to demonstrating the value of these tools.

II

ECONOMETRIC MODELLING IN KENYA

While econometric modelling is not of exceptionally recent vintage, its application to Kenya is. There have been four attempts to construct such a model, one of which was essentially an update of an earlier attempt.

In this chapter only the statistical problems of these other studies will be analyzed. By combining the econometric problems of these studies, presented here, with the specification errors they made, presented in Chapter IV, the reasons for the improved forecasting ability of this model are made comprehensible.

The first major attempt at modelling in Kenya was made by P. Clark, with later refinements by H. Kirani.[1] Rather than call their attempt an econometric model, it would be more appropriate to call it an arithmetic model. That is, they assume there is a relationship between two variables. There is no testing to see to what extent the relationship does exist. They take the average value of each variable and then assign a parameter that would bring about equality. Unless a constant term is somehow determined, this method assumes that the average value (i.e., average propensity to consume) equals the marginal value (marginal propensity to consume). In some cases this might be correct, however, using time series data in a growth oriented low-income country, this likelihood is greatly diminished. There is some prediction of variables from engineering studies and further estimation based on plan predictions as to import substitution, etc. This method places an exceptionally high premium on the modelers' knowledge of the economy.

Unless one or more of the coefficients are assumed, their method can not allow effectively more than one independent variable with each dependent variable. This is not meant to completely disparage their work. As an early attempt in the field and as a means to keep computational problems to a minimum, it enhanced the understanding of the researchers and provided some additional information on the operation of the economy. In fact, given Clark and Kirani's extensive knowledge of Kenya, the variables that they proposed shall serve as a guide in this thesis' attempts to formulate a more statistically accurate model.

A more statistically accurate model was created by Faaland and Dahl for the UNCTAD.[2] They show some awareness of the limits of modelling, although, there are a number of statistical errors in their report. "... [W]e have assumed that the basic structures in our model have not changed over the period 1956-1965 for which we have our data."[3] They could have improved their results if they had attempted to prove this assertion rather than just state it. A statistical test for structural change, albeit narrowly defined, is possible given the data they had available. With their use of ordinary least squares, the relatively simple Chou test could have been used.[4]

A more important error is their use of ordinary least squares when working with multi-equation models. If the error terms of the various equations are correlated, then this method leads to a statistical bias. The researcher should use some other form of estimation process to correct for this error, unless the assumption is made, and somehow supported, that either the error terms are not correlated or the effect of this correlation is not statistically important.[5] Since the major problem of low-income country modelling is specification and efficiency, and not error term correlation, these comments do not negate the value of that which they have done.[6] They did correctly show developing inflation pressures, but did not catch the improvement in the balance of trade.

Often the researcher needs, not the impact of the change in the value of a variable, but the elasticity. In an equation such as Y = a + bX, if X/Y remains constant then the elasticity will remain constant. Faaland and Dahl compute elasticity by redoing the equation in log form. While it is true that the coefficient on the logged variable is an elasticity, this is not the same elasticity as would be achieved with the unlogged formulation. They state

$$T = 0.206(GDP) - 14.986$$

$$\ln T = 1.328(\ln GDP) - 3.740$$

"It is ... interesting to note that the total tax income appears to be quite elastic with regard to changes in GDP, viz 1.33."[7] This is true using the second equation above. If the first formulation was used with data, then in 1965 the true income elasticity of taxation was 1.40. Their method of computing the elasticity hides a very interesting result which their original equation was telling them, i.e., tax collections were becoming less elastic with respect to gross domestic product. For predictive purposes this can be significant.

In their work they state: "The statistical fits are good -- although the D.W. [Durbin-Watson] statistic is not very good for the linear regression for [government consumption]."[8] They were referring to an equation where the Durban-Watson was 1.87. This value is clearly within the area that allows us to reject the hypothesis of serial correlation. Compared to their other results, with higher Durbin-Watsons, this result is the worst only if we are testing for positive serial correlation. Their statement that "Generally the higher the value of the D.W. statistic the stronger is the indication that the errors are not correlated" is false if the hypothesis of negative serial correlation is to be tested.[10] For the figures in the table referenced there was not any negative serial correlation. In their study they accept a number of equations as having no serial correlation when they do show negative serial correlation.[11] Even when they found positive serial correlation they did not do anything about it, such as generalized differences, or even first differences.

DePrince's model[12] is better formulated, reasoned and presented than the preceeding. Greater attention is paid to statistical problems. However, the present study improves on the statistical tools utilized. He decided to use ordinary least squares while acknowledging the superiority of other techniques. His rationale was the short period which he was analyzing.

> Methods especially adapted for estimating the parameters of [simultaneous] equations will not become an issue until (a) a larger number of observations become available and (b) there is reasonably good specification.[13]

Data covering a longer time period is currently available, making it possible to test and analyze the adequacy of the specification. Thus, while his argument made sense at the time he wrote, there is far less reason for not using two-stage least squares today.

Since he never made reference to the Durbin-Watson statistic or presented their values, the extent to which he found or responded to serial correlation is unknown. He seldom presented the various equation formulations that were possible nor the rationale for choosing one specific formulation. Lastly, he did not analyze specific data problems, indicate his sources, or explain how data definition changes were handled.

This work attempts to improve upon the methodology of these earlier studies, to correct some of the statistical errors made, to provide the reader with more information concerning the equations, and to test the entire model before using it to analyze the Development Plan. Its most significant differences are (1) improved statistical technique, (2) the analysis of structural change, and (3) model testing.

Footnotes to Chapter II

1. P. Clark: Development Planning in East Africa (East African Publishing House, Nairobi, Kenya, 1965, reprinted 1968); and H. Kirani: "A Projection Model for the Kenya Economy--Implications of the Kenya Development Plan 1966-1970," in East African Economic Review, vol. III, no. 1, June 1967.

2. J. Faaland and H.E. Dahl: The Economy of Kenya: An Econometric Study of Structural Relationships, 1956-1965 with Projections of Trade and Resource Gaps for 1970 and 1975 (The Chr. Michelson Institute, Bergen, July 1967). Delivered to UNCTAD, second session, New Delhi, India, date January 15, 1968, delivered on February 1, 1968.

3. Ibid., page 1.

4. J. Johnston: Econometric Methods (McGraw Hill Book Company, New York, second edition, 1972), page 206-207.

5. A. Goldberger: Econometric Theory (John Wiley & Sons, New York, 1964), Chapter Seven.

6. In a paper being completed a direct comparison of the results for a low-income country using ordinary least squares and two-stage least squares is made.

7. Faaland and Dahl, op. cit., VII, 3.

8. Ibid., VII, 2.

9. Ibid., I, 6.

10. This point is proven in E. Malinvaud: Statistical Methods of Econometrics (Rand McNally and Company, Chicago, 1966), pages 420-425.

11. Faaland and Dahl, op. cit., equation VB7 is accepted while the hypothesis of negative serial correlation is neither proved nor disproved (in the questionable range); equations VB9 and VB13 are both accepted even though there is very strong negative serial correlation.

12. A. DePrince: An Econometric Model of Kenya, 1965-1961 (unpublished thesis, the University of Michigan, Ann Arbor, Michigan, 1965).

13. Ibid., page 15.

III

STATISTICAL METHODOLOGY

One major problem related to the use of least squares in regression analysis concerns the problem of identification. This was discussed by D. Suits:

> A ... serious problem lies in the fact that, over the same period, the entire ... economy was characterized by a rapid and well sustained rate of growth. The result is intercorrelation among the various time series that is even more severe than is usually the case. Indeed, the problem is so serious in some instances that statistical formulations based on widely different theoretical explanations of behavior differ insignificantly in their results.[1]

In development studies this brings up two basic problems. The first concerns specifications. In a development program one of the important questions concerns how the various sectors are affected by proposed policy changes. Thus, correct specification becomes exceptionally important. The other problem concerns the statistical technique to be used. Since so many of the variables are highly correlated with each others, due to their growth orientation, one possible solution is to wait for more information. However, while more data will almost always allow for a better specified model, this is not a solution which will allow the useful information that is possible from regression analysis to be used now. Others suggest the use of first differences, consciously leading or lagging variables, etc. If such leading/lagging is justified theoretically then there is no complaint against it.

However, it then should have been used in the first place. It is wiser to be sure initially of correct specification and of the possible theoretical implications of a specific formulation. While this does not rule out the possibility of a different interpretation of the equation, it does mean, if the coefficients are justifiable, that the chance of improper specification is lessened. If when two independent variables are combined, one of the terms changes its sign, then we must make every effort to explain why this occurred. If no plausible explanation is possible of why the shift occurred, then the Suits argument can be brought in.

In simultaneous equation models, such as the proposed one, there is a problem of correlation of the error term and the independent variable.

> The disturbance term and the explanatory variable in the consumption equation are ... correlated, and ... the direct application of least squares ... will not yield unbiased estimates ....[2]

Some models[3] are created with the use of ordinary least squares after the researcher makes the assumption that the preceeding problem is not severe. Others say:

> Least squares methods were used to estimate the equations since past experience with such models has indicated that the additional improvement due to using less biased statistical techniques is less than the extra computational burden.[4]

In fact, the method of instrumental variables involves relatively little computational burden and if the instrumental variables are carefully chosen, the method yields unbiased, consistent and statistically testable results for relatively small samples. The statistical burden is lessened due to computer problems that allow easy specification of the instruments and technique. For almost all of the statistical work the Bank of Canada's Massager 70 program was used.

Since the process of choosing the instruments is of vital importance, we followed the suggestions of Wonnacott and Wonnacott.[5] These suggestions go further than needed but do provide an additional margin of security.

In any low-income country there is a problem of data accuracy. This problem is explored in greater detail later. Here we are assuming that the most recent data is the most accurate, and that there are greater errors in the older variable observations. We solve this problem in the manner suggested by Wonnacott and Wonnacott.

> The underlying philosophy [of weighted least squares] is simple enough. A greater error occurs in [some of] the observations ... thus these observations give a less precise indication of where the true regression line lies. Therefore, it is reasonable to pay less attention to them than to the more precise observations.... WLS provides a means of fitting a line by deflating the influence of the less precise observations.[6]

Given this function for the weighting scheme, it must have certain characteristics. Since Kenyan independence, all the weights must indicate an increase in accuracy and consistency, with the rate of change of the changing accuracy decreasing. This is reflected in the change to U.N. definitions of the statistics, thus improving the consistency. With that change completed, it is hard to continue to improve further (i.e., after achieving the correct definition of the variable, there is little further that can be done on that count). Since data collection techniques are still improving, we would like to have some improvement reflected in the coming years as the statistical office learns more of the interrelationships and the methodology of data collection. Learning behavior combined with the increasing budget and personnel makes a third order weighting scheme justified. This would indicate that the initial changes in office size and budget were not significant with respect to accuracy, but were significant with respect to learning about data collection, its meaning and methodology. In the middle years the changes were greater as they further learned their skill and could apply it. The changes in accuracy began to lessen (the second derivative turned negative) as the office began to near maximum possible efficiency asympotically. Thus, both early and late in the sample period the changes in accuracy are minor, but positive, leading to greater accuracy in the latter period.

The graph on the next page provides the weights as derived from the following formula:

$$Y = -0.00148(X^3) + 0.015387(X) + 0.64500$$

A prime limitation of a model for a low-income country concerns the very nature of the development effort. Most development plans indicate that there is a lack of satisfaction with the present state of the economy, at least on the part of some of the influential members of the society. Development becomes a process whereby the existing institutions, stimuli, reactive processes and signalling devices are changed. This is the meaning of structural change to Chenery and Robinson.[7] The assumption is that during the development process some values, such as the marginal efficiency of capital, the marginal propensity to save, the value of the marginal product of labor all must change, as will the redistribution of labor from agriculture to industry. In terms of an econometric model this means that some of the coefficients must either be changing their value, or that the entire equation will no longer hold, i.e., the dependent variable is now reacting to an entirely different set of independent variables. As more data becomes available, this time-consistency of the coefficients can be tested.

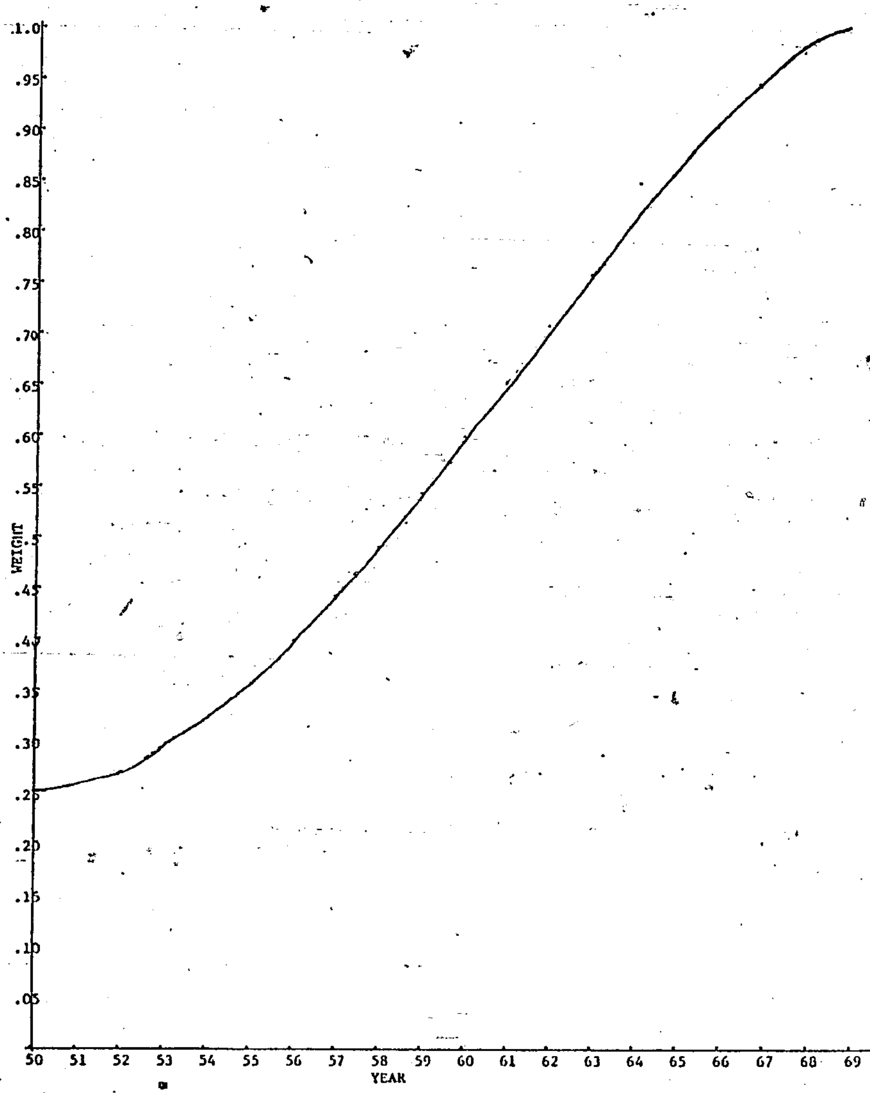
Using the sample period, a test for whether or not there has been a structural change in coefficient value can be made by following the method explained by Johnston.[8] The simpler Chou test is not possible due to the use of instrumental estimates. The technique discussed by Johnston involves using dummy variables that have a value of zero before the time of the presumed structural change and a value of one after it. Thus, in a simple case:

$$Y = a_1 + b_1 X$$

To test for structural change, the form alters to:

$$Y = a_1 + a_2 D + b_1 X + b_2 XD$$

where D is the column vector as already explained. A t-test is constructed to see whether a_2 and/or b_2 are statistically different


WEIGHT
1.0
.95
.90
.85
.80
.75
.70
.65
.60
.55
.5
.45
.40
.35
.30
.25
.20
.15
.10
.05
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69
YEAR

from zero. If they are, then the a's or b's are combined to form the value for the structurally changed coefficient. If only one is significantly changed, say b_2, then the equation is rerun thusly:

$$Y = a_1 + b_1X + b_2XD$$

If neither a_2 nor b_2 are statistically significant, then utilization of the original equation must be made. The hypothesis that there has not been structural change is not proven. Our only conclusion is that this method did not show any structural change.

