AN EMPLOYMENT AND OUTPUT PROJECTION MODEL FOR KENYA AND NAIROBI

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David E. Black

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ABSTRACT

This paper reports on a simulation model which is designed to predict certain characteristics of employment and output for Kenya and Nairobi. The model has been used to make a 1985 employment projection for the City of Nairobi, however for this paper the model tests the employment implications of a variety of different combinations of assumptions about economic structure and future changes in exogenous variables, e.g. population growth

1. INTRODUCTION[+]

This paper reports on a simulation model which is designed to predict certain characteristics of employment and output for Kenya and for Nairobi. The initial motivation for the model's construction arose from a need expressed by the Nairobi Urban Study Group for a projection of employment in Nairobi for the year 1985[1]. A Nairobi employment projection is important to the study group for purposes of city planning and policy-making. It is a crucial ingredient for projecting land use demand and formulating land use policy. Also, the likely extent of future urban unemployment is of increasing concern to the Nairobi City Council.

However, the construction of a simulation model accomplishes more than simply providing a means of satisfying a specific need of the Nairobi Urban Study. In fact, a specific projection is not presented in this paper. Because the model is in the form of a computer program, the employment implications of a variety of different combinations of assumptions about economic structure and future changes in exogenous variables, like population growth, can be easily investigated.[2] A comparison among alternative simulations reveals the degree of sensitivity of future employment to different assumptions. Furthermore, the model generates other projections in addition to Nairobi employment. It projects Nairobi GDP and labor force, and because of the considerable interdependence between the Nairobi and Kenya economies, the model also makes employment and GDP projections for Kenya. Finally, a simulation model, once constructed, can be of continuing usefulness. It can be updated easily as additional information becomes available

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[+]I wish to thank David G. Davies, of the Ministry of Finance and Economic Planning Nairobi, for his assistance in the initial stages of this research and Alek Rozenthal, of the Nairobi Urban Study Group, for his assistance in producing interesting and useful projections.

1. The Nairobi Urban Study Group is a part of Nairobi City Council and is financed by the Kenya Government and Nairobi City Council, with some foreign technical assistance.

2. A description of the computer program is contained in "Description of a Program which Projects Output and Employment for Nairobi and Kenya," I.D.S. Discussion Paper No. 142, July, 1972. A copy of the program itself is available in the I.D.S. library.

-- either through the passage of time or because of a change in official attitudes regarding the release of Nairobi output and employment data. It can also be extended and adapted so as to project such things as manpower supply and demand, and the demand for some public services.

The next section of this paper (section II) briefly outlines a simulation model which could be constructed, but was not. This is followed by a description of the model which was constructed. The technical details relating to the discussion are relegated to appendices where possible. Section III presents simulation results and reliability tests. The paper concludes with a discussion of a few implications of the results (section IV) and some suggestions for extensions and improvements to the model (section V).

II. DESCRIPTION OF THE MODEL

A. A Model Which Could be Constructed

A model which could be constructed for Kenya and Nairobi is one for which data availability problems and cost considerations are ignored. Although data requirements for this model do not exceed the limits of existing data, much of the necessary data is simply not available. Unfortunately, there is a substantial difference between data which have been collected and data which are made available.

Because of the interdependence between the Nairobi economy and the national economy, employment projection for Nairobi must be made within a framework which takes into account important features of national economic growth. A national macroeconomic model serving this purpose would, at the minimum, project GDP shares by two-digit sectors as a function of forecasted population and aggregate GDP. A more satisfactory, but more involved, model would project aggregate GDP in addition to sectoral GDP shares. In this case, exogenous forecasts of domestic investment, government expenditures and export demand would be necessary. Constraints imposed by resource potential and the balance of payments would also have to be built into the model.

Ideally, a macroeconomic model should also be constructed for Nairobi and should be tied to the national economy through Nairobi imports, exports, migration, etc.. Nairobi growth would depend upon differential shifts in demand for output produced in Nairobi and upon shifts in labor supply brought about by migration. However, the acquisition of data necessary to estimate this model would be a formidable task. A feasible substitute for a Nairobi macroeconomic model could be provided by comparing Nairobi GDP growth to Kenya

GDP growth by sector. If, over time, Nairobi sectoral GDP growth rates display a consistent relationship to Kenya sectoral GDP growth rates, then Nairobi sectoral growth rates can be projected from the national projections. In the unlikely event that consistent relationships between Nairobi and national growth rates are not evident, then the relationships could be exogenously determined, and the sensitivity of the projections to likely magnitudes of the parameters representing the relationships could be tested.

In order to project the employment growth which will accompany GDP growth, production functions for each sector could be estimated for Nairobi and for the rest of the economy. Or, if production functions cannot be satisfactorily estimated, incremental employment-output relationships could be estimated.

Employment rate projections require, of course, labor force projections. For the national economy, the projection procedure is straightforward. Because migration is likely to be insignificant and because the potential 1985 labor force is already born, information about the present age distribution of the population and estimates of labor force participation rates can be used to formulate labor force projections. For the Nairobi economy, labor force projection is more difficult. Unlike national population and labor force, the Nairobi population and labor force will be greatly affected by migration from the rest of Kenya to Nairobi. Not only is the total size of the migration important but also its composition. Moreover, the nature and extent of migration will be a function of relative living standards and job opportunities. Thus, Nairobi population and labor force growth should be an endogenous projection. The parameters describing migration over time would probably have to be estimated from cross-section migration data.

Once a model such as that described above, is structured, each simulation would not be a function of forecasts of Kenya population and of a few exogenous components of aggregate output and population. In order to construct such a model, one would need time-series data on employment and GDP by sector for Kenya and for Nairobi, from at least 1964 to present, and information on rural-urban migration.

