SENEGAL: A STUDY OF ALTERNATIVE FOREIGN BORROWING STRATEGIES

Hafez Ghanem

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Abstract

This paper studies the impact of alternative foreign borrowing strategies on economic growth and social welfare in Senegal. The main tool of analysis used is a dynamic optimal control model where the objective is to maximize the discounted sum of per capita utility using foreign borrowing and investment as controls. The model is used to assess past borrowing strategies and to present recommendations for the future. The assessment of past policies is carried out by comparing actual past behaviour with the model results. Thus, the paper presents estimates of past over-borrowing and over-investment and attempts to analyze the factors to which they can be attributed. A projections exercise is also carried out and desired future borrowing and investment paths are presented. The impact of domestic policy changes and of modifications in donors' behavior on those desired paths is also studied. Senegal is extremely vulnerable to exogenous random shocks. Therefore, the model is used to derive appropriate policy responses to the occurrence of droughts, changes in the terms of trade and changes in the cost of foreign borrowing.
Summary and Conclusions

Senegal's foreign liabilities have grown rapidly since the mid-1970's. Combined with severe shortfalls in recent export levels, rising debt service obligations have led to widening current account deficits. Senegal has been forced to reschedule its external obligations every year since 1981. Nor do prospects for the future augur well. These developments necessitate a major change in Senegal's external borrowing and macroeconomic policies. Therefore, the aim of this paper is to study the impact of alternative foreign borrowing and investment strategies on economic growth and social welfare. The main tool of analysis used here is a dynamic optimal control model where the objective is to maximize the discounted sum of per capita utility using foreign borrowing and investment as controls. This approach represents an improvement over existing tools of analysis. In the traditional planning models, domestic expenditures are determined exogenously; and thus planned levels of foreign borrowing are simply calculated as the difference between expenditures and production. In the model used here, the desired path of foreign borrowing and the level and composition of domestic expenditures are chosen simultaneously so as to maximize the discounted value of present and future private consumption.

This methodology permits a quantitative analysis of important policy questions. These are:

(1) Has Senegal Overborrowed in the Past? Our model results indicate that at no time during the period 1977-81 (the five years immediately preceding the first rescheduling) should Senegal have resorted to nonconcessional sources of foreign funds. That is, the amount of overborrowing is
exactly equal to the value of new nonconcessional commitments entered into during that period (around $573 million or one-third of total debt). Senegal is more vulnerable to exogenous shocks than most countries in its income class. This fact explains why its debt carrying capacity is lower than the average for those countries. Our results also indicate that Senegal has overinvested. Gross investment should have been some 40 percent lower than actual levels.

(ii) To What Can We Attribute This Overborrowing? The model conclusions indicate that Senegal’s past overborrowing and overinvestment cannot be attributed to the government’s inability to predict adverse shocks. Without droughts Senegal would still have been heavily overborrowed in 1981. Nor can they be attributed to an excessively high discount rate. This would have shifted resources from investment to consumption. Past practices can only be explained by the existence of ad hoc constraints on the government’s ability to adjust domestic expenditures. High levels of past domestic expenditures (including government consumption, private consumption and investment) and the concomitant accumulation of non-concessional foreign liabilities imply a reduction in future consumption and welfare.

(iii) What are the Prospects for the Future? Given the existing debt overhang, an appropriate policy for the future would be to avoid additional non-concessional borrowing and reduce investment to around 10-11 percent of real GDP. However, such a scenario implies a sharp decline in private consumption, which will probably not be feasible. On the other hand, if real per capita private consumption is to be maintained near present levels, investment will have to fall dramatically. This drop in investment
will result in a declining real per capita GDP. Both of the above scenarios are unacceptable.

(iv) What Would Be the Impact of Domestic Policy changes? The above conclusions indicate that the government should undertake policy changes that would lead to higher investment and growth without further jeopardizing the debt situation. Such policy changes should aim at: reducing government consumption, increasing the efficiency of capital, raising agricultural productivity and reducing private consumption.

(v) How Can the Donor Community Help Senegal? The donor community can help Senegal through the present crisis by increasing the amount of concessional funds made available to it, and by arranging for longer term reschedulings on concessionary terms. Furthermore, our results indicate that the availability of some concessional loans that are not tied to specific projects would be useful in helping Senegal adjust to the adverse shocks to which its economy seems to be so vulnerable.

(vi) How Should Senegal Adjust to Adverse Shocks in the Future? Senegal is vulnerable to three kinds of shocks: droughts, changes in the terms of trade and changes in the cost of foreign borrowing. Adjustment to a severe drought should be by a mixture of sharply reducing investment and some nonconcessional borrowing. The two other kinds of shocks should be mainly adjusted to by reducing investment. We calculated that a one percent deterioration in the terms of trade should lead to a one-half percent decline in desired investment, while a one percent fall in the level of concessional funds made available to Senegal, leads to a 1.6 percent decline in desired investment.
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I. Introduction

Senegal, with a population in mid-1982 of slightly over 6 million inhabitants, is a small country occupying about 200 thousand square kilometers on the Atlantic Coast of Africa just south of the Sahara. As a member of the West African Monetary Union (UMOA), its currency (the CFA franc) is pegged to the French franc at the rate of 50 CFAF/FF; and its money supply is controlled by the Union's Central Bank (BCEAO). Since 1960, Senegal has experienced the lowest GDP growth rate (2.3 percent) of any African state not affected by war or civil strife. At the current exchange rate Senegal had a 1982 per capita income of $490, placing it near the bottom of the ranks of lower middle income oil importers.

An important feature of the Senegalese economy is its extreme vulnerability to exogenous random shocks. This vulnerability is due to the country's heavy dependence on groundnut exports which has led to wide fluctuations in export revenues caused by changes in weather conditions and in international demand. In Table 1 an index of export instability, defined as the average absolute percentage deviation of current export revenues from a three year moving average, is calculated for Senegal and for seven other African countries. It is clear from the table that Senegal's export instability index was greater than the average for the seven countries. Moreover, the fact that the index calculated for groundnut exports only is higher than the one calculated for total exports supports the argument that the above average variability in export proceeds is mainly due to wide fluctuations in groundnut exports. The increase in the value of this index during the seventies reflects an increase in the frequency of occurrence and in the severity of droughts during the latter part of that decade.
Table 1: EXPORT INSTABILITY INDEX