If the Durbin-Watson statistic was such that the hypothesis of no positive or negative serial correlation could not be accepted, then the technique of generalized differences following the method outlined by Cochrane and Orcutt was utilized.[9]

Problems of multi-collinearity are bound to arise in models of low-income countries.

> Measures of independence within [the independent variables] ... beginning with the approximate Chi square transformation for the matrix of correlation coefficients over the entire set ... [will] quickly alert one ... to the existence of substantial multicollinearity.[10]

Those variables that are stable in their interrelationships can be spotted by high partial t_{ij}'s associated with high r_{ij}'s. The method of correction depends on the importance of the multicollinear variables to the model. One of the variables can be dropped, further information sought, exogenous coefficient estimation from other sources performed, or personal knowledge of the problem can be applied directly to the equation.

In summation, the methodology is one of weighted instrumental estimates, using covariance analysis to analyze structural change, generalized differences to correct for serial correlation and Chi-squares to check for multi-collinearity.

Footnotes to Chapter III

1. D. Suits: An Econometric Model of the Greek Economy (Center of Economic Research, Research Monograph #7, Athens, Greece, 1964), page 20.

2. J. Johnston: Econometric Methods (McGraw Hill, New York, 1963), page 233.

3. See, for example, T. Fukuchi: "An Econometric Model of the Indonesian Economy," in The Developing Economies, September 1968 (He presents a number of possible models of this economy.)

4. I. Adelman and Kim Mahn Je: "An Econometric Model of the Korean Economy (1959-1966)," paper delivered at Korean Conference, sponsored by the Council for Intersectoral Studies, Northwestern University, June 19-21, 1968, page 5.

5. R.J. Wonnacott and T.H. Wonnacott: Econometrics (John Wiley and Sons, New York, 1970), page 160.

6. Ibid., page 133.

7. Chenery, "Growth and Structural Change," in Finance and Development, #3, 1971, pages 16-27; B. Sherman Robinson: "Sources of Growth in Less Developed Countries," in Quarterly Journal of Economics, August 1971, pages 391-408; A.C. Kelley, J.G. Williamson, and R.J. Cheetham: Dualistic Economic Development (University of Chicago Press, Chicago, Illinois, 1972), Chapter One and Part 3.3.3 (pages 77-78). Other sources of information on this problem are: C.W. Reynolds: The Mexican Economy (Yale University Press, New Haven, Connecticut, 1970), Chapter Two; A.E. Haven and W.L. Flinn: Internal Colonialism and Structural Change in Colombia (Praeger, New York, 1970), Chapters Two and Fourteen.

8. Johnston, second edition, pages 192-206.

9. In "Application of Least Squares Regression to Relationships Containing Auto-Correlated Error Terms," in Journal of the American Statistical Association, March 1949, pages 749-809.

10. D.E. Farrer and R.R. Glauber: "Multicollinearity in Regression Analysis: The Problem Revisited," in Review of Economics and Statistics, February 1967.

IV

THE MODEL

In this chapter the model before adjustments due to structural change is presented. Some of the alternative formulations of each equation are presented in Appendix A.

1. $\log (Q_1/L_1) = -0.128 + 0.015(We) + 1.015 (\log [K_1/L_1])$

2. $\log (Q_2) = -1.810 + 0.897 (\log [K_2]) + 0.654 (\log [L_2])$

3. $Cons = 13.94 + 0.623(DY) + 0.560(BD)$

4. $Iag = -3.981 + 0.165(C_1)$

5. $Inag = 1.520 + 0.775(X23) + 0.721(GI)$

6. $GC = -14.649 + 0.252(YPL) + 0.033(DPOP)$

7. $GI = 21.514 - 0.259(YPL) + 1.384(T)$

8. $TD = -31.863 + 0.051(NI) + 173.439(RGL)$

9. $TIM = -4.735 + 0.047(GDP)$

10. $TM1 = 0.542 + 0.152(MW1) + 5.381(RG)$

11. $TM2 = -3.810 + 0.634(MW2)$

12. $TM3 = -4.453 + 0.207(MW3)$

13. $XM = GDP + TI - Cons - Iag - Inag - GC - GI$

14. $D = T - GC - GI$

DEFINITIONS

BD = total deposits in commercial banks

C_1 = domestic production of agricultural products less non-East African exports of agricultural products

Cons = private consumption

D = government deficit

DPOP = change in total Kenya population

DY = gorss domestic product less direct taxes

GDP = gross domestic product, factor prices

GC = government consumption

GI = government investment

Iag = agricultural investment

Inag = non-agricultural private investment

K_1 = agricultural capital stock

K_2 = non-agricultural capital stock

L_1 = agricultural labor force

L_2 = non-agricultural labor force

MW1 = non-East African imports of SITC 0-1 commodities

MW2 = non-East African imports of SITC 2-4 commodities

MW3 = non-East African imports of SITC 5-8 commodities

NI = gross domestic product less capital consumption allowance

Q_1 = agricultural output (includes non-monetary output)

Q_2 = non-agricultural output

RG = total government spending divided by gross domestic product

RGL = total government spending divided by gross domestic product, lagged one year

T = total tax collections

TD = total government direct taxes (includes export and personal taxes)

TI = total indirect taxes

TIM = non-import indirect tax collections (includes import tariff on SITC 9 commodities)

TM1 = import tariff collections on SITC 0-1 commodities

TM2 = import tariff collections on SITC 2-4 commodities

TM3 = import tariff collections on SITC 5-8 commodities

We = dummy variable, weather conditions

XM = export surplus, gross domestic product account

YP = private sector income

YPL = private sector income, lagged one year

Equations 2, 4, and 5 are reported in their transformed versions after performing generalized differences. The Durbin-Watson's for these equations prior to generalized differences were 0.829, 0.783 and 1.182. By the Henshaw procedure[1] all were clearly in the range where the hypothesis of non-autocorrelation must be rejected in favor of the positive autocorrelation hypothesis. After generalized differences the respective Durbin-Watson's were: 2.492, 1.673 and 1.776. All are sufficiently close to 2.000 so that the hypothesis of non-autocorrelation can not be rejected.[2]

In the first two equations the relatively standard Cobb-Douglas production function is used. This form has been used successfully in a number of different countries. There are many complaints against it. Some have found that it will provide statistically sound results with almost any form of data, even nonsense data.[3]

Others disagree with some of its basic assumptions.[4] Still others make the point that the Cobb-Douglas emphasizes that while an important source of growth is the increase in the capital stock, a possibly more potent source of growth is the improved utilization of existing capital stock; that is, not increasing the value of the variable, but changing the value of the coefficient on that variable.[5]

> Although it has worked well in most applications, the issue is not yet settled whether the Cobb-Douglas function, which has a unitary elasticity of substitution between factors, is a satisfactory representation of the aggregate production function. A variety of studies using both cross-sectional and time series data have tried to measure the elasticity of substitution between labor and capital, with confusing results. Cross-sectional studies typically measure this elasticity at about one or higher, whereas time-series studies find it to be less than 0.5. Moreover, the results vary erratically with minor changes in the data and in the specification of the estimating equations. Research aimed at clearing up these problems is still proceeding actively.[6]

If the traditional form of the Cobb-Douglas is used in the agricultural production function (Equation A5 in Appendix A) then in 1969 the elasticity of substitution was 0.378. For equation 2 the elasticity of substitution was 0.923. Thus, at least for the agricultural production function, the results support those discussed above.

One major element that will effect agricultural output is the weather. In order to measure this, a dummy variable was constructed which had a value of minus one if there was particularly bad crop weather for that year, zero if there was average weather and plus one if the weather was particularly good. Rainfall and average temperature figures as reported by the Nakuru station were used. This variable had a positive coefficient that was significantly different from zero. The effect of the weather on the output is undoubtedly higher than the coefficient indicates. However, there is a problem in that the measurement of weather conditions variable is too crude to allow for a sufficient range in values and, accordingly greater differentiation in conditions.

In equation 1 the marginal productivity of capital equaled $1.015(Q_1/K_1)$ and the elasticity of agricultural production with respect to agricultural capital stock is 1.015. So long as the assumption of constant returns to scale is not violated this constant elasticity will hold. If the marginal productivity of agricultural capital from 1950 to 1969 is computed, then over the entire time period the M.P.K. has increased slightly (0.719 to 0.741). As expected, just after the Lancaster House Conference the MPK_1 decreased substantially, but then recovered. There was another significant decrease just after independence, with again a quick recovery in the figures. These results would indicate the fears felt by the Europeans concerning the impact of independence on their role in the economy were not realized. The MPK_1 quickly returned to its "normal" level.

For equation 2 the marginal productivity of capital in non-agricultural production is $0.897(Q_2/K_2)$ and the elasticity is 0.897. As with agricultural production, there has been a slight increase over the time period covered in the value of the MPK (from 0.424 to 0.446), with a decrease in 1967 and steady increases since then. With respect to the effect of the Lancaster House Conference, the MPK_2 dropped for the next two years (from 0.377 to 0.373 to 0.364) before increasing again. The effect of actual independence was to stop this increase, but not to result in a decrease, i.e., the MPK_2 remained at 0.406. From this it is possible to tentatively conclude that the fears of independence were more prevalent among farmers than non-farmers. This could be due to the fear that independence meant land reform.

The negative exponent on the labor variable in agricultural production is a partial proof of the thesis of disguised unemployment of labor in agriculture. Due to the extreme aggregative quality of the data and its formulation there is no definitive conclusion that can be drawn, however.

Combining the MPK's and the MPL's, we find that it would increase output to switch capital to agriculture and workers to industry. This is based on behavior using past data, but does not mean that investments that could be made now would achieve the same results indicated by our coefficients.

CONSUMPTION

Faaland and Dahl regress private consumption against gross domestic product measured at market prices. In a footnote they state

> We have also run a regression between consumption and disposable income. Although this may be a more plausible relationship on *a priori* grounds, the indicators of statistical

> significance of the correlations are about equal. For reasons of convenience we shall therefore only make use of the structural relations in which GDP rather than disposable income enters as explanatory variable.[7]

This rationale appears weak. If something makes more theoretical sense and, based on their knowledge of Kenya, is more plausible, and the statistical results are as good, it appears that there is a good case for the use of the disposable income. They do not provide the regression results.

DePrince[8] included private with public consumption and ran it against gross domestic product without subsistence imputations. His derived marginal propensity to consume was 1.0190. Not liking this result, he included a dummy variable to indicate the change from colonial to independent status causing the MPC out of non-subsistence gross domestic product to drop to 0.9293. He did not show that the change in the value was statistically significant. Furthermore, although he stated that it would be better to use disposable income, he failed to explain why he did not use it.

The results in equation 3 combine the impact on consumption expenditures of income changes and liquid asset holdings (bank deposits). The latter was included in the formulation for its impact on a major portion of consumption, and the possible structural change in this coefficient due to either the Lancaster House Conference or the full granting of independence. The elasticity with respect to bank deposits was in 1969 0.179. In 1950 the figures was 0.199. However, the drop had not been steady.

In 1960 the elasticity was 0.140. The BD/Cons ratio dropped very precipitously in the years just prior to 1960, probably due to the outflow of capital with the fear of the coming independence. Since independence, the ratio has been rising as investments have returned and the people holding large accounts have found that there is less reason to fear the actions of the Kenyatta government than was originally expected.

AGRICULTURAL INVESTMENT

The United Nations assumes that foreign exchange generated exports are a prime constraint on development.

> If their terms of trade could be improved by ten per cent ... [and] underdeveloped countries were also enabled to improve their present share of total world trade ... the foreign exchange requirements for accelerated rate of growth would be covered....[9]

Faaland and Dahl[10] use simply gross domestic product and assume a linear relationship. Adelman and Kim[11] assume agricultural investment depends upon the change in value added in agriculture lagged two years and government real investment expenditures. Yamashita[12] uses gross domestic product and the net inflow of foreign capital. Fukuchi[13] uses imports of investment goods, imports of raw materials and foreign currency holdings. These models have had many problems achieving good data fits.

One problem is calculating the exact way that these determinates effect agricultural investment, i.e., the extent or the existence of lags. The problem is compounded since, no matter what aggregative measure is used, crops which are marketed early in the year are combined with some marketed late in the year.

In this study variables that would reflect either the supply of funds for investment or the demand for the output were sought. Most of the variables reflect both of these factors to some extent. Of the variables tried, consumption of agricultural products (domestically produced) and exports of agricultural products yielded the best results. Due to a very high multicollinearity, they could not operate together in an equation without both coefficients becoming either insignificant or difficult to explain (see equations D6 and D3 respectively in Appendix A). Consumption of domestically produced agricultural products was used since it tended to be stabler over time and yielded better predictions of the latter years that were internal to the data. The equation had definite serial correlation which we subsequently purged in order to get equation 4. The explanation for serial correlation could be the effect of other variables on agricultural investment. If agricultural investment were overestimated one year due to the effect of these other values being higher than expected, then there is a good chance that this parameter will continue to have an impact the following year with its impact gradually receding.