B. The Model Which Was Constructed

1. GDP, Kenya: Although a model like the one described above is relatively simple and demands only a modest amount of data, several important compromises in its structure were necessary. First,

instead of a macro-economic model of the Kenya economy, there are regression equations which project GDP shares for major sectors as a function of population and GDP per capita. The equations are based on work by Chenery and Taylor.[3] The purpose of their research was to provide evidence to test the hypothesis "that there are uniform patterns of change in the structure of production as income levels rise."[4] Their findings supported their hypothesis, although individual country differences are responsible for substantial variation. The pooled cross-country data which were used, were sub-divided into three groups according to the size of each country and its trade orientation -- toward primary or manufactured exports. Kenya falls into the small, primary-oriented classification along with sixteen other countries which are at various stages of development.[5] Thus the accuracy of Kenya sectoral shares projections, which are based upon Chenery-Taylor equations, depends on the extent to which the Kenya development process resembles that of other countries in the small, primary group.

Chenery-Taylor equations project three shares of GDP: industrial, primary, and services.[6] The equations are logarithmic and the independent variables are per capita GDP and population. Two different formulations of the equations can be used with available Kenya data. The constant terms in each formulation are adjusted so that the base year sectoral shares calculated by the equations equal the actual sectoral shares. When the projections, which are made by each formulation for the period 1964-1971, are computed to actual figures, it is clear that both formulations predict correctly the direction of changes in sectoral shares. However, both formulations underestimate the extent of the actual changes. For example, the

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3. H.B. Chenery and L. Taylor, "Development Patterns Among Countries and Over Time," Review of Economics and Statistics, November, 1968, pp. 391-416.

4. Ibid., p. 391.

5. Kenya, Cambodia, Congo, Ceylon, Rhodesia, Ecuador, El Salvador, Iraq, Honduras, Guatemala, Colombia, Malaya, Costa Rica, Chile, Venezuela, Denmark, Australia.

6. In the Kenya national income accounts, primary production equals Total Product outside the Monetary Economy plus Monetary Agriculture, Forestry, Fishing, and Mining and Quarrying; industry equals monetary Manufacturing and Repair, and Building and Construction; services equals all other sectors.

actual industrial share increased by 1.7 percentage points (12.5 per cent to 14.2 per cent) from 1964 to 1971 while the Chenery-Taylor equations predicted an increase of .5 to 1.3 percentage points. Since one of the two formulations predicts more rapid sectoral changes for each sector in the 1964-1971 period and for the purposes of this model, although results generated by the other formulation are also presented in Section III for comparison. The adjusted Chenery-Taylor equations are presented in Appendix E accompanied by regression statistics.

Because the 1964-1971 projections by the Chenery-Taylor equations were not entirely satisfactory, two alternatives to them were investigated. First, an attempt was made to estimate the Chenery-Taylor equations from 1964-1971 Kenya data. Although the estimated coefficients would not benefit from the influence of development patterns in more developed countries, the results might be adequate for a relatively short-term projection. However, the regressions were statistically very unsatisfactory. The second alternative is to project changes in sectoral shares at 1964-1971 average rates of change. Since these rates of change of sectoral shares depend to some extent on the aggregate rate of growth, the method is not very appealing on theoretical grounds. However, the results of this continued-trend method of projection are also presented in Section III for comparison with the Chenery-Taylor equation projections.[7]

In summary, the model contains a mechanism for projecting Kenya GDP shares for the three major sectors. Three different methods can be used (two sets of Chenery-Taylor equations plus a continued-trend method), and each projection depends upon an exogenous forecast of growth in aggregate GDP and population.

2. GDP, Nairobi: Data availability imposes a severe restriction on the method used to project Nairobi GDP. Nairobi GDP data is available for only one year, 1967. Therefore, it is impossible to compare past Nairobi GDP growth to Kenya GDP growth. In general, two factors can cause Nairobi's pattern of growth to differ from the national pattern: first, a Nairobi-Kenya difference between GDP mixes, i.e., different sectoral shares; and second, a Nairobi-Kenya difference between corresponding sectoral growth rates. 1967 Nairobi GDP can be used to estimate the importance of the first factor, different GDP mixes.

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7. See Appendix E for more information on this alternative method.

However, there is no sound basis for arriving at a quantitative estimate of either sectoral or aggregate Nairobi GDP growth rates. Thus, two alternative assumptions are made about the Nairobi-Kenya GDP relationships. The first assumption is that each of the Nairobi sectors grows at the national rate for that sector. The error which is possible with this assumption cannot be very great since Nairobi itself accounts for a relatively large proportion of Kenya GDP -- roughly 32 per cent of aggregate, 58 per cent of industry, and 47 per cent of services.

The second assumption which is made is that compared to the economy as a whole, Nairobi industrial GDP will grow at a slightly faster rate (10 per cent faster), and Nairobi primary GDP will grow more slowly (50 per cent slower). The present dominance of Nairobi industry is evidence of relatively faster Nairobi industrial growth in the past. It appears more than likely that a differential will persist for some time to come and that an arbitrary forecast of 10 per cent faster Nairobi industrial growth is probably conservative. With respect to primary production, a slower rate of growth for Nairobi is consistent with what one expects to occur in the usual process of urban growth. Although the specific forecasts of a 50 per cent slower primary growth rate is also arbitrary, the effect which this forecast will have on 1985 projections is insignificant because of the primary sector's very small share of total Nairobi GDP, less than 3 per cent of monetary sector GDP.

In summary, Nairobi projection for the three major sectors is based on an estimate of the Nairobi sectoral shares and two alternative assumptions about the future sectoral rates of growth for Nairobi relative to Kenya.