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<tbody>
<tr>
<td>Senegal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All exports</td>
<td>10.66</td>
<td>9.92</td>
<td>5.61</td>
<td>16.22</td>
</tr>
<tr>
<td>Groundnuts</td>
<td>19.98</td>
<td>5.66</td>
<td>8.34</td>
<td>34.22</td>
</tr>
<tr>
<td>Cameroon</td>
<td>5.21a/</td>
<td>n.a.</td>
<td>2.36</td>
<td>7.20</td>
</tr>
<tr>
<td>Ivory Coast</td>
<td>6.18</td>
<td>7.53</td>
<td>5.35</td>
<td>6.05</td>
</tr>
<tr>
<td>Mali</td>
<td>11.37a/</td>
<td>n.a.</td>
<td>10.53</td>
<td>12.04</td>
</tr>
<tr>
<td>Congo</td>
<td>12.61</td>
<td>16.68</td>
<td>5.32</td>
<td>16.98</td>
</tr>
<tr>
<td>Kenya</td>
<td>5.51</td>
<td>4.70</td>
<td>4.49</td>
<td>7.09</td>
</tr>
<tr>
<td>Madagascar</td>
<td>5.16</td>
<td>6.64</td>
<td>4.96</td>
<td>4.31</td>
</tr>
<tr>
<td>Malawi</td>
<td>3.94a/</td>
<td>n.a.</td>
<td>5.01</td>
<td>3.41</td>
</tr>
<tr>
<td>Average</td>
<td>7.14</td>
<td>8.89</td>
<td>5.46</td>
<td>8.15</td>
</tr>
</tbody>
</table>

a/ For the period 1960-79.

Source: Bank Staff Estimates

Senegal's worsening debt situation is clearly illustrated by the data presented in Table 2. Between 1970 and 1980 debt outstanding and disbursed (DOD) grew at an average rate of around 25 percent. As a result, the ratio of debt to GDP rose during that period from 11.6 to 30.1 percent while debt per capita rose from $20.1 to $157.0. The period 1970-75 witnessed a doubling of the ratio of total debt service to commodity exports which reached 8.5 percent in 1975 and remained stable at around that level up to 1977. In 1978 Senegal was faced with a drought which resulted in a sharp drop in agricultural exports, this occurrence together with the rapid increase in total debt service led to a jump in the debt service ratio which reached 25 percent. 1980 was another bad year for agricultural exports, total merchandise exports were less than three fourths of their 1977 level, while debt service obligations increased by over 300 percent. Thus, the debt service
ratio reached about 36 percent in that year. Faced with yet another drought in 1981, Senegal was unable to meet its debt service obligations and had to resort to a Paris Club rescheduling. Debt reschedulings became an annual occurrence since then.

Table 2: DEBT INDICATORS ($ million)

<table>
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<tr>
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<tbody>
<tr>
<td>DODa/</td>
<td>100.1</td>
<td>300.1</td>
<td>418.4</td>
<td>895.2</td>
<td>1492.8</td>
</tr>
<tr>
<td>Total Debt Service (TDS)</td>
<td>6.7</td>
<td>39.2</td>
<td>54.7</td>
<td>172.2</td>
<td>55.7 b/</td>
</tr>
<tr>
<td>Interest Service (IS)</td>
<td>1.8</td>
<td>18.5</td>
<td>20.6</td>
<td>54.8</td>
<td>39.0 b/</td>
</tr>
<tr>
<td>GDP</td>
<td>864.5</td>
<td>1896.2</td>
<td>1968.3</td>
<td>2970.2</td>
<td>2476.0</td>
</tr>
<tr>
<td>Merchandise exports</td>
<td>152.0</td>
<td>461.0</td>
<td>667.1</td>
<td>480.8</td>
<td>509.6</td>
</tr>
<tr>
<td>TDS/merchandise exports (%)</td>
<td>4.4</td>
<td>8.5</td>
<td>8.2</td>
<td>35.8</td>
<td>7.6</td>
</tr>
<tr>
<td>IS/merchandise exports (%)</td>
<td>1.2</td>
<td>4.0</td>
<td>3.1</td>
<td>11.4</td>
<td>7.6</td>
</tr>
<tr>
<td>DOD/GDP (%)</td>
<td>11.6</td>
<td>15.8</td>
<td>21.3</td>
<td>30.1</td>
<td>60.3</td>
</tr>
<tr>
<td>DOD per capita ($)</td>
<td>20.1</td>
<td>60.3</td>
<td>79.7</td>
<td>157.0</td>
<td>243.5</td>
</tr>
</tbody>
</table>

a/  Debt outstanding and disbursed, end of period figures. Medium and long term public or publicly guaranteed debt only.

b/  This figure represents actual payments; that is, it reflects the effect of the reschedulings.

Source: DRS, IFS and Bank Staff Estimates.

The developments described above necessitate a major change in Senegal's external borrowing and macroeconomic policies. Therefore, the aim of this paper is to study the impact of alternative foreign borrowing and investment strategies on economic growth and social welfare. The main tool used here is a dynamic optimal control model where the objective is to maximize the discounted sum of per capita utility using foreign borrowing and investment as controls. This approach represents an improvement over existing
tools of analysis. In the traditional planning models, domestic expenditures are determined exogenously; and thus planned levels of foreign borrowing are simply calculated as the difference between expenditures and production. In the model used here, the desired path of borrowing and the level and composition of domestic expenditures are chosen simultaneously so as to maximize the discounted value of present and future private consumption.

The paper is divided into four sections. After this introductory section, section II presents a description of the model which was applied to Senegal. In this section the analytical framework upon which the model is based is first presented. Then we describe the structure of the empirical model developed here and the method used in calibrating its various parameters. An assessment of Senegal's past borrowing strategy is presented in section III by comparing the model results with actual past practices. The sensitivity of our results to changes in the structure of the model is also analyzed in this section. In section IV we present desired borrowing and investment paths for the future, and study the effects of various policy changes on those paths. The manner in which borrowing and investment strategies should be adjusted in response to unanticipated shocks is also analyzed. The concluding part of the paper presents a summary of the main policy conclusions that can be derived from our analysis.
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II. An Optimal Borrowing Model For Senegal

This section describes the empirical model used to analyze Senegal's borrowing and investment strategies and its method of calibration. It is divided into three parts. In the first subsection the analytical framework upon which the model is based is described. The second subsection describes the main features of the model (all the model equations are presented in Appendix II). The third subsection describes how the different model parameters were calibrated. In this subsection we also demonstrate the model's ability to track the historical values of key macro variables.

1. The Analytical Framework

The model applied to Senegal is derived from the work of Kharas and Glick (1984 a). It is based upon the notion of the borrower country choosing appropriate levels of foreign borrowing and investment to maximize an intertemporal welfare function. 1\footnote{Examples of such "borrower optimizing" models include: Bazdarich (1978), Eaton and Gersovitz (1981) McCabe and Sibley (1976), Obstfeld (1981), Pitchford (1970) and Sachs and Cohen (1982). For a more exhaustive review of the literature see Kharas and Glick (1984 b).} The Kharas-Glick model consists of two sectors, producing tradeables and nontradeables, and two time periods. The planner's problem is to maximize welfare, which is a function of consumption of both commodities in the two time periods, subject to production and balance of payments constraints.