NON-AGRICULTURAL INVESTMENT

Aside from the formulations that were mentioned in the preceeding section, there were some additional formulations attempted here. ECAFE[14] broke this portion of investment into two sections. The first dealt with investment in mining and the second with manufacturing. For mining they used lagged foreign exchange reserves and the change in output in mining unlagged. For manufacturing they used the level of government investment and the level of investment in mining. Here they are assuming a partial accelerator model for mining. For manufacturing, they assume that the government creates the profitable opportunities that will get the private sector to make matching type investments. If the government invests in new plants and equipment, this will call forth from the private sector investments in those industries that service the building trades. The formulations that they use are very demand oriented, rather than assuming supply constraints, such as foreign exchange. Thorbecke and Condos preferred an investment function that included lagged exports and a variable that measured the price terms of trade, a supply constraint oriented model.[15] Lagged exports will give an idea as to the availability of foreign exchange with the assumption being that most of the investments need to be imported. Their terms-of-trade term will assist in analyzing the problems that could develop if import prices are increasing faster than the increase in exports.

Adelman and Kim[16] combined the approaches mentioned already by including lagged value added in mining and manufacturing (lagged two years) with the sum of the supply of money, time deposits and government non-consumption expenditures. The last set of terms was used to indicate the availability of funds for investment. The capital stock was included to round out their accelerator model.

Faaland and Dahl did not estimate via regression analysis an investment function; rather, they assumed a relationship. DePrince[17] used a flexible capital stock adjustment function where

$$Inag = g(K_t^* - K_{t-1})$$

Here K_t^* is the desired level of the capital stock and is assumed to bear some relationship to actual GDP. The results achieved here with this model were not statistically significant, nor theoretically justifiable. DePrince does not report the t-values in this case as he does for other equations. The reason could very well be that the results would show that there is too great a variance in the coefficients.

Clark[18] dealt with an accelerator model using urban income (gross domestic product originating in government, manufacturing services and transport).

Of these possible formulations the only one that worked well in the case of Kenya with the data available was the one suggested by the ECAFE. Here we assume that there is a constraint that is imposed by the availability of foreign exchange and further that there is a demand generated by government investment on private non-agricultural investment.

The existence of positive serial correlation can be explained much the same as in the last section; i.e., there are other variables that effect non-agricultural investment, and if they were unusually important one year, some of the impact carried over to the following year(s).

PUBLIC CONSUMPTION

These expenditures, while formally classified as consumption expenditures, do have an important investment component. They are important investments in human capital and should lead to an improved utilization of existing capital. The Kenya government's definition of investment expenditures were used and then subtracted from the total government contribution to gross domestic product to arrive at government non-investment (consumption) expenditures.

Most of the studies of low-income countries do not separate government expenditures into two categories. They treat total government contribution to GDP as one category and try to estimate it. Yamashita did just this.[19] He felt that the determinates of government expenditures were (1) gross domestic product, (2) last year's government expenditures and (3) total population, the rationale being that there is a growth rate in government spending that the lagged figure would capture. As the economy expands, there will be a need for government expenditures to expand regardless of whether there is any population growth or change in the past growth rate of government spending.

Fukuchi[20] separates government spending into non-military current expenditure and military expenditure. The latter he treats as exogenous and the former as being determined by last year's revenue. He disaggregates non-military current expenditure into consumption and investment portions. Government investment expenditures are an exogenous variable depending on non-controllable items such as the receipts of foreign loans and grants.

For Thorbecke and Condos[21] government consumption expenditures depend on the level of tax receipts that year. They argue that the government is able to keep reasonable track of its receipts and can adjust expenditures accordingly. An alternative hypothesis would be that the budget is promulgated after the government has attempted to match expenditures with receipts.

Adelman and Kim[22] look at the problem in much the same way as Thorbecke and Condos. This author was surprised to find that in their study the coefficient of the tax term was only 0.285, thus indicating a very low elasticity. This is contrary to expectations that it will be very close to unity. They do not explain their result. One possible explanation could be that expenditures by the government are fixed in amount and thus respond only slightly to changes in the ability to provide more.

For East Africa the results are less encouraging. DePrince[23] treats government consumption expenditures as exogenous. Faaland and Dahl[24] treat it as determined by unlagged tax collections. They end up with an elasticity of just slightly over one. This would indicate that there is pressure on the government to expand its provision of goods and services. Clark[25] treats all government spending as exogenous.

Using some of the other formulations of this equation (reported in Appendix A) we find that in 1950 the tax elasticity was 1.285. In 1960 it had dropped to 0.917, by 1965 it was 0.967, in 1966 it was 1.068, then 1.024 and finally 1.015. If this continues, it would indicate that more of the increasing tax funds will be diverted to government investment expenditures.

There has been a steady decline in the income elasticity from a high of 2.744 in 1950 to 1.532 in 1960 and presently a 1.229. Eleven low-income countries had a higher elasticity and thirteen a lower income elasticity than Kenya.[26] Kenya's present income elasticity is lower than the results for any of the African countries reported. Even if the elasticity is computed for the same year as the ones reported for each of the African countries, the Kenya income elasticity is still lower, albeit by not as much. This would indicate that the Kenya government responds less to the changing needs as reflected by income than do other African countries, but about as much as the other non-African low-income countries. There are many problems in dealing with "average" per capita income figures to explain this result, thus the fact that Kenya is "poorer" can not be adequately used. Lacking figures on the change in the income elasticity of these other countries, comparisons of the decreases noted for Kenya with theirs cannot be made.

Equation 6 accepts the ideas put forward by Meier and the World Bank

> The rapid increase in school age population and the expanding number of labor force entrants put ever-greater pressure on educational and training facilities and retard improvement in the quality of education.[27]

Further, it assumes that the government is subject to pressures as discussed by Yamashita earlier in this section. This formulation accepts the hypothesis that the meeting of current needs as reflected in government consumption is more important to the Kenya government than is the meeting of investment needs. Accordingly, if the pressure for more government services increases, these will be met and government investment will lag. This is partly shown by Clark.[28] He indicates that increases in tax revenue were quickly applied to government current expenditures. This would indicate pressure on tax revenue. This pressure comes from the increasing population and the changing incomes of the people. However, as with other hypotheses of this sort, more definite conclusions will have to wait until more data becomes available.

PUBLIC INVESTMENT

In a developed country a demand orientation to government investment is usually assumed. It is related to the demands for certain services. This is not the usual causality in low-income countries. The government will spend whatever is its income, with government investment having a lower priority than government consumption expenditures. The government fills its consumption needs from existing revenue with excess funds going into government investment.[29]

Many of the models we have seen of low-income countries emphasize the demand side of the model. Adelman and Kim[30] assume the determinates of gross fixed investment in social overhead are the size of the capital stock in the government sector (lagged three years), gross domestic product (lagged two years) and the level of government non-consumption expenditures. Their coefficient on the three year lagged capital stock variable is negative and the coefficient with government non-consumption expenditures is highly insignificant. They do not explain the possible implications of these.

Some models use gross taxes as the major explanator, with occasionally a demand oriented variable such as population size or income. Others assume that government investment is exogenously determined,[31] or they do not differentiate government investment from government consumption expenditures.

Kenyan government investment has been becoming less responsive to tax collection changes since 1965, with the exception of 1969. Thus, it is possible that 1969 was either a turning point or an erratic observation. Since government investment has been becoming less responsive to changes in private sector income, again except for 1969, possible conclusions are that (1) the pressures on government consumption have been dropping, a conclusion in keeping with the results in the last section, or (2) taxation is becoming a less significant source of government investment funds, as grants-in-aid, foreign loans and marketing boards increase in importance. A 10% increase in income brings forth a 14.1% increase in total tax collections presently. Multiplying these times their current levels and then times the equation coefficients will yield a 15.4% increase in government investment.

TAXES

The basic problem with all of the tax equations is to first determine the proper base for that tax[33] and then determine whether or not there are any exogenous factors that might explain changes in the rate structure. For direct taxes Clark's[34] approach cannot be used since he took GDP at factor cost and subtracted all government revenue, i.e., direct taxes, export taxes, customs duties and indirect taxes. Since GDP at factor cost did not include indirect taxes, it makes little sense to subtract it to achieve the proper base. Had he used GDP at market prices, then the need to subtract indirect taxes would have been more consistent.

Due to the frequently changing rate structures, it was difficult to achieve the same quality fits as we had in earlier equations. Attempts to explain the cause of these shifts in rates, i.e., balance of payments deficits, deficits on government current account or government spending as a percentage of GDP, were at best marginally successful. One problem with this approach is that in different years different taxes are utilized by the government to meet its special needs or to fill its shortfalls. Direct taxes and agricultural import tariff collections tend to be more responsive to these needs than other taxes.

EXPORT SURPLUS AND GOVERNMENT DEFICIT

These two equations are balancers and are determined as identities.

Footnotes to Chapter IV

1. R.C. Henshaw: "Testing Single Equation Least Squares Regression Models for Autocorrelated Disturbances," in Econometrica, July 1966, pages 646-660.

2. The phrasing is deliberate and comes from J. Johnston: Econometric Methods, second edition, page 252.

3. A. Shaikh in a lecture at the University of Michigan, April 1972 presented such information.

4. For example, K. Arrow, H. Chenery, B. Minhas and R. Solow: "Capital Labor Substitution and Economic Efficiency," in Review of Economics and Statistics, August 1961, pages 225-250.

5. M. Kalecki: "Theories of Growth" in Monthly Review, October 1971. Much the same point is brought out by A. Cairncross: Factors in Economic Development (George Allen and Unwin, London, 1962).

6. M. Bailey: National Income and the Price Level (2nd edition, 1971), page 131.

7. Faaland and Dahl: op. cit., VII, 2, footnote.

8. DePrince: op. cit., pages 19-22.

9. United Nations, Department of Economics and Social Affairs: The United Nations Development Decade, Proposals for Action (report of the Secretary-General, New York, 1962), also in G.M. Meier (ed.): Leading Issues in Economic Development (Oxford University Press, 2nd edition, 1970), page 33.

10. Faaland and Dahl: op. cit., VI.4 and VI.5.

11. Adelman and Kim: op. cit., page 14.

12. S. Yamashita: "Macroeconomic Effects of Foreign Aid" in The Developing Economies, September 1968.

13. T. Fukuchi: op. cit.

14. Ibid.

15. E. Thorbecke and A. Condos: "Macro Economic Growth and Development Models of the Peruvian Economy," in I. Adelman and E. Thorbecke (eds.): The Theory and Design of Economic Development (Johns Hopkins University Press, Baltimore, Maryland, 1966).

16. Adelman and Kim: op. cit., pages 15-16.

17. DePrince: op. cit., pages 24-26.

18. Clark: op. cit., pages 75-76.

19. Yamashita: op. cit.

20. Fukuchi: op. cit.

21. Thorbeck and Condos: op. cit.

22. Adelman and Kim: op. cit.

23. DePrince: op. cit.

24. Faaland and Dahl: op. cit.

25. Clark: op. cit.

26. The UNCTAD Secretariat: "The Mobilization of Internal Resources by Developing Countries," TD/7/Supp. 2, September 15, 1967, as reprinted in Meier (ed.): op. cit., pages 200-204.

27. The quote is from G. Meier: "Population and Poverty -- Note" from Meier (ed.): op. cit., page 590. The World Bank talks of this effect frequently in their publication: Population Planning Sector Working Paper (Washington, D.C.: March 1972).

28. Clark: op. cit., page 20.

29. United Nations, Technical Assistance Administration: Taxes and Fiscal Policy in Under-Developed Countries (St/TAA/M/8, United Nations, New York), page 6 (first part of this work was written by Professor Walter Heller of the University of Minnesota), and J.H. Adler: "What Have we Learned" in Meier (ed.): op. cit., page 52. Originally published as "What Have We Learned About Development?" in The Fund and Bank Review: Finance and Development, Vol. III, No. 3 September 1966.

30. Adelman and Kim: op. cit., pages 16-17.

31. As an example see N. Islam: A Short Term Model for Pakistan Economy (Oxford University Press, Lahore, Karachi and Dacca, Pakistan: 1965).

32. As an example see M.K. Evans: "An Econometric Model of the Israeli Economy, 1952-1965," in Econometrica, September 1970, pages 624-660.

33. Board of Inland Revenue: Income Taxes Outside the United Kingdom, Volume Two, Cameroums to Ellice Island (Her Majesty's Stationery Office, 1967, London), pages 312-323.

34. Clark: op. cit., page 76.

V

STRUCTURAL CHANGE

In order to test for structural change we use the method put forward by Johnston.[1] Thus, the type of structural change being measured is narrow. It is limited to testing whether or not the coefficient on each term and/or the constant term underwent a shift in their values. If only the constant term underwent a shift, then we are showing a parallel shift in the entire line. If the constant term did not shift, then we are showing a rotation of the line. The direction of the rotation depends on whether or not the coefficient increased or decreased in value.

There were two possible time during which there might have been a major shift in the value of these coefficients. The first was in 1960 due to the impact of the Lancaster House Conference when it was acknowledged that Kenya would eventually be a free and independent country; the second was in 1964 when that independence finally became a reality (actually independence came on December 12, 1963, but 1964 was the first full year that the impact could be felt and thus effect the value of the coefficients).

Accordingly, we took the equations set forth at the beginning of the preceeding chapter and, using dummy variables, tested for (1) structural change in 1960 only, (2) structural change in 1964 only and (3) structural change in 1964 given the structural change in 1960. The third was to be used only if the first two both showed that there was a structural change. In this case, the third item would tell us whether the change in the value of the coefficients between 1960 and 1964 was also significant. If only (2) was acceptable and not (1) or (3), this would be an indication that the changes were gradual in nature, with the cumulative impact being significant but not the parts.

The results are shown in Appendix B.

Those equations that evidenced structural changes are:

1. $\log (Q_1/L_1) = -.1264 + .0174(we) + 1.007(\log [K_1/L_1])$

2. $\log (Q_2) = -1.661 + 1.022(\log [K_2]) + 0.466(\log [L_2])$

4. $Iag = -14.604 + 0.251(C_1)$

8. $TD = -17.780 + 0.099(NI) + 73.238(RGL)$

9. $TIM = -11.602 + 0.063(GDP)$

For definitions see pages twenty and twenty-one.

For none of the equations was the structural change in 1960 utilized. In a number of cases it was significant, but since the equations showed a structural change between 1960 and 1964, we utilized the latter instead.

AGRICULTURAL OUTPUT

The structural change noticed took place over two time periods, with the latter negating the former. From the full sample period analysis to the analysis with the dummy variables positive from 1960 on, it was found that there was a downward shift of the production function, an increased importance to the weather and a vastly increased importance to capital. But between 1960 and 1964 this reversed, so that the current coefficients are only slightly different from those shown in the last chapter. Overall, there is an upward shift of the function, an increased importance to the weather and a decreased importance to capital. These results are in keeping with the results we presented in the last chapter concerning the direction of change in the marginal product of capital.