3. Employment, Nairobi and Kenya: Employment projections for Nairobi and for Kenya are based on the observed 1967-1971 relationship between Kenya wage employment and GDP.[8] For each of the three major sectors employment was regressed upon GDP. Because each regressions is logarithmic, the estimated coefficient of GDP is a constant elasticity estimate of the relation between employment and output.[9]

Using base year employment figures, the three elasticity estimates applied to sectoral GDP projections yield Kenya and Nairobi

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8. Unless otherwise stated, the definition of "employment" will be wage employment or monetary sector employment.

9. See Appendix D for more information about the regressions.

employment projections by sector. This method assumes, of course, that estimated Kenya employment output elasticities accurately characterize Nairobi employment-output relationships. Moreover, since a rate of labor productivity growth is implicit in each elasticity estimate, for any given rate of GDP growth, this assumption is equivalent to assuming that rates of labor productivity growth in each Nairobi sector are the same as the Kenya rates.[10] Such a situation is unlikely. One would expect the rate of productivity increase in the industrial and services sectors to be relatively higher in Nairobi. This has certainly been the case in the past. Relative to the economy as a whole, average labor productivity in Nairobi is now about 34 per cent higher in industry and 47 per cent higher in services. Production in Nairobi tends to be more capital intensive and on a larger scale. These factors and others can be expected to continue to lift the rate of labor productivity growth in Nairobi above the average national rate. In view of this, an alternative to the equal-productivity assumption is considered. Average labor productivity in Nairobi is assumed to be 10 per cent higher in the industrial and services sectors than that determined for them by the estimated employment-output elasticities. Employment growth rates are adjusted to reflect this productivity difference.[11]

In addition to wage employment projections, two different projections of Nairobi non-wage employment are made. One is based on the International Labour Organization estimate of 1969 Nairobi non-wage employment and the other on an official 1969 estimate of Nairobi

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10. The following shows how the rate of productivity growth depends on employment-output elasticities and output growth rate.

$$P_g = Q_g - E_g, \qquad (1)$$

where P_g is the rate of productivity growth,

Q_g is the rate of aggregate GDP growth, and

E_g is the rate of employment growth.

$$e = E_g / Q_g, \qquad (2)$$

where e is the employment-output elasticity. Rewriting (2)

$$E_g = e \times Q_g . \qquad (3)$$

Substituting (3) into (1)

$$P_g = Q_g - e \times Q_g$$

or,

$$P_g = Q_g (1 - e) .$$

non-wage employment. The ILO-based projection assumes total non-wage employment will grow at the same rate as wage employment in Nairobi services sector. On the other hand, since the official estimate is disaggregated by sector, non-wage employment in each of the three major sectors is assumed to grow at the projected Nairobi wage employment growth rate for that sector.

In summary, Nairobi and Kenya employment projections for the three major sectors are made by applying estimated employment-output elasticities to GDP projections. For Nairobi, one can assume that its labor productivity increases will be either equal to or somewhat above the national average.

4. Population and Labor Force, Kenya: Four alternative Kenya population forecasts are considered. Forecasts of average annual rates of population growth for the period 1971 to 1985 range from 3.28 per cent for the lowest to 3.66 per cent for the highest.[12]

There is only one labor force forecast. Since almost all of the potential labor force up to 1985 is already born, the projection is independent of population projections.[13]

5. Population and Labor Force, Nairobi: For Nairobi, migration is a dominant factor in determining population and labor force growth. Between 1962 and 1969 about 80 per cent of the 9 per cent annual increase in the African population of Nairobi was the result of in-migration. In the two Nairobi population forecasts which are used, it is assumed that migration will continue to be the most important factor in Nairobi population growth, but that its importance will gradually decline. The average annual rates of population growth for the two forecasts are 6.98 per cent and 6.41 per cent.[14]

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12. The assumptions upon which each of these forecasts is based are described in Appendix B.

13. Details of the forecast are contained in Appendix C.

14. Details of the forecast are contained in Appendix B.

Unlike the Kenya labor force forecast, the Nairobi forecast does depend on the rate and composition of Nairobi population growth between 1971 and 1985. This occurs because part of Nairobi population growth arises from in-migration of people who qualify as members of the labor force. Thus, there are two Nairobi labor force forecasts -- one derived from each of the population forecasts.[15]

6. Overview of the Model: The model which is described in the previous pages is not designed for the purpose of producing any particular projection. Instead its design allows for a variety of different projections, each one dependent upon a particular forecast of a few basic variables and assumptions about certain structural parameters. More specifically, four different Nairobi population forecasts are possible. Any rate of aggregate Kenya GDP can be selected. With respect to structural parameters, three ways of projecting Kenya GDP mix and two means of relating Kenya GDP growth to Nairobi GDP growth are possible. Nairobi monetary sector employment can be related to Nairobi GDP in two different ways, and Nairobi non-wage employment can be projected in two different ways. Once a combination of these alternatives is chosen, the model predicts annually (1972-1985) sectoral GDP for Kenya, sectoral and aggregate monetary GDP for Nairobi, sectoral and aggregate employment for Kenya and for Nairobi, monetary sector employment as a per cent of labor force for Kenya and Nairobi, and non-wage employment for Nairobi.

III. TESTS OF VALIDITY AND SIMULATION RESULTS

Some assessment of the predictive power of the model is necessary if it is to be used for planning or policy purposes. There are several criteria upon which to judge the reliability of a simulation model. Although individually none of the criteria are conclusive, together they can provide some basis for evaluation. One test of reliability is achieved by observing how well the model predicts the latest year for which data is available, 1971. A second, more general kind of testing is accomplished by examining the

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15. Details of the forecast are contained in Appendix C.

sensitivity of projections to alternative exogenous forecasts and structural assumptions. If reasonable limits of variation in individual alternatives are known, then the effects which variations in these individual alternatives have upon projections can be examined for reasonableness. Since sensitivity analysis does reveal the behavior of the model, it is useful not only for validity testing but also as a means of presenting results. Thus, this section discusses both model reliability and simulation results.