The full specification of the Kharas-Glick model is presented in Appendix I; this section will be restricted to studying their main conclusions by examining the first order conditions for a maximum in their model. Those first order conditions are given by the following two equations:
\( (1 + \delta) \left( \frac{C_2}{C_1} \right)^b = (1 + i) \left( \frac{P_2}{P_1} \right)^{a-1} \)  \hspace{1cm} (1) \\

\( (1 + \delta) \left( \frac{C_2}{C_1} \right)^b = \rho_2 \left( \frac{P_2}{P_1} \right)^{a-1} \)  \hspace{1cm} (2) 

where \( \delta, b, i, \rho_t \) and \( P_t \) are the pure rate of time preference, the Arrow-Pratt measure of relative risk aversion \(^1\), the international rate of interest, the marginal change in the value of output in period \( t \) from a unit increase in investment and the real exchange rate in period \( t \), respectively. \( C_t \) and \( a \) represent an index of aggregate consumption in period \( t \) and the share of traded goods in that index.

The right hand side of equation (1) is the real cost of foreign borrowing expressed in home goods terms. It depends upon both the world interest rate and the movement over time of the real exchange rate. \(^2\) If, as was the case in Senegal between 1975 and 1981, the real exchange rate is depreciating over time then the real cost of borrowing will be higher than the world interest rate. This reflects the fact that external borrowing adds traded goods resources in the present, when they are relatively cheap, while repayment obligations fall due in the future when they are relatively more expensive.

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\(^1\) See Arrow (1970) or Pratt (1964).

\(^2\) This conclusion can also be reached from the work of Hamada (1969) or Martin and Selowsky (1981).
The left hand sides of both equations represent the marginal rate of intertemporal substitution between present and future consumption, or alternatively, the real social discount rate. Because of diminishing marginal utility of consumption in each period, the real social discount rate falls as the relative level of present consumption increases.

Equation (1) sets out the first rule which should be followed when devising a foreign borrowing strategy. Since one of the functions of borrowing is to smooth out the consumption stream over time, the level of borrowing should be chosen such that the real social discount rate and the real cost of borrowing are equated. Equations (1) and (2) imply:

\[ \rho_2 = (1 + i) \]  

The above equation sets out the second optimal borrowing rule; namely that the marginal returns on capital should be equated to the real cost of borrowing.

The model which is applied here to Senegal (described below) is simply a disaggregated version of the Kharas-Glick model. Therefore, the interpretation of the first order conditions derived from the more complex model is very similar to the interpretation of the two first order conditions presented above. 1/ As a matter of fact, the discussion in Section III comparing the model results with Senegal's past borrowing strategies can be

1/ It should be noted that those first order conditions are derived under the assumption that the borrower is not credit constrained. Since (in theory at least) Senegal can borrow unlimited amounts from the Compte d'Operations (an account of the BCEAO with the French Treasury that provides a facility for drawing French Francs to meet any external obligations of the BCEAO); this assumption may not be too unrealistic. A detailed description of the assumptions used in our empirical model concerning Senegal's ability to obtain different types of loans is presented in the following subsection.
interpreted as a detailed analysis of how effectively this country has applied the two rules of optimal foreign borrowing.

2. An Empirical Model for Senegal 1/

This section will only present a verbal description of the optimal borrowing model which was applied to Senegal. A more detailed description of all the model equations is presented in Appendix II. It must be noted at the outset that since the sole purpose of this exercise is to study various borrowing strategies, the model abstracts from many of the complications in the economy that have no direct bearing on the problem at hand. For example, the model does not try to replicate the actual working of the Senegalese labor market nor the country's exact tax structure. This is the case because, although a thorough analysis of these issues would be an important contribution to our understanding of Senegal's economy, it would increase the complexity of the present model without being directly linked to the issue studied here. On the other hand, it is important for this type of model to replicate the characteristics of the economy that have a direct bearing on its debt carrying capacity. Examples of such characteristics would be: the volume and composition of exports and imports, the real cost of additional borrowing, private consumption behavior, and the nature of the shocks to which the economy is vulnerable.

The model presented here is a dynamic optimization model maximizing the discounted sum of per capita utility (which is a function of private consumption) over time, using borrowing and investment as controls, subject to the constraints implied by the structure of the economy. The main constraints

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1/ For a review of the various methodologies used in setting up computable general equilibrium models see Dervis et al. (1982).
consist of: production functions, market clearing conditions and the balance of payment condition. The most important features of this model can be described as follows:

(a) **The Objective Function.** As stated above the objective of this model is to maximize the discounted sum of per capita utility. Utility is derived from the private consumption of three categories of goods: agricultural goods, manufactured tradeables and nontradeables. The model treats government consumption as an exogenous variable. The main parameters of the objective function are: the utility weights attached to the consumption of each category of goods, the pure rate of time preference and the Arrow-Pratt measure of relative risk aversion.

(b) **Production Functions.** The Senegalese economy is divided into five sectors: groundnuts, other agriculture, manufactured tradeables, nontradeables and fish. Groundnuts and other agricultural goods are produced in the rural areas using rural labor and land as factors of production, while tradeables and nontradeables are produced in the urban areas using urban labor and capital. The output of fish is given exogenously in the model. All production functions are of the Cobb-Douglas form and exhibit constant returns to scale:

\[ Q = q L^\beta K^{1-\beta} \]

The Hicks-neutral constants in the production functions \((q)\) are allowed to vary from year to year. This was done for three reasons:

(i) It allows us to quantify past supply shocks and simulate shocks for the future. For example, in 1978 agricultural production fell sharply as a result of a drought although
there was no significant change in the amount of the factors employed in agriculture. The magnitude of this shock can be expressed in terms of the amount by which $q$ should fall in order for us to observe the actual quantities produced in 1978. Thus, in our projections exercise we can study how borrowing and investment strategies should adjust to a similar drought in the future by rerunning the model after assigning a value for $q$ equal to its 1978 level.

(ii) In this model capital does not enter directly in the production functions of the rural sector. Yet, it is clear that investment in agriculture can increase production through land reclamation or improved irrigation and drainage facilities. The effect of land reclamation is easily captured by increasing the amount of land available. Similarly, we capture productivity increases due to improved irrigation and drainage by increasing $q$.

(iii) Allowing those Hicks-neutral constants to vary also enables us to capture the impact of technical improvements in manufacturing as well as the effect of changes in capacity utilization.