There was a definite decrease in the marginal product in the late 1950's with some relatively steep increases in the period between 1960 and 1964 with gradual reductions since 1966. If these trends continue with the collection of more data, a test for structural change after 1964 would show a further decrease in the value of the log (K_1/L_1) coefficient. One possible explanation for the increase in the value of this term, using the dummy variables from 1960 on, would be the effect that the Lancaster House Conference had on the "mining" of capital, so as to get as much production as possible out of it before the feared government nationalization. The overall increase in the importance of the weather term could be explained by the increasing ability to take advantage of good climatic conditions.

NON-AGRICULTURAL OUTPUT

Being unable to show a clearly significant change in the value of the labor term's coefficient, only the other coefficients were tested for structural changes. The result was the equation shown earlier. There is a turn-around in the coefficient of the capital stock term and a steady decrease in the coefficient of the labor force term. Specifically, the capital stock term went from 0.897 to 1.042 to 1.022, and the labor force coefficient from 0.654 to 0.557 to 0.466. The latter change was not statistically significant. However, the change for the capital stock term was statistically significant, with the possible explanation being much the same as those just presented for the agricultural output, especially since the direction and the approximate size of the changes are the same. The only difference overall in the changes in the two equations is that the constant term (usually viewed here as representing disembodied technological progress) has not only statistically significant shifts, but also economically significant, i.e., the magnitudes are large and important. The implication is that there has been an improvement in the level of technical skills utilized by non-agricultural production since 1960. This could be an improved utilization of either both labor and capital or of one of these factors. The impact on labor could be due to the improved impact that more extensive schooling is having on the ability of the labor force to be productive. Overall, capital has become much more productive than it had been: thus, there is an assumption of some increase in the embodied technological progress. The decrease in the value of the labor term, while not statistically significant, could be explained by the impact of

Kenyanization on non-agricultural output. We do notice that the amount of the change in the coefficient is lessening; furthermore, if the new Kenyan workers learn the jobs, then we would expect that the coefficient will begin to increase.

AGRICULTURAL INVESTMENT

There was no significant shift at all for 1960 but a very definitively significant shift from 1960 to 1965. The nature of the shift was to greatly increase the reaction of agricultural investment to the consumption of domestically produced agricultural production. At the same time, there was a dramatic decrease in the intercept, i.e., the constant term. Due to land reform, farmers are producing more for the home market than the settlers were. While not uninterested in export production, they do not emphasize it as much as the former agricultural producers. Lack of statistical significance in the 1960 structural shift is explained by the need for formal independence before the impact of land reform was felt. It took that long for the Million Acres Redistribution Scheme to be begun and become operational.

DIRECT TAXES

As expected, there was an increase in the marginal effective rate of taxation due to the increase in income tax rates. Since the coefficient on the relative share of the government did not undergo any significant structural shift, we dropped the dummy variable's operation on that term in order to derive the equation presented earlier.

NON-IMPORT INDIRECT TAXES

Due to the expansion of the scope of the excise taxes and the increase in rates, we would expect a significant increase in the marginal effective tax rate.

> [For 1967] an increase in excise duties of nearly 50% is forecast, in spite of there being no significant increase in excise duty rate in the year except for the imposition of small excise taxes on soap and biscuits.[3]

> Excise duties have maintained a steady increase throughout 1963/64 and 1964/65 with rising consumption and in the case of cigarettes and tobacco, higher rates.[4]

> New excise taxes have been imposed [in 1969] to maintain revenue lost from declining imports following the growth of import substitution. This trend is likely to become more pronounced in the future years.[5]

The increase in the effective rate of taxation was 34.0%.

Another reason for the increase in the effective rate of taxation for the preceeding two equations is that both of them show very definite income elasticity. Thus, as income increases, the effective rate of taxation will also increase. None of the import tariffs showed this, largely because the import substitution worked against the income elasticity of these taxes so that the net impact was not significant.

IMPORT TARIFF COLLECTIONS SITC 5-8 COMMODITIES

Here we find that there is a decided drop in the effective rate of taxation, so that it would be, with structural change,

12. $TM3 = -.302 + 0.152(MW3)$

For definitions see pages twenty and twenty-one.

Here we find that there is a decided drop in the effective rate of tax collection, due to the impact of import substitution, which has reduced the amount of imports, combined with a government effort to allow those imports that are necessary to come in under reduced tariffs. If an item is taxed so substantially that imports fall to zero, then our regression cannot pick this up. It does not enter either the dependent or the independent variable.

Footnotes to Chapter V

1. J. Johnston: op. cit., pages 192-206.

2. See L. Schnittger: "Taxation and Tax Policy in East Africa," in P. Marlin (ed.): Financial Aspects of Development in East Africa (Ifo-Institute fur Wirtschaftsforschung, Afrika-Studienstelle, Weltforum Verlag, Munchen, Germany, 1970.

3. Republic of Kenya: Economic Survey, 1967 (Nairobi, 1967), page 101.

4. Republic of Kenya: Economic Survey, 1965 (Nairobi, 1965), page 63.

5. Republic of Kenya: Economic Survey, 1970 (Nairobi, 1970), page 155.

VI

THE FULL MODEL

(WITH STRUCTURALLY CHANGED COEFFICIENTS, WHERE JUSTIFIED)

1. $\log (Q_1/L_1) = -0.126 + 0.017(We) + 1.007 (\log[K_1/L_1]0$

2. $\log (Q_2) = -1.661 + 1.022 (\log[K_2]) + 0.466 (\log[L_2])$

3. Cons $= 13.94 + 0.623(DY) + 0.560(BD)$

4. Iag $= -14.604 + 0.251(C_1)$

5. Inag $= 1.520 + 0.775(X23) + 0.721(GI)$

6. GC $= -14.649 + 0.252(YPL) + 0.033(DPOP)$

7. GI $= 21.514 - 0.259(YP) + 1.384(T)$

8. TD $= -17.780 + 0.099(NI) + 73.238(RGL)$

9. TIM $= -11.602 + 0.063(GDP)$

10. TM1 $= 0.542 + 0.152(MW1) + 5.381(RG)$

11. TM2 $= -3.810 + 0.634(MW2)$

12. TM3 $= -0.302 + 0.152(MW3)$

13. XM $=$ GDP + TI - Cons - Iag - Inag - GC - GI

14. D $=$ T - GC - GI

DEFINITIONS

(See Chapter IV, pages 20-21).

VII

DATA ORIENTED PROBLEMS

All of the data for the model was gathered from official primary sources such as the Statistical Abstract, Economic Survey, Development Plan or the trade manuals put out by the Community or its predecessors. Some additional information came from official publications of Tanzania or Uganda. A small number of figures was gathered from secondary sources, but only when they indicated that their source was one of the above mentioned primary sources and the original source was not available.

The early data is not nearly as accurate as the later data, in fact

> ... figures concerning ... magnitudes for the period before 1950 are only partially available, the most for Kenya.... Thus there are no estimates of Gross Domestic Product (GDP) for Kenya before 1947....[1]

It is for this reason that no older data was utilized in this study.

Concerning the overall accuracy of the data, Vente points out, "In the three East African countries, regarded as a whole, there are relatively good statistical data available for a number of important sectors."[2] Many other sources agree that the data for Kenya is significantly better than comparable data in other low-income countries.[3] However, the International Monetary Fund cautions "... available data should be interpreted with caution and only as indicating an order of magnitude."[4] Helleiner puts it this way

> These annual estimates, although undoubtedly subject to wide margins of error, provide valuable guides as to the rate of economic progress and, perhaps even more importantly, as to the changing structure of the economies.[5]

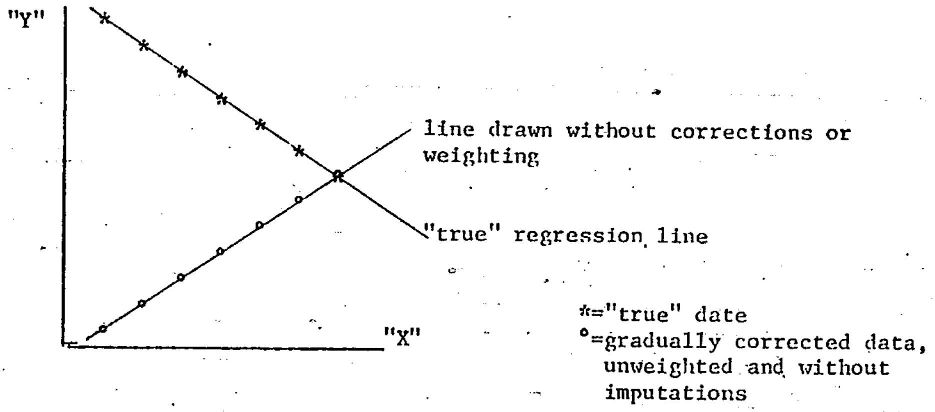
The Kenya government admits that there are shortages in the data, particularly in the fields of small scale agriculture, small scale industry, small scale commerce and the rural northern area. However, they note that work is in progress to estimate expenditures and spending patterns of consumers and business firms, as well as other data which the government now feels is needed for a more accurate economic plan. "Improvement on methodology and accuracy in the calculations of GDP have been made."[6] During the first plan additional data investigations were undertaken into the nature and value of certain key capital-output ratios and other needed data. Vente supports this by mentioning the improvement in coverage and quality and quantity of data collected and interpreted. In fact one set of data he mentions as being unavailable "comprehensive data ... for consumption, current government services and investment...." is now provided by the Statistics Office.

The data appears to be improving over time; and the reliance on it, whether justified or not, is increasing.

> [T]hese estimates <u>are</u> watched by those concerned with the overall progress of the economy and are treated seriously by both private and public policymakers.[8]

Thus, while the data is improving in coverage and accuracy, a number of problems remain for the researcher. Key variables change in the middle of a data sequence, or various definitions of the same concepts appear, even in the same Statistical Abstract, without any adequate explanation of the difference. Sometimes data with ostensibly the same definition changes in value from one page to the next. But these glaring problems are disappearing; and, for the most recent year, whenever there is a change in the definition or collection procedure used, there are also adjustments made for data reported over the past few years. This enables the researcher to make further imputations based on whether the changes are a constant, increasing or decreasing value or percentage change. Thus, many of the figures used in the regression analysis are closer to index numbers than the actual figures, since so many changes have had to be made in them in the interests of coverage consistency.

Were the changes not made, the problem presented below would be encountered. If only the raw gradually corrected data were used, then the slope of the "true" curve and the intercept would be incorrect. By adjusting the gradually corrected data to reflect the nature and form of data changes, and then by weighting the data so that the most recent observations have a greater weight, a better approximation of the "true" line can be achieved. Exactly how close the regression line is cannot be known due to ignorance of the "true" data. Estimates can be achieved by analyzing the forecasting ability.[9]



Deflation of money figures was not possible due to (1) the accuracy of the price deflators and (2) the lack of sufficient model disaggregation. In countries more inflation ridden than Kenya, deflation might be an absolute necessity. Harris and Todaro support the first item. "Neither output nor wages were deflated for price changes because of the lack of an adequate deflation."[10] Helleiner states "The real GDP estimates may ... be even less accurate than the money GDP estimates."[11] With respect to the second point the Kenya government statisticians believe

> ... such evidence as is available suggests that although a number of prices (of both outputs and inputs) have risen, others (mainly outputs) have fallen and the net effect of price changes over this period is probably small.[12]

While the reasoning is not impeccable, it does indicate that price data is insufficiently disaggregated at present and that there is not adequate interest on the part of the Statistics Office to do this job properly.

With some of the data there was a change in the early fifties from reporting it by the calender year to reporting by the fiscal year, or by the harvest year, and in some cases vice versa. This was handled in a rather arbitrary fashion. All fiscal year data were entered for computational purposes as if they corresponded to the earlier of the calender years covered by the fiscal year, the rationale being that this entailed the fewest number of errors in transcribing the data. And, in the absence of any consistent alternative, it was the only route available. Fortunately, this needed to be done for the earliest data only.

In some of the early years, data for a given year would be estimated only with no indication the following year of verification of this data. Thus, the pattern over a three year span might be to have the first year's data reported and verified, the second only estimated, with the third year's data estimated and then verified. All that was possible was to see that the estimate was in line with the verified figures. Whenever there were two estimates for a given year (as whenever there were two different reported figures), the newer data was utilized. It is recognized that even the verified data, or the "newer" data, still have significant elements of estimate about them.

In determining weather conditions, a number of problems developed. (1) There was a moving of the location of the reporting station within a given city. The Nakuru reporting station was used for the entire sample, but movements within the city did occur. However, this cannot be viewed as a major significance. (2) Data would not be reported for all months with no reason being given. In this case, it was assumed that the missing months were as much hotter or wetter than the months of the adjacent years for which data was available.

Population estimates are based on periodic censuses. For the years between these, the government has simply made an estimate of the probable population. However, when the new figures came in, the Statistics Office recomputed only the more recent years. This meant it was possible for one year the data be estimated using the old census only, while for the following year it would be estimated using both the old and the new censuses. The estimates were evened out in the interests of consistency and comparability. The data utilized includes all of the people in the country and not just Africans, Asians or Europeans. This variable was used in tax and government consumption expenditure equations where almost all of the people would be effected, especially in the most recent years. In addition, because this was to be one of the instrumental variables, to use only Europeans would be to establish a definite non-zero covariance between population and the error term. One additional problem remained: What if only the population figures were adjusted and not income, output, etc.? The data collectors might have found that they missed some people, but not have bothered to count other figures affected by these people.

Since capital stock figures were needed for the production functions, these had to be computed. Clark assumes that for Uganda the rate of retirement is about 7% of the new value per year.[13] This assumes a life span of just under 15 years. Rather than just accept this assumption as valid for Kenya other information was used to determine the retirement rate. This entailed a number of assumptions. (1) The marginal capital output ratios for 1950-1953 (after allowing for the "tested" retirement rate) equaled the average capital output ratio for 1950. (2) The marginal capital output ratios computed by the Kenya Ministry for Economic Planning for the years 1967-1969 are correct.

Different depreciation rates were used to determine net investment until one was found that would yield marginal capital output ratios approximately equal to those computed for 1967-1969. Using this methodology, the retirement rate for agricultural investment was 3% and for non-agricultural investment 4%.

The implications of this are that capital is in use for a longer period of time than Clark estimated for Uganda and is not discarded as fast; that there is much investment that is not counted and that there is more investment that is not counted in agricultural than in non-agricultural endeavors. Examples would be the inability to count domestically procreated animals or nurtured crops. Thus, the "true" retirement rate is higher than 4% or 3% for any particular piece of capital. However, there was more investment taking place than the data collectors could collect. Due to the stability of the results achieved, the assumption must be that the data collectors still fail to count much capital that significantly effects output. This retirement rate is an exogenous variable that can be changed in the model, if it is felt that for the coming years the "true" retirement rate will be some other, presumably higher, number.