With respect to the first kind of test referred to above, the model can be used to generate two different 1971 predictions for comparison with actual 1971 figures: a seven-year prediction (base year, 1964) of Kenya GDP shares and a four-year prediction (base year, 1967), of Kenya GDP shares and of Kenya employment by sector. The employment prediction is limited to only four years because adequate employment data for earlier years is unavailable.[16] Assuming that one would have forecast population growth and aggregate GDP growth accurately and using the Chenery-Taylor equation set which produces the smallest error, set (2), the seven-year projection would have made the following errors in Kenya sectoral 1971 GDP's: industry, -2.8 per cent; primary production, +8.4 per cent; services -6.7 per cent. Under the same conditions, the four-year GDP projections are in error by -4.92 per cent, +5.4 per cent, and -2.5 per cent for the same three sectors respectively. Employment projections for these three sectors are in error by -5.8 per cent, +2.1 per cent, and -0.9 per cent respectively. The total employment prediction is off by -0.4 per cent.

Similar testing of the Nairobi predictions was not undertaken. The results of such tests are meaningless because adequate time series data for Nairobi are lacking. Moreover, what the above Kenya prediction errors imply about the accuracy of Nairobi predictions is unclear, except to note that Kenya primary sector errors will have little impact on Nairobi predictions because of the relative unimportance of the primary sector in the Nairobi economy.

The results of sensitivity tests are contained in Tables 2-5. Table 1 presents some base year data for comparison with simulation results. Only the most interesting information from a selected number of the many possible simulations is presented. The difference among simulations in any given table is caused by changes

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16. The continued-trend method of prediction was not tried. Because it is based on actual trends, it necessarily makes a perfect 1971 projection.

in one or two structural assumptions or in one of the forecasts. An examination of the effects of alternative structures is followed by an examination of the effects of alternative population and GDP forecasts.

As stated earlier, there are three different methods of projecting Kenya GDP shares: two sets of Chenery-Taylor equations and a continued-trend method. By comparing Tables 1 and 2, it can be seen that all three methods predict the same direction of sectoral shares changes. Chenery-Taylor equation set (2) predicts the most rapid industrial growth. On the other hand, compared to the continued-trend projection, both Chenery-Taylor equation sets predict a less rapid decline in primary sector share and a less rapid increase in services sector share. Nairobi GDP and employment is relatively more sensitive to the choice of share projection method than is Kenya employment. For all of the simulations presented in Tables 3-5, Chenery-Taylor equation set (2) is used. (See discussion in II. B. 1.)

TABLE 1
GDP Shares and Employment Rates
(1971)

	Kenya	Nairobi
GDP Share (%)		
Industry	14.2	26.3[a]
Primary	38.1	2.8[a]
Services	47.7	70.9[a]
Employment Rate (%)	17.2	59.9

[a]These figures are estimates. See Appendix A.

Structural alternatives which involve the relation between Nairobi and Kenya with respect to GDP and labor productivity growth can only affect Nairobi projections. Table 3 shows the independent effect of a difference in GDP growth, simulation (2); a difference in labor productivity growth, simulation (3); and a difference in both GDP growth and labor productivity growth, simulation (4). Neither of these two differences are assumed in simulation (1). The 3.6 per cent increase in 1985 Nairobi GDP, which results from assuming that industry will grow 10 per cent faster and that primary production will grow 50 per cent slower than the corresponding Kenya sectors, is responsible for a 4.1 per cent increase in 1985 Nairobi employment. With respect to labor productivity differences, 10 per cent greater annual Nairobi productivity growth in industry and services cuts 1985 Nairobi employment by 5.4 per cent.

TABLE 2

Sensitivity to Method of Projecting Kenya GDP Shares

	Simulations		
	Chenery-Taylor (1)	Equations (2)	Continued-Trend
GDP, Kenya			
Shares (%)			
Industry	16.6	18.4	17.5
Primary	32.7	30.8	27.9
Services	50.7	50.8	54.6
GDP, Nairobi			
Shares (%)			
Industry	31.0	33.4	30.7
Primary	1.4	1.3	1.2
Services	67.7	65.3	68.1
Growth, 1972-1985	8.70-8.98	9.08-9.17	9.46-9.26
Total	531	552	569
Employment, Kenya			
Growth, 1972-1985	3.42-3.80	3.51-3.93	3.49-3.78
Total	1,114	1,132	1,119
Rate (%)	17.4	17.7	17.5
Employment, Nairobi			
Growth, 1972-1985	3.61-4.53	3.90-4.82	3.93-4.61
Total	297	309	305
Rate (%)	42.0	43.8	43.3

In all simulations: ave. annual population growth Kenya = 3.4%, Nairobi = 7.0%; ave. annual GDP growth Kenya = 8.0%; Nairobi GDP growth compared to Kenya: industry + 10%, primary - 50%; Nairobi labor productivity growth compared to Kenya: industry + 10%, services + 10%. (Growth rates are annual per cents. GDPs are in mil. £. Employment is in '000s. All figures are for 1985 unless otherwise indicated.)

TABLE 3

Sensitivity to Changes in Nairobi GDP and Productivity Growth Relative to Kenya

	Simulations (1)	(2)	(3)	(4)
GDP, Nairobi				
Shares (%)				
Industry	30.4	33.4	30.4	33.4
Primary	2.0	1.3	2.0	1.3
Services	67.6	65.3	67.6	65.3
Growth, 1972-1985	8.91-8.33	9.08-9.13	8.91-8.83	9.08-9.17
Total	533	552	533	552
Employment, Nairobi				
Growth, 1972-1985	4.18-4.76	4.37-5.20	3.72-4.39	3.90-4.82
Total	314	327	297	309
Rate (%)	44.5	46.3	42.0	43.8

Simulations

(1) Nairobi sectoral growth rates and sectoral productivity growth rates same as Kenya's.