(c) **Goods' Markets Clearance.** Groundnuts and fish are produced solely for export. Other agricultural goods are used for private consumption and as an intermediate product. The difference between domestic demand and production is imported. Manufactured tradeables are used for private
consumption, government consumption 1/, as intermediate goods, as investment goods 2/ and for export. The amount of tradeables that is exported is a function of the world price and international demand. The difference between domestic demand plus exports and production is imported. Nontradeables are used for private consumption, government consumption, as intermediate goods and as investment goods. Nontradeables' prices adjust so that the domestic demand and supply of nontradeables are equated, while prices of other goods (except groundnut producer prices which are fixed by the government) are equal to world prices plus tariffs.

(d) **Factor Markets Clearance.** The rural and urban labor forces grow at different rates. Rural labor is fully mobile between the two rural sectors. Thus, the distribution of labor between groundnuts and other agricultural goods is such that value marginal products in the two sectors are equated. The same is true for urban labor which is fully mobile between the two urban sectors. Wages adjust until both labor markets clear. Land is treated as a specialized factor of production. Thus, the amount of land available for the production of groundnuts and other agricultural goods is fixed. Due to installation costs, gross investment is not translated in its entirety into new capital formation. Following Lucas (1967), Uzawa (1964) and Hayashi (1982) installation costs are assumed to be an increasing and convex function of the level of investment. Capital in the model is putty-clay; it can be allocated to either of the two urban sectors before investment actually

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1/ It is assumed that tradeables are a fixed proportion of total government consumption.

2/ It is assumed that a fixed proportion of aggregate investment is in the form of tradeables (machines) while the remainder is nontradeable.
takes place, but once installed cannot be removed from the sector. The model chooses the optimum level of aggregate investment, but its intersectoral allocation is not optimized. Instead, we let profit shares determine the intersectoral allocation of investment.

(e) The Fiscal Accounts. Initially we assume that government carries out all the borrowing and shoulders the entire cost of investment goods that are then made available to the private sector which carries out all the production activities. Government obtains revenue from two sources: taxes, which are divided into lump sum and trade taxes, and net profits (may be negative) derived from the purchase of groundnuts at the domestic price and their export at the world price. The government's expenditures include government consumption, investment, debt service payments, export subsidies and transfers to the private sector (may be negative). The private sector receives the entire value added generated in the economy at domestic producer prices, and divides it between consumption expenditures, lump sum tax payments and private savings. Those definitions and the market clearing conditions imply that government transfers and private savings will always be equal in magnitude but have opposite signs, and that the value of investment expenditures equals the sum of foreign and domestic savings.

(f) Balance of Payments. Foreign borrowing is divided into concessional and nonconcessional loans. In addition to the interest differential between those two types of loans, all concessional borrowing is

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1/ It should be noted that since this class of models can be interpreted as one agent models, changes in the specifications of the roles of the public and private sectors do not affect its results; provided that no constraint is set on the amount of transfers that can take place between the two sectors.
assumed to be on a fixed interest rate basis while the interest rate payable on non-concessional borrowing is variable. Senegal faces an upper limit on the amount of concessional money made available to it. But, as a result of its ability to draw on the compte d'operations, (in theory at least) it faces no limit on the amount of nonconcessional credit it can obtain. Thus, the balance of payments constraint included in the model simply states that the total value of exports plus all new borrowing should be equal to the total import bill plus debt service.

(g) **Terminal Conditions.** The model's terminal conditions are determined by assuming that a steady growth state is reached by the tenth year. Such a state is defined as a situation when output, consumption and debt (all in real terms) are growing at the same rate with no change in relative prices or in per capita utility. In order to ensure that the results presented here are not unduly sensitive to the choice of terminal conditions the model is solved for ten years, but only the results of the first five years are used. The sensitivity of those results to changes in the terminal conditions will be studied in Section III.

3. **Sources of Data and Model Calibration**

Although the model was set up to be as simple as possible in order to minimize the number of parameters which needed to be estimated, a robust simultaneous estimation of all parameter values was impossible. Instead, a combination of base year calibration and econometric estimation was used. Clearly a complete construction of a model of this type requires a large amount of information, some of which was not available. Therefore, a few information gaps were filled by relying on indirect evidence or by making
educated guesses. The model was calibrated on the data presented in the 1984 CEM. 1/

The calibration procedure involved estimating (or calibrating) the shares of tradeables and nontradeables in government consumption and in investment, parameters of the intermediate demand functions, parameters of the objective function, the initial amounts of the factors of production, the parameters of the export supply function and the parameters of the production functions. This was done as follows:

(a) **The share of tradeables in Government consumption and investment.** Plasschaert (1984) presented a detailed analysis of Senegal's fiscal accounts. In this analysis government spending was broken down into its various components. We used this data to calculate the average share of tradeables in government consumption and assumed that it remains fixed. Similarly, we calculated the average share of tradeables (machinery and equipment) in gross investment using data from the 1979 CEM. 2/

(b) **Intermediate Demand Functions.** It was assumed that the input/output coefficients are fixed in quantity terms. Thus, the parameters of the intermediate demand functions were simply obtained from the 1979 input output table (after aggregation).

(c) **The Objective Function.** Five parameters enter into the objective function. These are: the utility weights assigned to each of the three consumption goods, the Arrow-Pratt measure of relative risk aversion and the pure rate of time preference. We started by calibrating the utility weights assigned to each good. Such calibration requires data on the

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1/ See World Bank Report No. 5243-SE.

2/ See World Bank Report No. 1720-SE, statistical annex tables 2.3 and 3.3.
composition of private consumption. This composition is not readily available. Therefore, we had to calculate it for each of the five years in our calibration period (1977-81). Sectoral GDP data was first obtained from the 1984 CEM. Under the assumption of fixed input/output coefficients aggregate production figures for each sector were then obtained. By adding imports to those gross production figures the total amount of each good available for different uses was calculated. Using our work described in (a) and (b) above we then calculated the amount of each good that went to government consumption and investment or was used as an intermediate product. The sum of those three uses was added to export figures thus giving us the total amount of each good used for purposes other than private consumption. Knowing the amount of each good that is available to the economy, as well as the composition of exports, intermediate demand, investment and government consumption, the composition of private consumption is then calculated as a residual. This was done for each year between 1977 and 1981.

At this point, it is easy to check the validity of our assumptions concerning the fixed share of tradeables in government consumption and investment, as well as the reliability of the input-output coefficients. This was done by comparing the aggregate consumption figure which we obtained from the above calculations with actual data. The result was that we tend to underestimate total private consumption by around 2 to 3 percent. Since this discrepancy seemed relatively small, and since the estimates used in our calculations came from reliable sources we decided that there was no need to change any of the assumptions used so far.

Price series for the different categories of goods can be easily calculated from available data. For example, using data on world prices,
exchange rates and import tariffs (obtained from GFS) a price series for agricultural goods and manufactured tradeables was constructed. Using the investment goods deflator (from the 1984 CEM) and the share of tradeables and nontradeables in investment calculated above we were then able to construct a price series for nontradeables. The utility weights assigned to each category of goods was then calculated by imposing the constraint that marginal rates of substitution are equated to price ratios. A different set of coefficients were calculated for each year in the sample period, and their mean was used in the model.