Consumption data was not reported directly until the 1970 Statistical Abstract. Thus, for the years not reported by that volume, the subtraction by components method must be used to estimate this variable, leaving all of the residuals and items not elsewhere enumerated in the consumption figures. Most importantly, this includes changes in stocks, inventory valuation adjustment and subsidies. Accordingly, the consumption figures are overestimated. For the most recent years, this is not greater than 3.5%; but in the forecasting period, it ran as high as 5.4% in 1971. With more observations, consumption figures will be capable of analysis using only the improved data.

Footnotes for Chapter VII

1. R.E. Vente: Planning Processes: The East African Case (Ifo-Institut fur Wirtschaftforschung Munchen, Afrika-Studien 52; Welt-Forum verlag, Munchen, 1970), page 113.

2. Ibid., page 112.

3. See Economic Commission for Africa: "Economic Planning in Kenya" (Conference of African Planners, second session, Addis Ababa, December 4-15, 1967, E/CN.14/CAP.2/INF23), page 2. Faaland and Dahl, op. cit., and L. Reynolds: Three Worlds of Economics (Yale University Press, New Haven, Connecticut, 1971), page 99.

4. International Monetary Fund: Surveys of African Economies, Vol. II, Kenya, Tanzania, Uganda and Somalia (Washington, D.C., 1969), page 2.

5. G.K. Helleiner: "The Measurement of Aggregate Economic Performance in East Africa," in Eastern Africa Economic Review (June 1968), page 87.

6. Economic Commission for Africa, op. cit., page 2.

7. Vente: op. cit., page 114.

8. Helleiner: op. cit., page 87.

9. I am grateful to Professor P. Eckstein for bringing this to my attention.

10. J.R. Harris and M.P. Todaro: "Wages, Industrial Employment and Labour Productivity: The Kenyan Experience," in Eastern Africa Economic Review (June 1969), page 35.

11. Helleiner: op. cit., page 88.

12. Statistics Division, Ministry of Economic Planning and Development, Republic of Kenya: Economic Survey, 1967 (Nairobi, June 1967), page 4.

13. P.G. Clark: Development Planning in East Africa (East African Publishing House, Nairobi, 1965, reprinted 1968), page 82.

VIII

ECONOMETRIC PERFORMANCE

The first general question of importance in a model such as has just been presented is: How well does it operate? One way of showing how well it operates is to see how well it is able to forecast. If the model has the values of those variables that are fully exogenous added to it, then a comparison of the results that the model achieves with those that actually occurred can be made. However, due to some unusual changes in the economy, two imputations must be made first.

> [Part] ... of the increase [in direct tax collections] is explained by the change-over in tax collection procedures introduced in last year's budget [1969/1970] which attempted to eliminate the eighteen month time lag between earning and payment and to bring the entire income tax collection system onto a pay-as-you-earn basis. Thus growth in income tax revenue attributable to this factor is of a transitional nature although it will influence income tax receipts for the next four years.[1]

The non-explained increase in the direct tax collections was treated as a single year valued exogenous shock. They feel it will effect collections for the next four years, i.e., through 1975. A linear reduction in this shock each year was assumed.

> Non-capital expenditure increased by 15.3 per cent between 1968/1969 and 1969/1970 -- compared to an increase of 7.3 per cent between the two previous years.... [T]he main reason for this was the takeover of health, road and education services by the Central Government.[2]

The impact here is such that the total government contribution to gross domestic product did not change; but since the central government makes almost all of the capital investments, this major shift caused an increase in the proportion of the government's GDP contribution for consumption purposes to increase and that for investment purposes to decrease from what they would have been without the change. This should be a permanent change and not just a single year impact, unless the assumption is that the government will give these functions back to the local government and re-emphasize its capital formation role.

There were some other changes that the Ministry of Finance and Economic Planning considered important and significant. However, after analyzing the results and their causes, it appears that these were just normal responses to the stimuli being given.

The comparison of the model's forecast to the actual values for both 1970 and 1971 are presented on the next page. It must be pointed out that with each new Statistical Abstract or Economic Survey the planners go back over some of the earlier data and make changes in it. Thus, the Economic Survey, 1971 changed the non-import indirect taxes (but inclusive of SITC commodities) from K£ 16.98 million to K£ 18.34. The Economic Survey, 1972 further revised this figure to K£ 19.965 million. They both also revised some of the pre-1969 figures. Therefore, it is entirely possible that some of the "actual" figures for 1970 or 1971 might be changed as more information becomes available. Due to the changes

TABLE I

RATIOS OF ACTUAL TO FORECASTED VALUES USING THE STRUCTURALLY-CHANGED MODEL

Variable	Year 1970	Year 1971
TM1	1.092	1.137
TM2	0.962	0.945
TM3	0.972	1.046
TD	0.999	1.008
TIM	0.976	0.959
GC	1.008	1.007
GI	0.963	1.010
Iag	1.029	1.011
Inag	1.012	1.039
Cons	0.985	0.995
Q_1	1.009	1.003
Q_2	1.018	0.995
GDP	1.015	0.998
XM	0.440	1.081
D	1.015	1.021

in the values of some of the endogenous variables, the new figures were adjusted so that they would be more compatible with the older ones. Had weighted instrumental estimates on the years from 1950 to 1971 been performed, this would have been done automatically. The method was to see whether the changes in the earlier data were related to the original figures by an absolute amount change or a percentage change and then to find the direction of those changes. These changes were continued into the 1970 and 1971 period. When there were no discernable patterns, the growth rates in the new figures were assumed to equal the growth rates of the old figures. It should be noted that the only times that these imputations might have been significant, i.e., resulted in changing older figures by over 5%, would be for: (1) non-import indirect taxes (includes SITC 9 import tariffs) and (2) public consumption.

Following Johnston,[3] the standard error of the prediction is computed (see table following this page). For all of the equations and for both years all estimates are well within the confidence intervals set up by taking $\pm$ 1.96 (SEP) where SEP is the standard error of the prediction.

The ratio of the actual figures to the SEP can be viewed as a measure of the sureness of the equation fit. Using this method, the equations which show the greatest need for more work, since their error ratios are the greatest, are in order: (1) Non-import indirect taxes (includes import tariffs on SITC-9 commodities);

TABLE II

STANDARD ERROR OF THE PREDICTION
(in millions of Pounds)

Variable	Year 1970	Year 1971
TM1	0.2005	0.3181
TM2	0.7935	1.0252
TM3	1.0568	1.5011
TD	1.3804	1.8302
TIM	2.6310	3.1933
GC	4.5685	5.3812
GI	3.0848	4.5786
Iag	1.3775	1.1297
Inag	4.9194	7.3974
Cons	4.6448	5.6356
Q_1(*)	10.1990	8.5102
Q_2(*)	8.9643	18.1020

(*) These are after conversion from log form, and, in the case of Q_1 after dividing by L_1. Thus both are the standard error of solely the variable listed in its unlogged form.

(2) non-agricultural investment; (3) import tariffs on SITC 2-4 commodities; and (4) government investment. The best equations, so measured, are in order: (1) private consumption; (2) direct taxes; (3) non-agricultural output and (4) agricultural output.

Another way to evaluate a model is to look at the growth rates that the model forecasts. If these are exploding or wildly oscillating, then it appears that the model might be having some structural or specification problems.

In order to determine these forecasts, some assumptions as to the growth in the fully exogenous variables in the time period after 1971 must be made. These are estimated to grow as fast as a weighted average of their growth during the period from 1960 to 1969, using the weighting scheme discussed earlier.

The results of this portion of the model are presented on the next page. For 1970 and 1971 the growth rates are those that the model predicted, using the actual values of the exogenous variables. The only result that is behaving strangely, and even it is not exploding, is the net exports term, currently negative. Since it is decreasing by a relatively constant absolute amount, the percentage change is subject to wider fluctuations.

From these results, the model's estimate of the various tax elasticities can be computed. Those results are presented in Table IV. Here it is noted that the most elastic tax presently is the non-import indirect tax, with agricultural import tariff collections being the least elastic. In fact, only the two major

TABLE III

ANNUAL GROWTH RATES WITH THE STRUCTURALLY CHANGED COEFFICIENTS MODEL

Year	TM1	TM2	TM3	TD	TIM	GC	GI	Iag	Inag	Cons	Q_1	Q_2	GDP	XM	D
1970*	1.173	1.134	1.219	1.276	1.228	1.099	1.159	1.123	1.187	1.105	1.069	1.087	1.081	2.757	0.883
1971*	1.262	1.110	1.092	1.222	1.160	1.100	1.405	1.104	1.309	1.095	1.026	1.148	1.103	1.855	1.344
1972	0.958	1.107	1.090	1.098	1.155	1.060	1.031	1.118	1.031	1.098	1.070	1.122	1.104	0.712	0.924
1973	0.979	1.104	1.089	1.082	1.145	1.130	1.056	1.123	1.046	1.098	1.075	1.116	1.102	0.923	1.128
1974	0.975	1.101	1.088	1.091	1.137	1.106	1.059	1.128	1.048	1.096	1.081	1.110	1.100	0.828	1.068
1975	0.977	1.099	1.087	1.092	1.131	1.108	1.065	1.132	1.051	1.096	1.086	1.106	1.100	0.824	1.082
1976	0.981	1.097	1.085	1.122	1.131	1.105	1.113	1.137	1.080	1.096	1.091	1.107	1.102	0.917	1.094
1977	0.980	1.095	1.084	1.123	1.131	1.104	1.109	1.141	1.079	1.098	1.097	1.108	1.105	0.814	1.083
1978	0.981	1.093	1.084	1.123	1.130	1.107	1.106	1.145	1.079	1.100	1.103	1.108	1.107	0.711	1.087
1979	0.981	1.092	1.083	1.124	1.130	1.109	1.104	1.149	1.078	1.102	1.108	1.109	1.109	0.467	1.088
Average Growth Rates	1.020	1.103	1.099	1.124	1.147	1.103	1.117	1.130	1.096	1.099	1.080	1.112	1.101	0.945	1.072

(* for these years the actual values of the exogenous variables was utilized, for all others a weighted average of the growth of the exogenous variable during the 1960's was used.)

TABLE IV

TAX AND GOVERNMENT SPENDING ELASTICITIES WITH RESPECT TO GDP

Year	TM1	TM2	TM3	TD	TIM	GC	GI
1970*	2.136	1.654	2.704	3.407	2.815	1.222	1.963
1971*	2.544	1.068	0.893	1.184	1.553	0.971	3.932
1972*	-.404	1.029	0.865	0.942	1.490	0.577	0.298
1973	-.206	1.020	0.873	0.804	1.422	1.275	0.549
1974	-.250	1.010	0.880	0.910	1.370	1.060	0.590
1975	-.230	0.990	0.870	0.920	1.310	1.080	0.650
1976	-.186	0.951	0.833	1.196	1.284	1.029	1.108
1977	-.190	0.905	0.800	1.171	1.248	0.990	1.038
1978	-.178	0.869	0.785	1.150	1.215	1.000	0.991
1979	-.174	0.844	0.761	1.138	1.193	1.000	0.954
AVERAGE ELASTICITY	0.198	1.020	0.980	1.228	1.455	1.020	1.158

(* for these years the elasticities are computed using actual exogenous variable values for 1971 and preceding, for all other years a weighted average of the growth of these variables during the 1960's was used for forecasting purposes.)

taxes, the non-import indirect tax and the direct tax, are elastic at the end of the time period analyzed. Due to the generally higher elasticities for the tax equations when compared to the spending equations, it does appear that the government will be increasingly able to get its mounting deficit under control. This, indeed, it must somehow do in order to be able to lessen current inflation.

Lastly, a comparison of the results that were achieved with the structurally changed model with those that would have been achieved using the full sample period, ordinary instrumental estimated model without structural changes are presented. The ratios of the actual to the predicted values for all of the variables are given in Table V.

Since for a number of equations it was found that there was a definite and significant structural shift to the values of some of the coefficients, it is not surprising that overall the results show that the structurally changed model is better at forecasting.

The net impact of the structural change was to increase both of the predictions for direct and non-import indirect taxes. Thus, the structural change was towards higher tax rates. The next major structural change was in government investment. Here the shift was such that the government is investing much more. It is necessary to add that, while no change in the coefficients on this equation was noticed, the impact of the other shifts was such as to improve our prediction for public investment. This same

TABLE V

RATIOS OF ACTUAL TO FORECASTED VALUES FOR 1970 AND 1971 FOR THE STRUCTURALLY CHANGED MODEL AND THE NON-STRUCTURALLY CHANGED MODEL

Variable	Year 1970		Year 1971	
	Structurally changed	Non-structurally changed	Structurally changed	Non-structurally changed
TM1	1.092	1.103	1.137	1.159
TM2	0.962	0.962	0.945	0.945
TM3	0.972	0.972	1.046	1.046
TD	0.999	1.066	1.008	1.124
TIM	0.976	1.067	0.959	1.085
GC	1.008	1.008	1.007	1.007
GI	0.963	1.129	1.010	1.264
Iag	1.029	1.131	1.011	1.133
Inag	1.012	1.098	1.039	1.174
Cons	0.985	0.994	0.995	1.006
Q_1	1.009	1.009	0.998	1.003
Q_2	1.018	1.045	0.995	1.032
GDP	1.015	1.032	0.998	1.020
XM	0.440	0.556	1.081	1.423
D	1.015	1.041	1.021	1.077

conclusion was reached for non-agricultural private investment. While there was no structural change within the equation, the impact of the other structural changes increased the forecast for 1971 by 13.00%. For agricultural investment the structural change in the responsiveness to the consumption of domestically produced agricultural products was such as to increase our forecast by 12.04% for 1971. In agricultural output there was a very definite shift in structural coefficients; however, the impact of this shift appears to have been very slight. It decreased the prediction for 1970 and increased it for 1971. There does not appear to be any net improvement in the ability of the structurally changed equation to perform better. For non-agricultural output the effect on the prediction for 1970 was marginally significant at best, an increase in the prediction of 2.67%, while for 1971 it was 3.69% higher for the structurally changed equation.

Using as a measure for accuracy of prediction the absolute sum of the variation from the actual figures, then the sum for 1970 of the structurally changed coefficients was 1.245. For 1971 the figures were 0.471 and 1.607 respectively.