(2) Nairobi industry GDP growth rate 10% greater and primary GDP growth rate 50% less than Kenya's. Nairobi sectoral productivity growth rates same as Kenya's.

(3) Nairobi sectoral GDP growth rates same as Kenya's. Nairobi rates of industry productivity growth and services productivity growth 10% greater than Kenya's.

(4) Nairobi industry GDP growth rate 10% greater and primary GDP growth rate 50% less than Kenya's. Nairobi rate of industry productivity growth and services productivity growth 10% greater than Kenya's.

In all simulations: ave. annual population growth Kenya = 3.43%, Nairobi = 7.0%; ave. annual GDP growth Kenya = 8.0%; Kenya GDP share projection method is Chenery-Taylor equation set (2). (Growth rates are annual per cent. GDPs are in mil. £. Employment is in '000s. All figures are for 1985 unless otherwise indicated.)

TABLE 4
Sensitivity to Kenya Population Growth

	Simulations (1)	(2)	(3)	(4)
Population Growth, 1972-1985	3.58-3.76	3.58-25	3.58-3.09	3.58-2.92
GDP, Kenya				
Shares (%)				
Industry	18.3	18.4	18.5	18.5
Primary	31.1	30.8	30.7	30.6
Services	50.6	50.8	50.9	50.9
GDP, Nairobi				
Shares (%)				
Industry	33.3	33.4	33.4	33.5
Primary	1.3	1.3	1.3	1.3
Services	65.5	65.3	65.3	65.3
Growth, 1972-1985	9.08-9.09	9.08-9.17	9.08-9.20	9.08-9.23
Total	549	552	553	554
Employment, Kenya				
Growth, 1972-1985	3.51-3.91	3.51-3.93	3.51-3.94	3.51-3.95
Total	1,131	1,132	1,133	1,133
Rate (%)	17.7	17.7	17.7	17.7
Employment, Nairobi				
Growth, 1972-1985	3.90-4.75	3.90-4.82	3.90-4.84	3.90-4.86
Total	308	309	309	310
Rate (%)	43.6	43.8	43.8	43.9

In all simulations: ave. annual population growth Nairobi = 7.0%; ave. annual GDP growth Kenya =8.0%; Nairobi GDP growth compared to Kenya: industry + 10%, primary - 50%; Nairobi labor productivity growth compared to Kenya: industry + 10%, services + 10%; Kenya GDP share projection method is Chenery-Taylor equation set (2). (Growth rates are annual per cents. GDP's are in mil. £. Employment is in '000s. All figures are for 1985 unless otherwise indicated.)

Alternative rates of Kenya population growth appear to have very little effect on 1985 projections, as one can see from Table 4. Even though the four projections assume substantially different fertility changes (See appendix B.), the impact of the differences on 1985 population is not very great. At most the difference in 1985 population is less than a million or slightly over 4 per cent. For a longer simulation period, e.g., to 2000, a continuation of the two extreme projections produces a 2000 population difference of over ten million, a difference of about 35 per cent.

An important shortcoming of this model is that Nairobi population growth must be exogenously forecast and affects only the Nairobi employment rate. The highest of the two Nairobi population growth forecasts produces a 1985 employment rate projection of 43.8 per cent, and the lowest forecast produces a projection for 47.2 per cent.

Compared to the effects of reasonable variations in Kenya population forecasts, reasonable variations in Kenya aggregate GDP forecasts, shown in Table 5, have far greater impact on 1985 projections. A two percentage point increase in the annual rate of Kenya GDP growth raises the rate of Nairobi GDP growth by about 2.5 percentage points, the rate of Kenya employment growth by about 1 percentage point, and the rate of Nairobi employment growth by over 1 percentage point. The positive effect on the Nairobi employment rate is probably overstated since the rate of in-migration to Nairobi is likely to depend positively upon the rate of GDP growth.

The projections of Nairobi non-wage employment are contained in Table 6. The column-one projection is based on a 1969 ILO estimate of "informal" sector employment in Nairobi. Its ratio to Nairobi monetary sector employment is about 0.18 in 1971 and 0.13 in 1985. The other projection shown in Table 6, one which surely under-estimates non-wage employment, is based on the official 1969 estimate of non-wage employment by sector in Nairobi. The ratio of this projection to monetary sector employment declines slightly from 0.05 to 0.04.

TABLE 5

Sensitivity to Kenya GDP Growth

	Simulations		
	(1)	(2)	(3)
GDP Growth	6.0	8.0	10.0
GDP, Kenya			
Shares (%)			
Industry	16.8	18.4	20.1
Primary	33.8	30.8	28.0
Services	49.4	50.8	51.9
Total	1,161	1,508	1,950
GDP, Nairobi			
Shares (%)			
Industry	31.1	33.4	35.6
Primary	1.6	1.3	1.0
Services	67.3	65.3	63.4
Growth, 1972-1985	6.63-6.74	9.08-9.17	11.54-11.59
Total	402	552	752
Employment, Kenya			
Growth, 1972-1985	2.61-2.83	3.51-3.93	4.42-5.11
Total	989	1,132	1,301
Rates (%)	15.5	17.7	20.4
Employment, Nairobi			
Growth	2.83-3.34	3.90-4.82	4.97-6.41
Total	260	309	369
Rate (%)	36.8	43.8	52.3

In all simulations: ave. annual population growth Kenya = 3.43%, Nairobi = 7.0%; Nairobi GDP growth compared to Kenya: industry + 10%, primary = 50%; Nairobi labor productivity growth compared to Kenya: industry + 10%, services + 10%; Kenya GDP share projection method is Chenery-Taylor equation set (2). (Growth rates are annual per cents. GDPs are in mil. £. Employment is in '000s. All figures are for 1985 unless otherwise indicated.)