The choice of the Arrow-Pratt measure of relative risk aversion was based upon economic theory. Arrow (1970) argued that this parameter should be given a value somewhere close to unity. Therefore, we assigned it a value of 0.8. This implies that utility is slightly less concave than a logarithmic function. Since the algorithm used in solving the model does not handle uncertainty (chance constraints), the model was solved under certainty conditions. As a result, the optimal solutions obtained here are not very sensitive to the choice of this parameter.

The pure rate of time preference was calibrated to reflect Senegal's past consumption and investment choices. We estimate that those choices are best explained by a pure rate of time preference of around 4 percent. Some may argue that we are assigning too low a value to this parameter. However, in the following section we show that if we raise this value to 6 percent then Senegal's desired past investment path would have been not to invest at all. Conversely, a reduction of this value to 2 percent would have implied historical consumption levels that are much lower than actual values. It should also be noted that in situations like Senegal's where consumption was growing at such high rates the real social discount rate is much higher than
the pure rate of time preference. Nevertheless, some uncertainty does surround our choice of the objective function's parameters. Therefore, an analysis of the sensitivity of our policy conclusions to the choice of those parameters is presented below.

(d) **Factors of Production.** Estimates of the rural and urban labor forces and their historical growth rates were obtained from Braverman et. al. (1983), and from Jansen (1984). The distribution of land between groundnuts and other agricultural goods was also obtained from Braverman et al. Capital stock figures were not so easy to obtain. Ideally, one would want census data on the market value of the capital stock in each sector of the economy. Such data was not available. However, some data on the distribution of the stock of capital between the various sectors were obtained from Christin (1983). An estimate of the total stock of capital in the economy was obtained by applying an average capital output ratio to GDP in 1979 (our base year). This estimate was used as a first guess and was subsequently modified to improve the model's ability to track history. The final capital stock figure used implied an average profit rate of around 10 percent, which seems to be consistent with the results obtained from previous industrial sector work. The choice of a capital stock figure is the most important uncertainty surrounding our work. Changes in this figure affect the marginal product of investment which could have an important impact on the desired borrowing and investment paths. In the following section we analyse the sensitivity of our conclusions to the choice of an initial capital stock. The results of this analysis indicate that even if the actual stock of capital is 25 percent lower than our estimate (indicating higher rates of return) our main policy conclusions will not change significantly.
(e) **Parameters of the Production Function.** Ideally, the production elasticity of each factor in the different sectors should be obtained from a social accounting matrix (SAM). However, no such matrix is available for Senegal.\(^1\) Therefore, those parameters had to be obtained by relying on indirect evidence or by estimation. As far as the two rural sectors are concerned, the factor elasticities estimated by Braverman et al. (1983) were used. However, unlike those authors, we assumed that the production functions exhibit constant returns to scale.\(^2\) As discussed earlier, in order to quantify the degree of production uncertainty, the Hicks neutral constants of the production functions were allowed to vary such that with historical prices, historical values of each sector’s output in each year is reproduced. On the other hand, the information available concerning production technologies in the urban sectors is minimal. Therefore, the production elasticities for those two sectors had to be estimated. They were chosen to minimize the variance of the Hicks neutral constants, subject to the constraint that wages in both sectors are equalized. The parameters estimated in this manner were compared with similar parameters estimated for other countries and were found to be consistent.

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\(^1\) A SAM for Senegal is currently being constructed by the "Groupe Macroeconomique" at the Ministry of Planning.

\(^2\) Since they let land be perfectly mobile between the different rural sectors, Braverman et. al. had to assume decreasing returns to scale in order to ensure the existence of an interior solution to their model. Given our assumption that the land available to each sector is fixed, an interior solution will always exist in our model even with the linearly homogenous production functions.
f) **Export Supply and the Investment Function.** The price elasticity of export supply was estimated econometrically. The parameters of the investment function was chosen such that on average 5 percent of gross investment was used in installation costs.

In order to test the calibration of the model, gross investment and borrowing were initially fixed at their actual historical levels. The model was then solved as a recursive dynamic computable general equilibrium model. Since output (especially in agriculture) fluctuates substantially from year to year, picking a particular year for which to calibrate the model runs the risk of generalizing results from a special case. To avoid this problem, the model was calibrated to match actual imports, exports, private consumption and GDP during a five year period (1977-81). Figures 1-8 present a comparison between the model results when investment and borrowing are fixed at actual levels, and actual data for the period 1977-81. The average absolute percentage deviation of the model results from actual data is 2.1 and 1.6 percent for real and current exports, 1.4 and 1.1 percent for real and current imports, 2.8 and 4.1 percent for real and current GDP and 4.5 and 6.2 percent for real and current private consumption.
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III. Assessing Past Borrowing Strategies

In this section an assessment of Senegal's foreign borrowing strategies prior to the first rescheduling in 1981 is made by comparing actual practices with results obtained from the optimal borrowing model presented in Section II. The section is divided into six subsections. In subsection 1, past practices are compared to the results obtained from the model under the assumption of perfect foresight. The results of this analysis indicated that Senegal should not have resorted to nonconcessional sources of finance and that investment levels ought to have been some 40 percent lower than actual historical figures. We then compare past reactions to adverse external shocks to the model's reactions. Moreover, experiments were carried out where we changed international interest rates and raised the upper limit set on the amount of concessional funds available. Those experiments indicate that borrowing and investment strategies should be sensitive to changes in the interest rates and that Senegal would have benefitted from an increase in the amount of concessional money made available to it.

A number of uncertainties surround our choice of terminal conditions, welfare, production and investment functions as well as our estimate of the capital stock. Therefore, the second subsection examines the impact of changes in those parameters on the model conclusions. This sensitivity analysis indicated that our conclusions that Senegal should not have relied so heavily on nonconcessional sources of finance and should have decreased the level of public investment are fairly robust to changes in the model specification.
Past work attempted to explain Senegal's overborrowing by referring to the government's inability to perceive shocks. This hypothesis is tested in subsection 3 where we run the model under alternative assumptions. The results of this analysis indicate that even in the absence of shocks Senegal would still be heavily overborrowed. In subsection 4 we rerun our model after modifying our assumptions concerning the structure of the urban labor market to allow for wage rigidities and unemployment. We conclude that this change does not alter our main conclusions; Senegal should not have relied so heavily on nonconcessional sources of finance. The government's past borrowing and investment strategies can only be explained in terms of the existence of ad hoc constraints on its ability to adjust investment and private consumption. This is demonstrated in subsection 5 where we rerun our model after incorporating such adjustment constraints. Those constraints have led to a decline in welfare. Therefore, we then point out some policy measures which if undertaken would have brought the actual borrowing path closer to the desired one without violating the adjustment constraints. The effect that those policies would have had on welfare is quantified by rerunning a constrained optimal borrowing model which incorporates those policy changes. Finally, the sixth subsection presents a summary of the lessons learned from the counterfactual experiments carried out here.