Footnotes for Chapter VIII

1. Republic of Kenya: Economic Survey, 1971 (Nairobi, 1971), page 181.

2. Ibid., page 175.

3. Johnston: op. cit., pages 152-155.

IX

SENSITIVITY ANALYSIS

In order to measure how well the model reacts to changes in the values of the exogenous variables, a number of different tests were performed. Since this section is only concerned with how sensitive the model is to these changes, the author has decided to use the model only after it had forecast a sufficiently long period of time to allow all of the growth rates of the endogenous variables to settle. In this way only the sensitivity of the model to these exogenous changes can be analyzed, and the impact of changing endogenous behavior is eliminated.

The effect of population growth on the economy is frequently discussed in low-income countries. The model can compute the cost to the economy of increased population, so long as that cost is narrowly defined. If the growth of the population is lowered to 2.0%, then the savings, in the form of reduced government consumption expenditures, would be K£ 8.75 million; if the rate of population growth could be reduced another percentage point, then the pressure for public consumption would drop a total of K£ 16.01 million over a ten year period. The short term advantages of population growth rate reduction becomes visible. If the government were able to achieve this end with an expenditure exactly equal to the "cost" of increased population, then it would have to spend over the ten years approximately 2.82% of its budget for this program. According to the World Bank, no country is currently spending that large an amount.[1]

The government stated in 1966 that it would "... pursue vigorously policies designed to reduce the rate of population growth through voluntary means...."[2] In order to do this it set up the Family Planning Association of Kenya. Its 1968 budget was K£ 67,000, and over the planning period it was expected to rise to K£ 150,000 per annum. Over a ten year period this would work out to a maximum expenditure of K£ 1.5 million being spent. If this is the total expenditure, then the effort will be worthwhile if the reduction in the growth rate is 0.17%.

If the speed with which capital is consumed is accelerated to such an extent that for agricultural uses depreciation becomes 5% and non-agricultural depreciation becomes 6%, then there would be a general reduction in the values of most of the endogenous variables over the ten year testing period. This reduction in the size of the capital stock would mean that agricultural output would be 12.89% lower and non-agricultural output 0.61% lower, or GDP would be 10.81% lower. This would be further reflected in a reduction in public consumption expenditures of 9.93% and public investment of 6.42%. More severely curtailed would be agricultural investment which would be reduced by 15.12%. Non-agricultural investment would be reduced by 4.79%; it does not appear to be nearly as dependent on the size of output as in agricultural investment. The net surplus in the balance of trade, GDP account, would be reduced by 47.70%. Since taxes would not be reduced as much as would government spending, the size of the government deficit would have decreased by 2.82%. Further, the long run impact on growth rates is such that direct and non-import indirect taxes would be growing at 2.0% slower rate per year, public consumption at 2.10% slower rate and agricultural investment at 3.1% slower rate. Consumption would be growing at a 1.8% slower rate, while agricultural output would grow 3.1% slower. All of the other figures, except for the import tariffs, would also grow considerably more slowly. Thus, it becomes obvious that, if the type of capital that will be invested has a shorter life expectancy than the already-in-place capital, the government will have to find some way to increase the respective marginal productivities of capital for agricultural and non-agricultural production so that these will not be rather drastically reduced.

If the movement of labor from agricultural to non-agricultural employment continues, and indeed accelerates, then the result would be a slight increase in gross domestic product over a ten year period of 1.36%. This assumes that agricultural employment drops by 4% per year and non-agricultural employment increases by 1% more than it has. This would allow for only insignificant changes in unemployment. Since the agricultural marginal productivity of labor was negative, there would be an increase in agricultural production of 0.34% overall. None of the long run growth rates are substantially effected, i.e., none of their growth rates change by as much as 0.5%.

In order to get at the impact on the economy of a prolonged drought or other adverse climactic condition, the model forecasted the impact of such a three year condition. For the years during which the drought would exist, output would drop by 5.82%. Over the ten year period it would drop by 3.83%, or KE 356.30 million. As late as seven years after the end of the drought and the return of normal weather, output would be reduced by KE 61.59, or 3.69%. The effect of the drought would be an overall reduction in agricultural investment of KE 89.43 million and in consumption of KE 205.72 million, or 4.51% and 1.20% respectively. It would, naturally, reduce the size of the export surplus, in this case by KE 26.35 million. Since none of these impacts are minor, it therefore becomes incumbant upon the Kenyan government to do that which is possible to contain the negative impact of such climactic uncertainties.

The effect of three consecutive good years in roughly the exact opposite as that just presented. Agricultural output increases by 4.15%, stimulating agricultural investment; increasing the size of the export surplus and slightly increasing the size of the government deficit, i.e., by KE 7.49 million or 0.64%. Neither a drought nor good weather has any substantial impact on the long run growth rates of any of the included variables.

If we allow the size of commercial bank deposits to grow by 15% per year, then the only impact of the model will be a substantial increase in domestic consumption of 5.32% or KE 908.68 million over a ten year period, and a consequent reduction is the size of the export surplus. It is entirely possible that if these deposits increase this much faster that there will be some form of structural shift of the model. This will probably also hold for any of the remaining changes made in the magnitude of the exogenous variables.

If imports of all products increase, the following results, assuming that agricultural imports increase by 10% per year and intermediate products by 15% per year, as do manufactured imports. The effect is, of course, a substantial increase in these tariff collections over a ten year period of 34.70%, 46.42%, and 45.13% respectively. There is a 46.03% increase in government investment, a 34.33% increase in non-agricultural private investment, a 15.02% increase in non-agricultural output, an increase in export surplus due to the increase in productive ability of KƂ 86.51 million and an increase in the size of the government deficit of KƂ 78,91 million. The long run impact on growth rates, other than tariff collections, would be to increase the growth of public investments by 7.0%, non-agricultural private investment by 6.4% and non-agricultural production by 5.3%. These results are not as would be expected. The results will only hold if the assumption made in the estimation of public investment remains valid, i.e., taxes serve as seed money for the acquisition of international loans and grants. Thus, with increased domestic taxation, the result of increased public investment holds. This assumption appears to be pushed to, if not beyond, its limits here.

Similarly, if agricultural investments increase by 10% per year, then agricultural investment will drop over a ten year period by 5.07%. The reason is that agricultural investment depends on domestic consumption and not exported production. Accordingly the increase in exported production reduces production available for domestic consumption, thus reducing agricultural investment and also agricultural output (reduced by 2.32%). It is expected that, if exports began increasing by 10% per year, it would indicate an increased export orientation causing a different specification (such as equation D1 in Appendix A) to become valid.

In the model, non-agricultural private investment is semi-export oriented. Thus, if the exports of category two and three commodities begins increasing by 7.5% per year, it can show the impact in the manner expected. In such a case, non-agricultural private investment would increase its long run growth rate by 0.8% per year for a cumulative increase over 10 years of KĿ 81.86 million, or 5.15%. Non-agricultural production would increase by 0.99% or KĿ 156.30 million. Due to the impact of these on consumption and public behavior, there is a slight reduction in the size or the export surplus. This illustrates that there is a tendency within the economy to use the export surplus as a vent, as well as showing how fragile that surplus is. Almost anything can work to reduce it because, in this case, of a desire and ability to respond to the increased availability of funds and changing income.

In all of the shifts in the exogenous variables that the model was subjected to, it showed a remarkable degree of stability; and, so long as the assumptions behind the model hold, the effect and direction of these changes is as expected.

Footnotes for Chapter IX

1. Population Planning: op. cit., page 23.

2. Kenya Development Plan: op. cit., page 500, subsequent figures come from pages 500-502.

X

IMPACT MULTIPLIERS

To take advantage of the recursive quality of the model, the impact of variable changes over a number of years was measured.

To measure the total impact of a single-year change in government consumption the change was added to the government consumption equation, and this new equation was used to solve the system of equations. This was subtracted from the values that would have existed had the change not taken place. The difference is the impact of a just increase in government consumption expenditures.

A single-year increase in public consumption of K£ 10 million will lead to a K£ 25.59 change in GDP over a ten year period for a full multiplier of 2.110. This takes place in the model mainly because of the impact on taxes, private and public non-agricultural investment. The effect after three years is a multiplier of 0.62. Thus, most of the impact of the change in public consumption takes place over the later years in the analysis. Initially, its main impact is to increase the size of the government deficit and also decrease the size of the export surplus. Over the years the export surplus will be reduced by 0.4% and the deficit increased by 1.0%. After one year, productive ability will have increased by K£ 3.19 while the demand for the output will have increased by K£ 17.46. Accordingly, while most of the increased inflationary pressures take place during the first year, there will be some heightened pressure for each of the years in the recursive system.

These results can be contrasted with a similar increase in public investment. Here the export surplus actually increases due to the increase in productive capacity beyond the increase in the domestic demand for that capacity. The net change in the export surplus will be an increase over ten years of 1.2% with a similar increase in the government deficit over the ten years. The value of the multiplier for the change in investment is 2.710 after three years and over the entire time period is 8.13. This rather high multiplier is due mainly to the impact of the structurally changed non-agricultural production function, which has indicated a major upward shift in the marginal productivity. While somewhat higher than some of the other studies surveyed, the figure is not out of line for a growth-oriented developing economy. In the later years of the analysis the impact of the investment stimulation will be such that there will be increased inflationary pressures with balance of trade problems reappearing. However, that is only during the last years. Overall, the situation is an improvement in both.

However, if the government wants to increase its spending by KL 10 million, it will need a funding supply. The effect of obtaining those funds from the following different sources is next examined: (1) from a decrease in government consumption, (2) from an increase in direct taxes, (3) from an increase in indirect taxes,

(4) from a decrease in private savings, (5) from a decrease in private consumption. Presumably the government would be interested in pursuing that method of financing which leads to the best impact on overall output, improves the export surplus and reduces the size of the government debt.

If public consumption is decreased by K£ 10 million, then the net impact on GDP is +0.38%, while the export surplus would improve (over the ten year period) 1.59% and the deficit worsen by 0.26%. If the government increased direct taxes just enough to pay for the increase in government investment, then the net change on GDP over a ten year period would be 0.50%, while the export surplus would improve 1.58% and the deficit worsen 0.59%. Unless the worsening deficit bothers the government planners excessively, this method would yield greater output and not change the export surplus. All of the figures are the same if the government finances the increased expenditures through an increase in indirect taxes, except that the export surplus would improve further to 1.82%. The regressive quality of most indirect taxes, and thus their greater ability to restrain consumption thereby improving the goods and services available for export, is a basic point indicated by this analysis. If the government somehow forced citizens to loan it K£ 10 million as a permanent reduction in their savings, the impact on total output would be the same (the same amount of investment being made); but, we find that there would be an 8.52% improvement in the export surplus and a worsening of the deficit (now including the savings as a form of tax) by 0.35%. If there were some easy method to directly reduce consumption by the amount needed for the government investment (i.e., rationing), then the government deficit would be slightly worse and the export surplus not nearly as good. This might be explained by the impact that the permanent reduction in private savings would have on consumption for each of the years in the time series, as opposed to the single year reduction in consumption. It would also reduce the funds available to the private sector for the needed investment there.

If pressure to shift funds from government investment to public consumption were to become sufficiently severe that the transfer was necessary, then over the ten year period following such a single year move GDP would be reduced by 0.38%, the export surplus reduced 1.50% and the deficit improved only marginally (by 0.26%). Over the first year of such a transfer the reduction in GDP would be about 0.64%. If such a transfer were to be permanent, the impact on GDP would be a reduction of 2.27% and a worsening of the export surplus by 7.84%. This form of pressure, which the Economic Survey, 1971 indicated might already have taken place, would thus have a substantial impact on future growth possibilities, while at the same time making it increasingly difficult to effect a permanent GDP account balance of trade surplus.

Accordingly, if the government had such an open choice as to the source of funds, they would be wise to finance the needed revenue from indirect taxes leading to the smallest inflationary pressure, while still allowing almost all of the positive impact of increased investment to be known. Were it possible to effect a permament loan to the government, then that solution would result in an even more favorable impact.

Earlier, the marginal productivity of capital in agriculture was computed as greater than in non-agricultural production. If agricultural investment were increased by K£ 5 million, then the increase in agricultural production would more than offset the reduction in non-agricultural due to a reduction in investment there of K£ 5 million. Over a ten year period there would be an increase in gross domestic product of 0.88%. Such a shift, if made permanent, would result in an increase in government spending of K£ 32.03 million. Provided the cost to the government of achieving such an end is somewhat less than that amount, the net impact as far as funds available to the government would be positive (i.e., the deficit would remain essentially stable).

XI

THE MODEL AND THE SECOND DEVELOPMENT PLAN

If modelling is of value, it should be able to assist economic planners in the accurate derivation of their plans. While the model that has heretofore been created is necessarily a small one, it still identifies and uses some of the more important values of concern to the economic planners. From the figures derived many other figures can be calculated and some of the broad outlines of the possible development plan can be sketched.

In the Second Development Plan[1] a number of different forecasts are made. If we take their forecasts for 1974 and assume that there will be a constant growth from the 1969 figures until then, we have the individual year forecasts. In some cases, the planners provide more detail allowing the actual forecasts for 1970 and 1971 to be derived. More detail on this will be provided later in this chapter.

In order for the model to be made operational, it must have the exogenous variables supplied. Two possible methods were tried. The first uses the estimates for those exogenous variables as derived from the Development Plan, and the second uses the estimates as derived from the performance of the economy during the decade of the 1960's. The two estimates can be viewed as the optimistic and the pessimistic projections, the former assuming that the great changes are possible in the economy and the latter assuming that the changes that have been taking place will continue to take place.

Table VI provides the three forecast ratios.

A high percentage of the variables covered were more accurately forecast by the model, using either of the two sets of exogenous variable values, than the Development Plan forecasts for both 1970 and 1971. The Development Plan estimates were more accurate only for import tariff collection on category one (SITC 0-1) and category two (SITC 2-4) type goods because they were better able to forecast changes in coverage and rate structure than the model. They also made more accurate forecasts, albeit marginally so, for agricultural investment in 1971, non-agricultural investment in 1970 and the export balance in 1971. None of the models predicted the export balance for 1970 or 1971 well. However, using the standard errors of the predictions for both 1970 and 1971, at a 95% level of confidence only the tariff collections on SITC 0-1 commodities were outside the prediction limits. All of the others were well within the confidence margin.

The Development Plan's forecasts for the values of the exogenous values yielded a closer prediction than the ones constructed using the data from the 1960's. This was not true in the cases of: (1) non-agricultural labor force for both years, (2) imports of SITC 2-4 commodities for 1970, (3) exports of agricultural products for 1971 and (4) exports of non-agricultural products for 1970.