TABLE 6

Non-Wage Employment, Nairobi

	Projections	
	(1)	(2)
1971	30,800[a]	9,738[b]
1985	40,899	16,499

[a]Based on the 1969 estimate of "informal" sector employment in Nairobi made by the International Labor Organization.

[b]Based on the 1969 estimate of non-wage employment in Nairobi by the Statistics Division, Ministry of Finance and Economic Planning. Published in "Nairobi and National Employment: Structure and Growth, 1964-1970," A-M Vukovich, p. 10, Table 14.

IV SOME IMPLICATION OF THE PROJECTIONS

The simulation results suggest a growing problem of unemployment for Nairobi. Given the conditions of simulation (2), Table 5, the employment rate falls by about 16 percentage points by 1985. Even if an optimistic 10 per cent rate of GDP growth is assumed, the rate still falls by over 7 percentage points. By using the slowest Nairobi population forecast, the extent of the decline in the employment rate is reduced by less than 4 percentage points. Although wage employment (as employment is defined here) is only part of total employment, both of the non-wage employment projections grow at even slower rates than wage employment. Clearly, if Nairobi is to avoid a severe urban unemployment problem which is so common in the developing world, some kind of employment policy measures are necessary.

The results also suggest that although the long-run effects of present population control efforts may be great, the short-run effects are not. Even optimistic population control results have little effect on 1985 projections. The effect of fertility rate decreases are offset for some time by the rapid increase in women of child bearing age resulting from the recent population upsurge.

Finally, the results illustrate the very important effect which overall economic growth is likely to have on Nairobi development. Unfortunately, the model is not designed to illustrate the equally important influence which Nairobi growth is likely to have on Kenya development. Nevertheless, the interdependence between the two economies is already

considerable, and unless decentralization efforts are more effective than they have been so far, the Nairobi economy will probably play a leading role in Kenya's industrial development.

V. IMPROVEMENTS AND EXTENSIONS

Much could be done to improve the simulation model described in the previous pages. The method of projecting Kenya GDP shares would be improved by the use of a relatively simple macro-model instead of the Chenery-Taylor equations which characterize the average behavior of a group of countries. The assumption that Kenya development is likely to follow the average pattern is not a very good substitute for basing aggregate output projections on forecasts of exogenous factors which are likely to be important to the Kenya economy.

The model of Nairobi economy is even less satisfactory than that of Kenya. Although the Nairobi economy is an integral part of the national economy, the various interacting production and supply relationships are not taken into account by explicit behavioral relationships. Instead, arbitrary assumptions about relative Nairobi-Kenya productivity and GDP growth rates are employed. Moreover, the process of migration is very inadequately treated. It is exogenously forecast and affects only Nairobi population growth and employment rates. In fact, the nature and extent of migration will be both a function of, and a determinant of, the course of urban and rural development.

Another possible improvement could be achieved by disaggregating the model. The present level of aggregation requires generalizations about employment-output relationships among production processes which vary considerable in nature. The services sector, for example, includes both utilities and government.

Unfortunately, these improvements involve more detailed modelling which is difficult to achieve, if not impossible, without more data than is now available. This is particularly true with respect to the Nairobi economy. The reliability of Nairobi projections, even with the model in its present form, would be much improved if more Nairobi data were available.

Little effort would be required to extend this model. The computer program is written so that new segments can be easily added. Using projections of income, population, and employment, demand projections could be made for such things as housing, schools, social services, power, and roads. If greater disaggregation can be achieved, manpower projections could also be generated.

APPENDIX A

TABLE A1

Nairobi Employment and GDP
(Both Monetary Sector)[a]

	1967	1967	1969	1971
GDP (mil , 1964 prices)				
Industry	29.7			42.7[c]
Primary	3.6[b]			4.5[c]
Services	85.3			115.2[c]
Total	118.6			162.4[c]
Employment				
Industry	45,081	46,491	45,432	55,638[d]
Primary	6,622	6,566	6,429	6,558[d]
Services	111,989	110,834	111,754	107,917[d]
Total	163,692	163,891	163,615	170,113[d]
Population				585,191[e]

[a]Data Sources: GDP data from "Technical Appendix No. 1, Population and Employment," A-M. Vukovich (based on tables specially prepared by Ministry of Finance and Economic Planning, July 31, 1971); Employment data from "Nairobi and National Employment 1964-1970," A-M Vukovich, Table 11 (based on tables specially prepared by Ministry of Finance and Economic Planning, October, 1971).

[b]Estimate. An official figure is available for only part of Nairobi primary sector GDP, mining £ 0.4 mil.. The agricultural component was therefore estimated. Two methods of estimation were attempted. First, the official estimate of 1967 monetary sector agricultural earnings in Nairobi was used by assuming that the average 1967-1971 ratios of Kenya earnings to GDP in monetary sector agriculture are the same as Nairobi's. The resulting estimate of current price Nairobi agricultural GDP is £4.0 mil.. Calculations are shown below. (Nairobi figures are for 1967).

GDP in Nairobi monetary sector agriculture in a/b,

where a = earnings in Nairobi monetary sector agriculture, and

b = 1969-1971 average Kenya ratio of monetary sector agricultural earnings to GDP.

Since a = £0.8 mil., and

b = 0.21,

GDP in Nairobi monetary sector agriculture = £4.0 mil..

The second method of estimation makes use of the 1967 official estimate of Nairobi employment in monetary sector agriculture and assumes that the ratio of modern sector agricultural GDP per employee in Kenya is

the same as that for Nairobi. By this method Nairobi monetary sector agricultural GDP is £2.0 mil.. Calculations are shown below. (all figures are for 1967).