1. The Base Case

The base case scenario presented here describes an "ideal" borrowing path which assumes that policy makers have perfect foresight and that there are no constraints on adjustment. That is, the results of this scenario were obtained under the assumptions that the timing and magnitude of all shocks
were known with certainty \(^1\) and that there is no limit on the policy makers' ability to alter private consumption and investment in response to those shocks. Naturally, those assumptions are not realistic. However, this ideal setting provides a useful yardstick against which actual practices can be compared. Moreover, a comparison between the optimal solution obtained under those assumptions and the solutions obtained after imposing the relevant constraints provides a measure of the welfare loss which may be attributed to constraints on adjustment and the inability to predict various shocks.

The model was run for the period 1977-1987; however, in order to reduce the sensitivity of our conclusions to the choice of terminal conditions, only results from the first five years were used. Actual data were used for the period 1977-84. Between 1984 and 1987 all variables were assumed to follow their historical trend growth rates. The only exception to this are interest rates, which were assumed to be equal to the average of the preceding seven years, the exchange rate, which was assumed to remain at its present level, and the availability of concessional funds, which was fixed at its 1984 level.

The results of this base run indicate that Senegal should at no time have resorted to nonconcessional sources of finance. The optimal level of nonconcessional borrowing in this run is zero. On the other hand, the level of concessional borrowing undertaken under this scenario is equal to

\(^1\) These include droughts as well as changes in interest rates and prices.
actual borrowing. 1/ That is, it was desirable for Senegal to borrow on concessional terms up to the credit ceiling imposed by the suppliers of this kind of credit. A comparison between actual borrowing and the desired borrowing path under the base case is presented in Figure 9. The lower level of borrowing does not necessarily imply a dramatic reduction in private consumption. On average, the level of private consumption implied by this scenario was only 2 percent below actual levels 2/ (see Figure 10). However, the level of gross investment implied by this run is much lower than actual investment levels. On average the level of investment implied by the model is only slightly more than half that which has actually taken place (see Figure 11). In addition to the difference in volume, the investment strategy implied by the model had a different pattern from actual behavior. Whereas in the past, investment in Senegal was biased towards the production of nontradeables 3/, the results of the model indicate that the opposite should have taken place. The base run results show the capital stock in the tradeables' sectors

1/ This conclusion is explained by the fact that during the period 1977-81 the interest cost of concessional loans was on average 5 points below that on nonconcessional loans.

2/ In order to distinguish between discrepancies due to the difference between the model parameters and reality and those due to changes in the levels of borrowing and investment, actual consumption here refers to the results of the simulation run described in the preceding section.

3/ For a detailed description of investment patterns in Senegal, see the 1984 CEM, World Bank Report No. 5243SE.
growing at an average annual rate of 2.0 percent while the nontradeables' capital stock grows at 1.2 percent.  

A detailed analysis of how foreign borrowing and investment strategies should be adjusted in response to transitory shocks will be presented in Section IV. However, at this point a comparison will be made between actual reaction to the adverse shocks (droughts) of 1978, 1980 and 1981, and the model results. In 1978, the government did not undertake any policy measures aimed at reducing private consumption which remained at roughly the same level as 1977, gross investment fell slightly by about 4 percent and borrowing on nonconcessional terms was around double its level in 1977. The model's reaction to this shock was different; private consumption was reduced by 1 percent and gross investment fell by roughly 80 percent: thus, no use was made of nonconcessional borrowing. In 1980 and 1981 Senegal reacted to adverse exogenous shocks by reducing investment by around 15 percent while private consumption continued to rise. This does not occur in the model where both private consumption and investment remained flat (at levels below actual figures), and the shocks were compensated for by the greater availability of concessional money.

The above result does not imply that Senegal should have refrained from nonconcessional borrowing under any circumstances. Experiments were carried out where the interest rates on nonconcessional loans were reduced,

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1/ This can be explained by the higher rates of return in the tradeables' sector. It should also be noted that investment allocation is not optimized in this model. If it were, the share of investment going to tradeables would have been even higher. This is the case because an optimal allocation rule is to equalize the marginal returns to investment across sectors.
and the impact of such reductions on borrowing, investment and private consumption was studied. The results indicated that if interest rates had been 20 percent below actual figures, some borrowing on nonconcessional terms would have been useful in 1977, 1978 and 1981 (see Figure 12). The positive nonconcessional borrowing in 1977 and 1978 can be explained by the fact that interest rates in those two years were lower than in the following three, and the small amount of nonconcessional borrowing in 1981 is explained by a combination of adverse shocks and a decline in the availability of concessional credit. It is also important to note the sensitivity of the desired levels of consumption and investment to changes in the marginal cost of borrowing. This 20 percent decline in the cost of nonconcessional funds led to an average increase in private consumption of 4 percent (see Figure 13), and an average increase in gross investment of 7.7 percent (see Figure 14).

Although the results of the base run indicated that Senegal should have borrowed on concessional terms up to the ceiling imposed on this type of credit, it seems intuitively obvious that it does not imply that, had such ceilings not existed, the country should have borrowed infinite amounts of concessional money. The validity of this statement was tested by rerunning the base case scenario after removing the upper limit imposed on concessional borrowing. The result of this run was that concessional borrowing, gross investment and private consumption were on average 800, 91 and 68 percent higher than in the base run (see Figures 15 - 17). Those results indicate that Senegal could have greatly benefited from an increase in concessional

1/ Or, alternatively, if capital productivity was 20 percent higher.
credit. Moreover, it should be noted that the desire to acquire concessional
debt is sensitive to the terms on new commitments. Figure 15 shows that the
desired amount of borrowing jumps in 1979 (when the interest cost of new
commitments was 3 percent) then drops sharply in 1980 (when the interest rate
was 5.9 percent).

The analysis presented above indicates that whereas Senegal would
have benefitted from an increase in concessional credit during the five year
period immediately before the first rescheduling, the increased reliance on
nonconcessional borrowing which characterized this period was not desirable,
and has led to a decline in welfare. This analysis also showed that Senegal's
desired borrowing and investment levels should be sensitive to the real cost
of borrowed funds. Past policies did not make use of this rule. Borrowing
and investment remained at high levels during the period 1977-81 despite the
rapid increase in the marginal cost of borrowing.