TABLE VI

RATIO OF ACTUAL TO FORECASTED VALUES FOR 1970 AND 1971 FOR THE STRUCTURALLY CHANGED COEFFICIENT MODEL AND FROM THE SECOND ECONOMIC DEVELOPMENT PLAN

Variable	1970			1971		
	Model Using Development Plan Exogenous Values	Model Using Past Experience Exogenous Values	Development Plan Estimates	Model Using Development Plan Exogenous Values	Model Using Past Exper- Exogenous Values	Development Plan Estimates
TM1	0.783	0.770	0.850*	0.633	0.610	0.704*
TM2	1.053	1.017	0.998*	1.109	1.037	0.996*
TM3	0.984	0.955	0.919	0.942	0.889	0.851
TD	1.044	1.032	0.926	1.011	0.984	0.965
TIM	1.069	1.055	0.892	1.072	1.038	0.834
GC	0.986	0.986	0.967	1.016	1.007	0.881
GI	0.975	0.937	1.152	0.957	0.897	0.942
Iag	1.042	1.044	1.043	0.978	0.983	1.104*
Inag	0.973	0.916	1.103*	0.931	0.837	0.840
Cons	1.000	0.995	0.960	0.983	0.970	0.906
Q_1	1.004	1.004	0.974	1.005	1.006	0.980
Q_2	1.019	1.004	0.974	1.030	0.996	0.930

TABLE VI (continued)

Variable	1970			1971		
	Model Using Development Plan Exogenous Values	Model Using Past Experience Exogenous Values	Development Plan Estimates	Model Using Development Plan Exogenous Values	Model Using Past Experience Exogenous Values	Development Plan Estimates
GDP	1.013	1.004	0.968	1.021	0.999	0.947
XM	-.089	-.105	3.943	0.407	0.399	0.507*
D	0.858	0.866	1.807	0.976	0.974	1.026
Absolute value of error	37.641	33.381	120.377	70.106	65.206	151.043
Absolute value of ratio variance from 1.00	1.774	1.840	4.546	1.461	1.550	1.747
The above without last two variables	0.543	0.601	0.796	0.844	0.923	1.228

Using both versions of the model, with exogenous variables determined from past experiences and from the Development Plan, then a comparison with the Development Plan's forecast for the end of the Plan can be made. (Table VII).

Overall, the model shows the government able to collect more tax revenue than anticipated, but due mainly to a shift in tax reliance from direct to indirect taxes. The shortfall in direct taxes is more than made up in the over-predicted collections in categories two (SITC 2-4) import tariffs, category three (SITC 5-8) import tariffs and non-import indirect taxes (includes SITC 9 tariffs). This is further demonstrated by a lesser deficit than forecast for 1974, albeit not sufficiently less to substantially lessen the forecasted inflationary pressures. Notice, in addition, that private and public consumption will both be substantially more than forecast in the Plan. This, when combined with output that is only moderately higher than the forecast, indicates that the problems with inflation will be much more severe than the planners believed they would be. These pressures have already been seen in the economy.

Overall, it does not appear that there will be substantial problems in meeting the goals of the Second Development Plan except for direct taxes and non-agricultural investment. However, the achievement will be marred somewhat by an inflation that will be substantially greater than originally forecast.

TABLE VII

RATIO OF THE MODEL'S FORECAST WITH THE DEVELOPMENT PLAN'S FORECAST FOR 1974

Variable	The Model Using Exclusively the Dev. Plan's Estimates for all Exog. Variables	The Model Using Exclusively Prior Experience to Estimate all Exog. Variables	The Full Model With Actual Exog. for 1970-1971, and Prior Experience After Than
TM1	0.689	0.634	0.888
TM2	1.271	1.089	1.108
TM3	1.207	1.050	1.125
TD	0.884	0.805	0.763
TIM	1.689	1.526	1.433
GC	1.202	1.142	1.062
GI	1.166	0.984	1.065
Iag	1.071	1.081	1.135
Inag	1.105	0.845	0.908
Cons	1.305	1.238	1.235
Q_1	1.155	1.159	1.097
Q_2	1.332	1.186	1.136
GDP	1.272	1.177	1.122
XM	-.191	-.072	0.859
D	0.900	0.879	0.840

Footnotes for Chapter XI

1. Republic of Kenya, Ministry of Economic Planning and Development: Development Plan, for the Period 1970-1974 (Government Printer, Nairobi, 1969).

XII

CONCLUSION

Although a sound model is herein developed, data limitations are still a problem in development economies. As more and better data becomes available, it will be possible to construct a more accurate instrumental estimate model. Since the model needed data for so many years in order to achieve sufficient statistical degrees of freedom, this study was unable to disaggregate the results as much as would be necessary for a more concrete analysis of the Kenya economy. With improved statistical coverage over the next few years, further disaggregation and more equations will be estimable.

The model was constructed and analyzed in the light of structural change in two specific years. It would be worthwhile to look into the possibility of finding structural change in more than one year simultaneously, as well as to look at some of the possible structural changes after independence. Since for the years utilized the degrees of freedom got as low as four it was not possible to analyze coefficient changes in the post-independence years, where it would get even lower. With more observation, clearer indications as to the direction and nature of structural change can be achieved. This will be of value in the forecasting of change in the economy for future Development Plan construction and analysis. This model already performs better than whatever model the planners utilized.

However, its area for improvement is extensive and deserves to be undertaken as more information is amassed.

Since the model was designed to address some very limited questions, it does not reach sufficient breadth for other purposes. With a larger model, more of the interactions of structural change can be achieved, as well as indicating the possible impact of those changes that might be initiable by the government. Neither is this a policy options model, but with a better comprehension of the need, nature and impact of structural change it is hoped that models of Kenya that include more policy options can be accurately constructed.

As even more worthwhile analysis would be to isolate those forms of structural change which exist due to growth and those which exist due to conscious development actions. This work cannot make that distinction. However, such information is necessary in order to understand policy options and their implications on the attainment of economic development goals. In order to achieve this, some models, necessarily smaller than the one constructed here, for other countries may be constructed. Comparisons of the nature of the changes can isolate the unique from the relatively routine elements of coefficient shifts.

An additional limitation of the current work involves the assumptions that went into each of the acceptable formulations. If any of these assumptions are violated, there will be problems in achieving the results forecasted. A specific example is public investment. The model assumes that domestic taxation can be supplemented by external loans and grants. If these do not continue as they have over the last five years, then the forecasted government investment will not be possible at all, and instead the growth orientation of the model will be severely curtailed.

Data drawn from slightly over 10% of the Kenya Development Plan's pages were used directly in this model. Much of the remaining analysis is project analysis and thus depends on the macroeconomic variables considered here. This model yielded more accurate forecasts than whatever method the planners utilized. It thus becomes incumbent upon us to make sure that the information provided is as accurate and flexible as possible in order to meet the needs of the government for comprehensive and informative planning.

APPENDICES

APPENDIX A

NON-UTILIZED MODEL FORMULATIONS

Each of the tables within this appendix presents the major formulations for each equation that was attempted. The formulations that were finally utilized (subject to adjustment for serial correlation or structural change) are presented on page 47. There were many other formulations that were attempted for each equation. A full listing can be provided.

Each of the tables will present the coefficient determined, the name of the independent variable (defined below each table), the standard error, the Durbin-Watson statistic and the $\bar{R}^2$. After the standard error of the coefficient appears between zero and three asterisks, with none indicating that the coefficient was not significant at the 0.10 level of significance; one indicating significance at the 0.10 level; two at the 0.05 level and three at the 0.01 level. After the Durbin-Watson statistic appears either a plus, minus, a question mark or a blank space with the plus sign indicating that we can reject the hypothesis of no serial correlation in favor of positive serial correlation. The minus sign indicates the same except that we show negative serial correlation, the question mark indicates that the Durbin-Watson is in the area where no firm conclusion can be drawn concerning the existence of positive or negative serial correlation. Finally, a blank space indicates that there is no serial correlation according to the Durbin-Watson statistic. If the acceptable formulation was in the questionable range, we narrowed the Durbin-Watson range via the Henshaw procedure in order to be a bit surer of the existence of serial correlation. If the equation showed definite serial correlation, then generalized differences were performed. These results are shown in the main text. All of the Durbin-Watson's are at the 0.01 level of significance.

After the Durbin-Watson is a column labeled ratio. This is the ratio of the computed values for the past two years divided by the actual values with that specific formulation. Thus, if the value is greater than one, it indicates that the equation was overestimating the most recent years; and, if the value is less than one, that the equation underestimated the most recent years. Due to the forecasting nature of the model it was desired that the forecasted values be within 5% of the actual values.

TABLE A1

AGRICULTURAL PRODUCTION FUNCTION

Equation Number	Constant (1)	Variable	Standard Error of the Coefficient	$\bar{R}^2$	Durbin Watson	Ratio
A1#	-0.627	-0.0032Ti -0.0427lgL/K	0.003 0.045	.8446	1.956	.922
A2#	-0.124	0.0160lgL/k	0.037	.8370	1.867	.927
A3##	-0.0627	-0.0033Ti 1.0427lgK/L	0.003 0.045***	.9525	1.956	.922
A4##	-0.1247	1.0161LgK/L	0.37***	.9502	1.867	1.01
A5###	0.736	-0.241LgL 0.8658lgK	0.115** 0.081***	.9995	2.200	1.01
A6##	-0.1276	+0.0146We 1.0151gK/1	0.0023*** 0.0209***	.9847	1.728	.980

(1) to convert this to the Cobb-Douglas actual format take the anti-log

\# Dependent Variable is log Q/K
\## Dependent Variable is log G/L
\### Dependent Variable is log Q
Ti = time, 1950 = 1, 1970 = 21
lgL/k = common log of agricultural labor per unit of agricultural capital
lgK/L = common log of agricultural capital per agricultural laborer
lgL = common log of agricultural labor force
lgK = common log of agricultural capital stock
We = dummy variable, weather conditions
LgQ/L = common log of output in agriculture per agricultural worker
lgQ/K = common log of agricultural output per unit of agricultural capital
lgQ = common log of output in agriculture

TABLE A2

NON-AGRICULTURAL PRODUCTION FUNCTION

Equation Number	Constant (1)	Variable	Standard Error of the Coefficient	$\bar{R}^2$	Durbin Watson	Ratio
B1#	-0.389	0.0008Ti 1.0571lgK/L	0.006 0.148***	.563	.425+	1.159
B2#	-0.405	1.0759lgK/L	0.809***	.557	.425+	1.147
B3##	-2.06	-0.0098Ti 0.8026lgL 0.9158lgK	0.003*** 0.098*** 0.055***	.999	1.96	0.998
B4##	-1.786	0.852lgL 0.692lgK	0.062*** 0.146***	.999	0.82+	0.999
B5##	-0.25	0.00007lgL 0.9999lgCU 1.0000lgK	0.0003 0.0004*** 0.0000***	.999	0.16+	1.000
B6##	-0.25	0.00001lgL 0.9999lgCUK	0.0003 0.0001***	.999	0.08+	1.000

(1) to convert to Cobb-Douglas format take the anti-log

\# Dependent Variable is log Q/L
\## Dependent Variable is log Q

Ti = time, 1950 = 1, 1970 = 21
lgK/L = common log of capital per laborer in non-agricultural activity
lgL = common log of non-agricultural labor force
lgK = common log of non-agricultural capital stock
lgCU = common log of capacity utilization of capital in non-agricultural activities
lgCUK = common log of capacity utilization of capital times existent capital stock in non-agricultural activity
lgQ/L = common log of output per non-agricultural laborer
lgQ = common log of non-agricultural output

TABLE A3

THE CONSUMPTION FUNCTION

Equation Number	Constant	Variable	Standard Error of the Coefficient	$\bar{R}^2$	Durbin Watson	Ratio
C1	24.483	-0.67DYL +1.41DY	0.394* 0.371***	.994	3.08-	1.01
C2	10.69	0.760DY	0.015***	.997	1.58	.986
C3	13.94	0.623DY 0.560BD	0.047*** 0.019***	.999	1.84	.993
C4	10.45	0.748DY 0.006KS	0.129*** 0.064	.997	1.66	.986
C5	10.58	0.763DY -.013In	0.035*** 0.137	.997	1.65	.986
C6	12.24	-.121Ti 0.762DY	0.873 0.021***	.999	1.59	.986
C7	16.95	0.701GDP	0.013***	.999	1.729	.989

DYL = lagged disposable income
DY = disposable income
BD = total deposits in commercial banks
KS = total value of capital stock
In = total private and public, agricultural and non-agricultural investment
GDP = gross domestic product, factor prices
Ti = time, 1950 = 1, 1970 = 21

TABLE A4

AGRICULTURAL INVESTMENT FUNCTION

Equation Number	Constant	Variable	Standard Error of the Coefficient	$\bar{R}^2$	Durbin Watson	Ratio
D1	1.206	0.539X1L	0.065***	0.957	1.380	0.938
D2	-6.579	0.186C1	0.021***	0.959	0.74+	0.939
D3	1.185	-1.376C1 4.127X1	2.733 7.209	0.152	2.396	1.127
D4	0.764	0.083X1L 0.162BD	0.131 0.045***	0.972	1.388	1.009
D5	-0.668	0.033C1 0.159BD	0.052 0.049***	0.972	1.300	1.009
D6	84.605	-2.025C1L 5.666X1	9.149 23.325	--	2.862	1.114
D7	103.317	3.988X1L -.021POP	6.567 0.039	0.284	2.651	0.809

X1L = exports of agricultural product to non-East African countries, lagged
C1 = consumption of domestically produced agricultural products
X1 = exports of agricultural products to non-East African countries
BD = total deposits in commercial banks
C1L = consumption of domestically produced agricultural products, lagged
POP = total population, mid-year estimates

TABLE A5

NON-AGRICULTURAL PRIVATE INVESTMENT FUNCTION

Equation Number	Constant	Variable	Standard Error of the Coefficient	$\bar{R}^2$	Durbin Watson	Ratio
E1	10.524	1.251DC	0.521**	.531	2.713	1.170
E2	2.044	0.063YP 0.605GI	0.036* 0.305**	.923	1.133?	1.079
E3	2.304	0.037DC 0.382BD	1.831 0.613	.882	1.089?	1.075
E4	30.762	-1.359I2L 2.469DGDP2	10.785 11.412	--	3.451	1.074
E5	14.040	0.085XM 1.071DGDP2	0.296 0.304***	.778	2.478	1.093
E6	2.296	0.707X23 0.737GI	0.402** 0.239***	.926	1.182?	1.074
E7	1.074	0.239X23L 0.349BD	0.755 0.159***	.879	1.056?	1.061
E8	7.749	0.338XM 1.248GI	0.219* 0.228***	.905	1.094?	1.089
E9	3.024	0.632GI 0.033KS2L	0.340** 0.022*	.896	1.104?	1.085