GDP in Nairobi monetary sector agriculture c x d,

Where c = GDP in Kenya monetary sector agriculture per employee, and

d = employment in Nairobi monetary sector agriculture.

Since c = £329 and

d = 5,959

GDP in Nairobi monetary sector agriculture = £2.0 mil..

Since there is no reason for choosing one of these estimates over the other, £3.0 mil. is taken as the current price, 1967 agricultural GDP for Nairobi. This estimate is converted to 1964 prices by applying the Kenya price index for monetary agriculture. The resulting estimate in 1964 prices is £3.2 mil..

[c]Estimates. These estimates were made by applying the 1967-1971 Kenya growth rates by sector to the 1967 Nairobi GDP (in 1964 prices) by sector. The resulting estimated growth in Nairobi constant price GDP is 39.2 per cent. This compares to a 34.8 per cent growth rate for Kenya over the same period.

[d]Estimates. In order to estimate 1971 Nairobi employment by sector, the ratios of Nairobi to Kenya employment for 1967-1969 were calculated in each of eight sectors (agriculture, mining, manufacturing, construction, electricity and water, commerce, transport, and services). Then, based upon apparent trends in these ratios, 1971 ratios were estimated and used with 1971 Kenya employment figures to derive the 1971 Nairobi employment estimates. These eight estimates were aggregated to the three major sectors used in this model. The estimates imply that Nairobi's aggregate monetary sector employment grew by 4.0 per cent from 1969 to 1971. Kenya aggregate monetary sector employment grew by 8.4 per cent over the same period.

[e]Estimated by A-M. Vukovich in "Technical Appendix No. 1."

TABLE A2

Kenya Employment (Monetary Sector) and GDP (Monetary Plus Non-Monetary Sectors)[a]

	1964	1965	1966	1967	1968	1969	1970	1971
GDP (mil.£, 1964 prices)								
Industry	40.99	42.49	46.69	50.83	56.38	60.44	64.56	73.08
Primary	145.05	133.12	161.17	164.24	173.05	183.95	192.04	195.57
Services	142.40	155.24	171.31	181.33	197.68	209.94	228.90	244.75
Total	328.44	330.85	379.17	396.40	427.12	454.33	485.50	513.40
Employment								
Industry				98,163	102,583	101,688	113,082	127,609
Primary				192,448	193,069	197,592	207,387	214,106
Services				306,758	310,758	327,934	324,012	338,012
Total				597,369	606,410	627,214	644,481	679,727
Population ('000s)								11,694

[a]Data Sources: GDP data from Economic Survey 1970, 1971, and 1972; Employment data from Employment and Earnings 1963-1967, 1971 Statistical Abstract, and tables specially prepared by the Ministry of Finance and Economic Planning.

APPENDIX B

ALTERNATIVE POPULATION PROJECTIONS

Kenya[1]

Four alternative Kenya population forecasts are considered. They are described in Table B1. All assume that there will be no change in the estimated 1969 fertility rate of 7.6 through 1975, and that life expectancy will lengthen steadily from an estimated 49 years in 1969 to 54.7 years by 1985. The projections differ with respect to fertility trends after 1975. The highest population projection, (1), assumes that the fertility rate does not change. The lowest projection, (4), assumes that the fertility rate falls by 25 per cent to 5.6 by 1985. The two intermediate projections assume less rapid declines in fertility rates.

As can be seen from Table B1, projection (1) is the only projection for which the rate of population growth rises. This occurs even though births per 1,000 population decline continuously, as in the other projections. Although the rapid decline in fertility implied by projection (4) would be difficult to achieve, the overall rate of population growth for this projection is, in fact, equal to the rate of population growth in all of Africa during the 1960's and only slightly below the estimated 1969 rate of population growth in Kenya, 3.30 per cent.

TABLE B1

Population Projections

Kenya

	Alternatives			
	(1)	(2)	(3)	(4)
Growth Rates (%)				
1971-1975	3.58	3.58	3.58	3.58
1976-1980	3.65	3.43	3.32	3.27
1981-1985	3.76	3.25	3.09	2.93
1971-1985 ave.	3.66	3.43	3.35	3.28
Population, 1985 ('000s)	19,337	18,756	18,541	18,374

1. Kenya population projections are taken from the Kenya Statistical Digest, pp. 1-3.

Nairobi[2]

Two Nairobi population forecasts are described in Table B2. Both forecasts assume that the Nairobi fertility rate will decline from the 1969 estimate of 5.5 to 4.7 by 1985 and that life expectancy will steadily rise from the 1969 estimate of 55 years to 58.6 years by 1985. The difference between the projections arises from different rates of in-migration(as a per cent of total population). The relatively small difference between in-migration rates and total population growth rates shown in Table B2 results from an assumed decline in the Asian population and a very slow increase in the European population. The natural rate of increase among Africans in Nairobi is a little less than 3.0 per cent.

TABLE B2

Population Projections

Nairobi

	Alternatives (1)		Alternatives (2)	
	Growth Rate %	In-Migration Rate %	Growth Rate %	In-Migration %
1971-1974	7.3	6.5	6.9	6.0
1975-1979	7.3	5.7	6.7	5.0
1980-1984	6.7	4.7	6.0	4.0
1985	5.8	3.5	5.4	3.0
1971-1985	7.0	5.4	6.4	4.7
	Population ('000s)			
1985	1,505		1,396	

2. Nairobi population projections are taken from "Nairobi -- Initial Population Projections," A-M. Vukovich. A complete discussion of all the underlying assumptions involved in these projections is available in this paper.