2. Sensitivity Analysis

As was stated in Section III, a number of uncertainties surround our
choice of terminal conditions, welfare, production and investment functions,
as well as our estimate of the capital stock. Therefore, this subsection
examines the impact of changes in those parameters on the base case
conclusions described above. It should be noted at the outset that the
conclusion that Senegal should have avoided borrowing on concessional terms
seems to be insensitive to minor changes in the specification of the model.
The robustness of this conclusion is demonstrated by the fact that in all
except one of the sensitivity runs described below, the optimal level of
nonconcessional borrowing remained at zero.
In order to test the sensitivity of our results to changes in the terminal conditions, an extra year was added to the model. That is, it was assumed that the steady growth state is reached in the 11th rather than in the 10th year. This modification led to no change in the optimal borrowing level and to slight changes in the levels of investment and private consumption (see Figures 18 and 19). Investment increased slightly above the base case levels, but remained at roughly half the actual figures. Private consumption decreased slightly below the base case levels.

The model results are not very sensitive to changes in the Arrow-Pratt measure of relative risk aversion (the parameter b). In the base case this parameter is given a value of 0.8. Raising this value to 0.9 does not affect the level of borrowing, but leads to insignificant increases in gross investment and decreases in consumption (see Figures 20 and 21). We even experimented with decreasing this parameter by as much as 40 percent to 0.5. This had no effect on borrowing, but led to a reduction in investment and an increase in consumption (see Figures 22 and 23).1/  

The results of the model are sensitive to the choice of a pure rate of time preference (the parameter delta). The sensitivity analysis carried out on this parameter indicated that our choice of a value of 4 percent seems to be fairly reasonable. An increase in the value of this parameter to 6 percent resulted in a slight increase in borrowing (Figure 24), but desired investment fell to zero. On the other hand when its value was decreased to 2

1/ This result should not come as a surprise since the model is solved under the assumption that the future values of all variables are known with certainty. Changes in this parameter only affect the desire to smooth the consumption path over time.
percent, investment rose, but private consumption fell to about 70 percent of
actual values (see Figure 25). Therefore, we concluded that a figure of
around 4 percent provides a relatively fair description of Senegal's time
preference as is evidenced from past choices.

We also experimented with reducing our estimate of the initial stock
of capital by 25 percent. This resulted in no increase in desired borrowing,
but lead to a rise in the level of desired investment (Figure 26). Finally,
the parameters of the investment function were modified to imply an increase
in efficiency; that is, a decrease in installation costs. This change had no
effect on desired borrowing but did lead to some increase in desired
investment levels (see Figure 27). 1/ Nevertheless, the desired level of
investment implied by the two runs described above remained much lower than
actual levels.

The above analysis indicated that our conclusions that Senegal
should not have relied so heavily on nonconcessional sources of finance and
should have decreased the level of public investment are fairly robust to
changes in the model specification. In all of the sensitivity runs (with the
exception of the one where the pure rate of time preference was raised to 6
percent) the desired level of nonconcessional borrowing was zero. Moreover,
in all those runs the desired level of investment was much lower than actual
levels. A study of Figures 18-27 indicates that while changes in the model
parameters affect the desired levels of the different variables, it does not

1/ This is the case, because a decrease in installation costs implies an
increase in the efficiency of investment. However, in this run the rise
in investment efficiency was not sufficient to make nonconcessional
borrowing desirable.
affect the direction in which those variables tend to move in response to various shocks and policy changes. This fact enhances our confidence in the reliability of the qualitative conclusions derived from this model concerning the appropriate response to various kinds of shocks, and the impact of policy changes on the desired levels of borrowing and investment. 1/

3. Model Results Under Alternative Assumptions

Previous work attempted to explain Senegal's overborrowing and overinvestment by referring to the government's inability to perceive adverse shocks. 2/ In this subsection we rerun the model under alternative assumptions about expectation formation and the types of foreign loans made available to Senegal. By studying the desired borrowing paths under those alternative assumptions we can determine whether past overborrowing and overinvestment can be explained by the government's inability to perceive shocks or by the fact that most concessional borrowing is tied to specific projects.

We reran the model under the assumption that Senegal faced no shocks. That is, all exogenous variables take their mean values throughout the model period. 3/ Two scenarios were studied under this assumption. In the first scenario the upper limit on concessional borrowing was allowed to vary reflecting the actual availability of such credit, and in the second scenario this upper limit remained fixed at the mean. The desired borrowing

1/ The remainder of this paper will be mainly devoted to the study of such conclusions.

2/ See for example Ghanem, Kharas and Myers (1984).

3/ This includes "truly" exogenous variables such as world prices and interest rates, but excludes policy variables such as government consumption and tax rates. The latter type of variables were allowed to take their actual historical values.
path in those two runs turned out to be the same as in the base case; no nonconcessional borrowing takes place in either scenario. The mean of the desired level of investment was roughly the same in both scenarios as in the base case. However, in the no shocks and fixed upper limit on concessional loans scenario, investment levels do not fluctuate from year to year by as much as they did in the base case (see Figure 28). The reason for this result is obvious. The model's reaction to the various kinds of adverse shocks is to reduce investment rather than cut private consumption or resort to nonconcessional borrowing. Hence, investment levels will be more stable in a setting where no such shocks occur.

The case where all shocks are unanticipated was also studied. The model was solved under the assumption that policymakers perceived shocks in the present period but had no information concerning which state of nature will occur in the future, and therefore assume that future variables will be equal to their respective means. The results of this run were not significantly different from the base case. No nonconcessional borrowing took place and investment levels remained much lower than actual levels (see Figure 29). The above analysis seems to indicate that the deviation of actual behavior from desired patterns cannot be explained by the policymakers' inability to perceive or predict shocks. Actually, the introduction of uncertainty to the model would yield results that are even more conservative than those obtained from the base case scenario where perfect foresight is assumed.

It could be argued that concessional borrowing is not very useful in mitigating the impact of adverse shocks since such borrowing is usually tied to specific projects, and therefore cannot be used in consumption smoothing.
This fact may explain Senegal's reliance on nonconcessional sources of finance. To test the above statement an equation restricting the use of concessional money to investment purposes was added to the model which was then solved for the constrained optimum. The desired borrowing path resulting from this run was the same as the one derived from the base run. Any borrowing on nonconcessional terms remained undesirable. A comparison between the desired investment path derived from this run and the base case results is presented in Figure 30. This shows that the additional constraint became binding only in the years when droughts occurred (1978, 1980 and 1981). Since this constraint reduced the country's ability to adjust gross investment downwards, private consumption had to be reduced in response to adverse shocks (see Figure 31). Naturally, the value of the welfare function in this constrained run was below that in the base case. The above analysis shows that the fact that most or even all concessional loans may have been tied to investment cannot explain Senegal's excessive use of nonconcessional sources of finance. This run also indicated that the availability of some untied concessional money is very useful in helping Senegal adjust to the external adverse shocks to which its economy seems to be so vulnerable.