YP = private sector income
GI = public investment
DC = the change in private consumption
BD = total deposits in commercial banks
I2L = non-agricultural investment, lagged one year
DGDP2 = the change in non-agricultural production
XM = balance of trade, GDP account
X23 = export to non-East African countries of non-agricultural products
X23L = exports to non-East African countries of non-agricultural products, lagged
KS2L = non-agricultural capital stock, lagged

TABLE A6

PUBLIC CONSUMPTION EXPENDITURE FUNCTION

Equation Number	Constant	Variable	Standard Error of the Coefficient	$\bar{R}^2$	Durbin Watson	Ratio
F1	-0.312	0.831T	0.026***	.995	1.574	1.003
F2	19.364	0.208GDP	0.006***	.996	2.128	0.986
F3	-15.871	0.169GDP 0.152T	0.083** 0.328	.996	2.116	0.990
F4	-11.467	0.125YP 0.470T	0.068** 0.193**	.995	2.037	0.987
F5	-22.649	0.252YPL 0.033DPOP	0.034*** 0.015**	.985	2.589	0.983
F6	-23.142	0.253YP 0.021DPOP	0.030*** 0.014*	.988	2.320	0.983
F7	-9.014	0.098YPL 0.570T	0.044** 0.114***	.997	1.760	0.988

T = total tax collections
GDP = gross domestic product, factor cost
YP = private sector income
YPL = private sector income, lagged
DPOP = the change in population, mid-year estimates

TABLE A7

PUBLIC INVESTMENT FUNCTION

Equation Number	Constant	Variable	Standard Error of the Coefficient	$\bar{R}^2$	Durbin Watson	Ratio
G1	4.27	0.064DPOP -.012YP	0.035** 0.073	.508	1.77	0.966
G2	86.962	-7.30Ti 0.253YP	0.469* 0.107**	.293	0.32+	0.968
G3	21.514	-0.259YP 1.384T	0.060*** 0.227***	.962	1.993	0.989
G4	22.330	1.463T -.287YP 0.392Ti	0.262*** 0.074*** 0.492	.960	2.238	0.996
G5	28.646	-.287GDP 1.924T	0.081*** 0.427***	.944	1.890	1.016

DPOP = the change in population, mid-year estimates
YP = private sector income
Ti = time, 1950 = 1, 1970 = 21
T = total tax collections
GDP = gross domestic production, factor cost

TABLE A8

DIRECT TAX COLLECTIONS FUNCTION
(includes land premia, income taxes, personal taxes, export taxes)

Equation Number	Constant	Variable	Standard Error of the Coefficient	$\bar{R}^2$	Durbin Watson	Ratio
H1	-7.083	0.082NI	0.006***	.976	0.73+	0.966
H2	33.261	0.205NI -.009POP	0.025*** 0.002***	.986	3.14?	1.017
H3	-14.022	1.669NI 1.869(T-CG)	0.228*** 0.622***	.930	1.737	0.993
H4	40.198	0.257NIL -.11POPL	0.049*** 0.003***	.965	2.393	1.025
H5	-31.863	0.051NI 173.439RGL	0.014*** 56.857***	.965	1.441	1.042

NI = gross domestic product, factor cost, less depreciation estimates
POP = total population, mid-year estimates
(T-CG) government balance on current account
NIL = gross domestic product, factor cost, less depreciation estimates, lagged
RGL = total government spending divided by gross domestic product, lagged
POPL = total population, mid-year estimates, lagged

TABLE A9

NON-IMPORT INDIRECT TAX COLLECTIONS FUNCTION
(Includes excises, stamp duties, petro-diesel taxes, licenses, etc., and import tariff collections on SITC 9 commodities)

Equation Number	Constant	Variable	Standard Error of the Coefficient	$\bar{R}^2$	Durbin Watson	Ratio
I1	-9.588	0.147Q1	0.017***	.937	1.832	0.914
I2	-11.956	0.202Q1X	0.024***	.937	1.751	0.906
I3	-31.383	3.573Q1I	0.413***	.932	1.728	0.900
I4	-1.893	-.012Q1 0.074Q2	0.099 0.045*	.964	2.096	0.979
I5	-7.430	0.075Q1 0.260I2	0.076 0.257	.903	1.604	0.918
I6	-9.861	0.156Q1 -.603DI2	0.027*** 0.754	.857	2.327	1.094
I7	-12.513	0.182Q1 0.424(T-CG)	0.034*** 0.467	.905	2.087	0.925
I8	11.850	-2.228Q1 0.197Q2G	3.946 0.133*	.934	1.915	0.983
I9	-4.735	0.047GDP	0.004***	.961	2.049	0.955
I10	-5.855	0.067Cons	0.006***	.963	2.176	0.969

Q1 = agricultural output
Q1X = non-exported agricultural output
Q1I = agricultural output, less agricultural investment
Q2 = non-agricultural output
I2 = non-agricultural investment
DI2 = the change in non-agricultural investment
(T-CG) government balance on current account
Q2G = gross domestic product from non-agricultural production less government consumption and non-agricultural investment
GDP = gross domestic product, factor cost
Cons = private consumption

TABLE A10

IMPORT TARIFF COLLECTIONS ON SITC 0-1 COMMODITIES
(food, beverage and tobacco)

Equation Number	Constant	Variable	Standard Error of the Coefficient	$\bar{R}^2$	Durbin Watson	Ratio
J1	-0.771	0.509MW1	0.773	.558	1.036?	.683
J2	1.88	0.069MW1 -.060(T-CG)L	0.084 0.057	.900	2.028	1.034
J3	2.548	0.047MW1 -.736Q1GN	0.089 0.658	.679	2.271	1.084
J4	0.542	0.152MW1 5.381RG	0.039*** 3.000**	.965	2.523	1.005

MW1 = non-East African imports of SITC 0-1 commodities
(T-CG) government balance on current account, lagged one year
Q1GN = gap of actual and potential agricultural output per capita
RG = total government contribution to GDP divided by gross domestic product

TABLE A11

IMPORT TARIFF COLLECTIONS ON SITC 2-4 COMMODITIES

Equation Number	Constant	Variable	Standard Error of the Coefficient	$\bar{R}^2$	Durbin Watson	Ratio
K1	-3.810	0.634MW2	0.068***	.962	1.110?	1.049
K2	7.250	1.083MW2 -82.269RG	0.542** 90.825	.798	1.480	0.958
K3	2.639	0.851MW2 -46.342RGL	0.245*** 42.624	.843	1.148	0.970
K4	-3.325	0.518MW2 -.193(T-CG)	0.079*** 0.119*	.937	1.766	1.017

MW2 = import of SITC 2-4 commodities from non-East African countries
RG = total government contribution to GDP divided by GDP
RGL = total government contribution to GDP divided by GDP, lagged
(T-CG) = government balance on current account, lagged one year

TABLE A12

IMPORT TARIFF COLLECTIONS ON SITC 5-8 COMMODITIES
(Chemicals, finished products and manufactured items)

Equation Number	Constant	Variable	Standard Error of the Coefficient	$\bar{R}^2$	Durbin Watson	Ratio
L1	-4.453	0.207MW3	0.016***	.971	0.922+	1.020
L2	12.324	0.338MW3 -124.375RG	0.338MW3 82.178*	.941	1.914	0.939
L3	5.869	0.274MW3 -73.821RGL	0.053*** 47.133*	.939	1.343	0.948
L4	-3.548	0.179MW3 180.854DRK	0.054*** 246.400	.724	1.730	0.960
L5	-3.136	0.167MW3 -.262(T-CG)	0.025***	.960	3.241-	0.989

MW3 = non-East African imports of SITC 4-8 commodities
RG = total government contribution to gross domestic product divided by gross domestic product
RGL = total government contribution to gross domestic product divided by gross domestic product, lagged one year
DRG = the change in total government contribution to gross domestic product divided by gross domestic product, from one year to the next
(T-CG) = government balance on current account, lagged one year

APPENDIX B

STRUCTURAL CHANGE LOGS

In the following tables the structural change logs on the equations which were accepted during the fourth chapter are presented. For each of the acceptable formulations an attempt was made to find whether there was statistically significant structural change. The method utilized was explained in Chapter III. Additional regressions on each equation utilizing dummy variables were run. As an example we use the first equation reported in Table B1.

$$\log (Q_1/L_1) = -.2141(K) + .0844(K)(d) + .0263(We) - .0050(We)(d) + .6577 (\log [K_1/L_1]) + .3916 (\log [K_1/L_1])(d)$$

where all of the variables are as they were defined in Chapter IV, with K standing for the constant term (i.e., the column vector of the weights) and "d" for the dummy variable term. In this case it stands for structural change in 1960, and only takes a positive value after that year. If all of the coefficients with the dummy variable term were significant then the coefficients were not significant, thus indicating a lack of proof of structural change in that variable, the equation was re-run dropping that dummy term. The results of these runs are also presented on the following pages. When a term was not subjected to structural change a bar (——)

appears over the name of the variable.

For each of the equations we provide the value of the coefficients (i.e., in the above case we sum the first two coefficients to -.1297) as well as the variable name. After this appears from zero to five stars with no asterisks indicating that the dummied variable was not significant at the 0.10 level; one indicating significance at the 0.10 level; two at the 0.05 level; three at the 0.025 level; four at the 0.01 level and five at the 0.005 level. After this appears the $\bar{R}^2$, followed by the sum of the squares of the residuals, the Durbin-Watson (plus an indication of positive serial correlation [+], negative serial correlation [-], in the questionable range [?], or ni serial correlation shown [a blank space]). After this is the standard error of the estimate.

The complete logs are available.

TABLE B1

PRODUCTION FUNCTION STRUCTURAL CHANGE LOGS

Agricultural Production Function

1. structural change in 1960

$\log(Q_1/L_1)$	$= -0.1297$	*	.985	.00092	2.878	.0081
	$+0.0213(We)$					
	$+1.049(\log[K_1/L_1])$	**				

2. structural change in 1964

$\log(Q_1/L_1)$	$= -0.1264$	***	.984	.00097	2.516	.0083
	$+0.0174(We)$	***				
	$+1.007(\log[K_1/L_1)$	*				

Non-Agricultural Production Function

1. structural change in 1960

$\log(Q_2)$	$= -1.821$		.999	.00063	2.116	.00672
	$+1.1455(\log[K_2])$	*****				
	$+0.396(\log[K_2])$					

2. structural change in 1964

$\log(Q_2)$	$= +0.333$		.999	.00077	1.696	.00742
	$+1.827(\log[K_2])$	**				
	$-1.146(\log[L_2])$					

TABLE B1 (continued)

3. structural change in 1960, L_2 not changed

$\log(Q_2)$	$= -1.956$ $+1.042(\log[K_2])$ $+0.557(\log[L_2])$	***** 	.999	.00061	2.285	.00637

4. structural change in 1964, L_2 not changed

$\log(Q_2)$	$= -1.661$ $+1.022(\log[K_2])$ $+0.466(\log[L_2])$	*** **** *****	.999	.00094	1.839	.00782

TABLE B2

CONSUMPTION AND INVESTMENT FUNCTION STRUCTURAL CHANGE LOGS

Consumption Function						
1. structural change in 1960						
Cons	= +30.993 +0.491(DY) +0.944(BD)	*	.999	109.134	2.532	2.279
2. structural change in 1964						
Cons	= 0.040 0.734(DY) 0.410(BD)		.999	138.852	2.451	3.149
Agricultural Investment Function						
1. structural change in 1960						
Iag	= -15.223 +0.254(C_1)		.969	17.295	1.735	1.040
2. structural change in 1964						
Iag	= -14.604 +0.251(C_1)	***** *****	.982	9.920	1.560	0.787

TABLE B2 (continued)

Non-Agricultural Investment Function

1. structural change in 1960					
Inag	= -18.614 +2.068(X23) +0.376(GI)	.903	223.972	1.887	4.000
2. structural change in 1964		.915	197.496	1.884	3.756

TABLE B3

GOVERNMENT CONSUMPTION, INVESTMENT AND DIRECT TAX COLLECTIONS STRUCTURAL CHANGE LOGS

Government Consumption Function

1. structural change in 1960

GC	= −42.574 +0.094(DPOP) +0.268(YPL)	.993	56.521	2.594	2.085

2. structural change in 1964

GC	= −38.269 −1.238(DPOP) +1.581(YPL)	.911	644.363	3.350(−)	7.040

Government Investment Function

1. structural change in 1960

GI	= 74.168 −0.700(YP) 2.185(T)	.831	190.387	2.552	3.687

2. structural change in 1964

GI	= −231.193 +1,788(YP) −3.792(T)	.326	737.077	1.696	7.353

TABLE B3 (continued)

Direct Tax Collections Function

1. structural change in 1960

TD	= -19.478 +0.093(NI) +41.021(RGL)	*	.991	8.588	2.747	0.812

2. structural change in 1964

TD	= -15.294 +0.136(NI) -56.437(RGL)	** ***	.990	10.134	1.667	0.883

3. structural change in 1964, RGL held constant

TD	= -17.780 +0.099 $\frac{(NI)}{(RGL)}$ +23.238(RGL)	***** *****	.991	9.183	1.899	0.810

TABLE B4

INDIRECT TAX COLLECTIONS STRUCTURAL CHANGE LOGS

Non-Import Indirect Tax Collections (includes import tariff collections on SITC 9 commodities)

1. structural change in 1960

TIM	= -4.860 +0.047(GDP)		0.956	19.813	2.106	1.112

2. structural change in 1964

TIM	= -11.602 +0.063(GDP)	*	.960	18.063	2.584	1.063

Import Tariff Collections, SITC 0-1 Commodities

1. structural change in 1960

TM1	= -0.552 +0.219(MW1) +8.307(RG)		.935	0.705	1.778	0.224

2. structural change in 1964

TM1	= -8.639 +0.046(MW1) +39.105(RGL)	*** ***	.966	0.363	1.594	0.161

3. structural change in 1964, RGL held constant

TM1	= +8.880 +0.046(MW1) -28.636($\overline{RGL}$)		.848	1.755	1.570(?)	0.342

TABLE B4 (continued)

Import Tariff Collections, SITC 2-4 Commodities						
1. structural change in 1960						
TM2	= -1.119 +0.447(MW2)		.966	2.889	1.594(?)	0.425
2. structural change in 1964						
TM2	= -3.886 +0.619(MW2)		.939	5.461	0.768(+)	0.584
Import Tariff Collections, SITC 5-8 Commodities						
1. structural change in 1960						
TM3	= -1.439 +0.166(MW3)		.983	5.239	1.835	0.572
2. structural change in 1964						
TM3	= -0.302 +0.152(MW3)	*	.975	7.462	1.831	0.682

TITLE OF THESIS Structural Change in a Low-Income Country: An Econometric Approach Using the Republic of Kenya

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