APPENDIX C

LABOR FORCE PROJECTIONS

Kenya[3]

Although labor force projections are a function of the age-sex distribution and of total population growth, the 1985 labor force does not depend upon population changes between 1971 and 1985 because these people in the potential 1985 labor force are already born. Thus, there is only one labor force projection. This projection assumes that the labor force will be composed of 95 per cent of all males and 45 per cent of all females between the ages of 15 and 59 years. The usual international assumption of 64 years as the upper age limit for members of the labor force is modified because of the relatively shorter life expectancy in Kenya. The projection is described in Table C1.

TABLE C1

Labor Force Projection

Kenya

	LABOR FORCE ('000s)	GROWTH RATE %
1971	3,948	
1971-1975		3.41
1976-1980		3.48
1981-1985		3.57
1985	6,384	

Nairobi[4]

The Nairobi labor force projection is based upon estimated 1971 and projected 2000 Nairobi population by age and sex. From these two distributions the 1985 age-sex distribution was interpolated. Then, by assuming that the labor force will be composed of 95 per cent of all

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3. The Kenya labor force projection is taken from the Kenya Statistical Digest, pp. 4,5.

4. Nairobi labor force projections are based upon data and projections contained in two publications: "Nairobi -- Initial Population Projections, "A-M. Vukovich, Table 4; "Technical Appendix No. 1," A-M. Vukovich, page 4.

males and 45 per cent of all females between 15 and 59 (the same assumption as for the Kenya labor force), the projected 1985 labor force participation rate was calculated. Participation rates between 1971 and 1985 were obtained by interpolation. Thus, a labor force projection can be produced by applying projected participation rates to the total Nairobi population projection. Although there are two projections of Nairobi population (See Appendix B.), each with a slightly different age-sex distribution for the over-fifteen population the implied labor force participation rates are virtually the same, and therefore, only one set of participation rates is used. As shown by Table C2, labor force participation rates decline gradually. This is caused by a slow change in Nairobi age-sex population distribution in the direction of the national distribution. At present the proportion of working age males in Nairobi is well above the national proportion.

TABLE C2
Labor Force Participation Rate Projections
(Selected Years)
Nairobi

	RATES (%)
1971	48.5
1975	48.0
1980	47.4
1985	46.9

APPENDIX D

EMPLOYMENT-OUTPUT ELASTICITIES

The relationships between employment and GDP for each of the three major sectors were estimated by ordinary least squares regressions. In each regression the dependent variable was monetary sector employment and the independent variable was monetary sector constant price GDP. Since a logarithmic formulation of the relationship was used, the coefficient of GDP is an estimate of the constant elasticity relationship between employment and output. The regression results are shown below:

$$\log E_I = 5.24 + 0.729 \log Y_I \qquad R^2 = .939$$
$$(1.34) \quad (0.154)$$

$$\log E_P = 8.67 + 0.398 \log Y_P \qquad R^2 = .877$$
$$(1.12) \quad (1.126)$$

$$\log E_S = 9.60 \quad 0.310 \log Y_S \qquad R^2 = .921$$
$$(0.75) \quad (0.076)$$

E_I, E_P, and E_S are monetary sector employment in industry, primary production, and services; Y_I, Y_P, and Y_S are monetary sector GDP for the same three sectors. Standard errors are in parentheses. Five annual observations (1967-1971) were used in the regressions.

APPENDIX E

CHENERY-TAYLOR EQUATION ADJUSTMENTS AND AN ALTERNATIVE METHOD OF PROJECTING KENYA GDP SHARES.

Two sets of equations which were estimated by Chenery and Taylor, provide the basis for projecting sectoral GDP shares.[5] Ordinary least squares regression techniques were employed. The regressions are based on cross-country data from countries whose trade patterns are oriented toward primary exports. The intercept in each regression is adjusted so that the regressions would estimate base year (1971) GDP shares correctly. The adjusted equations are as follows:

Set (1) Regression Equations

$$\log X_I = -1.7243 - \underset{(.29)}{0.4748} \log y + \underset{(.02)}{0.0705} (\log y)^2 + \underset{(.02)}{0.0257} \log N \qquad R^2 = .716$$

$$\log X_P = -2.1470 + \underset{(.24)}{0.6374} \log y + \underset{(.02)}{0.0863} (\log y)^2 + \underset{(.02)}{0.0066} \log N \qquad R^2 = .684$$

$$\log X_S = -1.6911 + \underset{(.16)}{0.3910} \log y - \underset{(.01)}{0.0257} (\log y)^2 + \underset{(.02)}{0.0210} \log N \qquad R^2 = .271$$

Set (2) Regression Equations

$$\log X_I = -4.6947 + \underset{(.02)}{0.3439} \log y + \underset{(.02)}{0.0569} \log N \qquad R^2 = .697$$

$$\log X_P = -1.1357 - \underset{(.02)}{0.3652} \log y - \underset{(.02)}{0.0312} \log N \qquad R^2 = .659$$

$$\log X_S = -0.8240 + \underset{(.01)}{0.0924} \log y - \underset{(.01)}{0.0323} \log N \qquad R^2 = .259$$

X_I, X_P, and X_S are sectoral Kenya GDP shares of industry, primary production and services; y and N are GDP per capita and population. Standard errors are in parentheses below the estimated coefficients. A standard error is not given for the intercept term because the intercepts shown above are not the same as those in the original regressions.

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5. Chenery and Taylor, "Development Patterns." p. 400.

An alternative to the Chenery-Taylor equations as a method for projecting Kenya sectoral shares is based upon 1964-1971 trends in sectoral shares. Over the 1964-1971 period, the industrial share expanded at an annual rate of 1.89 per cent and services at 1.36 per cent per annum. These rates of change were used to project sectoral shares from 1971 to 1985. In Table 2 this method is referred to as the "continued-trend" projection.

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