4. Changing the Structure of the Labor Market

Most governments argue that their investment expenditures should be kept high in order to avoid unemployment. Therefore, one may criticize our base case conclusions by arguing that in cases where unemployment may occur, because of wage rigidities, the desired investment and borrowing paths will be higher than those which we derive from our full employment model. That is, the fact that urban wages in Senegal are rigid downwards may provide an explanation for past borrowing and investment decisions.
In order to test the validity of the above argument we reran our model after changing the structure of the labor market to allow for unemployment. This was done by imposing a minimum wage (in real terms), and by changing the labor market clearing condition in the urban sector into an inequality constraint. \(^1\) The results of this run showed no increase in borrowing. Nonconcessional borrowing remained zero. However, investment did rise by an average of 74 percent over the base case level (Figure 32), but remained below actual figures by about 8 percent. This rise in investment was financed by a reduction in private consumption, which fell to roughly 85 percent of the base case levels (Figure 33). The urban unemployment rate averaged 6.5 percent.

The above results can be easily explained. It is clear that an increase in employment, by raising output and consumption, is a welfare gain. However, in a model with a minimum wage legislation this rise in employment is not costless, since it can only be achieved by increasing investment. Increases in investment expenditures may be financed by domestic savings (a reduction in consumption) or by raising foreign borrowing or by a combination of both. In order to maximize social welfare, the least cost method of financing the rise in investment should be used; and investment should be raised up to the point where the welfare gain from an additional unit of investment (including the gain from more employment) is equated to the

\(^1\) That is, the urban labor market clearing condition in the base model was modified to read that the sum of labor employed in the tradeable and nontradeable sectors be less than or equal to the total urban labor force. Also an equation was added constraining real wages to be greater than or equal to the lowest value calculated from the simulation run (section II).
welfare loss associated with reducing consumption by one extra unit or with a marginal increase in foreign borrowing. Such a point can be reached even when some labor continues to be unemployed.

The results of the present run namely zero borrowing on nonconcessional terms while some unemployment exists, indicate that Senegal should not have used foreign borrowing as a tool for economic stabilization. The intuition behind this conclusion is fairly obvious. If a country borrows at commercial terms in the present time to finance inefficient investments with the aim of reducing unemployment, when the time comes to repay those loans it will be forced to undertake severe deflationary measures and hence suffer from even more serious unemployment problems in the future. This conclusion implies that Senegal should have tried to avoid high unemployment by using domestic policy instruments such as government wage policy, minimum wage legislation, tax incentives to private employers, etc. rather than by resorting to high levels of nonconcessional foreign borrowing which it used to finance inefficient investments.

The level of private consumption in the previous run is unacceptably low. Therefore we reran the model with the modified structure of the labor market after imposing a constraint on the minimum level of private consumption. The result of this run was that some nonconcessional borrowing was used (Figure 34). But, although the desired borrowing path implied by this run was higher than that derived from the base case it remained much lower than actual levels. This run was also characterized by a low and declining investment path (Figure 35). Due to the decline in investment, unemployment was higher than in the previous run; now, urban unemployment was on average 8.3 percent. The above results indicate that past borrowing and
investment decisions cannot be rationalized by referring to a preoccupation with employment.

5. The Impact of Domestic Policy Changes

So far we have not been able to come up with a satisfactory explanation for Senegal's past borrowing and investment practices. Therefore, we ran a model in which some constraints on the government's ability to adjust investment expenditures and private consumption were added. It was assumed that government could not reduce investment or per capita private consumption beyond the lowest level actually observed during the period 1977-83. The result of this run yielded a desired borrowing path which is quite close to actual practice. Therefore, it seems that the phenomena of overborrowing and overinvestment observed in Senegal can only be explained by the government's inability (or unwillingness) to adjust investment and private consumption in response to changes in the external environment. The fact that the solution to the constrained model lies within the feasible set for the unconstrained model (the base case) indicates that this inability to adjust has not been costless. It has actually led to a significant welfare loss.

The above argument indicates that policy measures resulting in bringing actual borrowing closer to the desired path described by the base case scenario would have reduced this welfare loss. Policy recommendations will be discussed in detail in the following section where a future borrowing strategy is presented. At this point, we will only present some examples of structural changes and what their impact would have been on the desired level of borrowing. Clearly, the most straightforward way of bringing down past borrowing levels would have been to remove the constraints on adjustment, and reduce domestic expenditures in response to external shocks. However,
assuming that the obstacles to adjusting investment and consumption were insurmountable, there are several structural changes which, if brought about, would have reduced the desired level of borrowing (making it closer to the base case results) without violating the constraints set on the levels of investment and private consumption. We experimented with introducing such changes into the model with the constraints on adjustment. The first of those counterfactual experiments indicated that a 20 percent reduction in government consumption would have brought down the desired level of borrowing by an average of 30 percent (Figure 36). A similar reduction in desired borrowing could have been achieved by a 20 percent productivity increase\(^1\) in the tradeables urban sector (Figure 37). Since the nontradeables sector is the largest sector in the model, a 20 percent increase in productivity there would have made the desired level of borrowing equal to that in the base run. Finally a 20 percent increase in productivity in both agricultural sectors would have reduced the desired level of borrowing by an average of 25 percent (Figure 38).

6. Lessons From Past Experience

The results of our base run indicate that Senegal's past practices were not desirable. The government overborrowed and overinvested. The base case solution showed that foreign borrowing should have been limited to concessional loans only and that gross investment should have been reduced by roughly 40 percent. The sensitivity analysis carried out seems to indicate

\(^1\) It is clear that "productivity" is not a policy variable. However, government can undertake some policy measures that would result in increases in productivity. Examples of such measures are described in the following section.
that the model's qualitative conclusions are fairly reliable. It was shown that actual past behavior can only be explained in terms of the existence of ad hoc constraints on adjustment. But the counterfactual experiments carried out here proved that the government could have resorted to several policy measures to reduce foreign borrowing without violating the constraints on the minimum levels of private consumption and investment. Thus, the lesson derived from past experience is very straightforward. Senegal should avoid resorting to high cost sources of foreign finance. This can be achieved in the short run mainly by reducing domestic expenditures.

Therefore, the main conclusions reached here are not totally different from those reached in previous work /1/ where it was argued that the major reasons for the present debt servicing crisis were overborrowing and overinvestment. However, the present framework in which the problem is analyzed offers us greater flexibility in studying the impact of various policy and structural changes on the desired level of foreign borrowing and the effects on social welfare of deviations from this desired path. For example, it was shown here that Senegal should have reacted to the adverse shocks of the '70s by reducing investment rather than resorting to nonconcessional borrowing. It was also shown that foreign borrowing and investment strategies ought to be sensitive to interest rates and that foreign borrowing should not be used as a stabilization tool. Those conclusions as well as a quantification of the effect of changes in the international rate of interest on the desired levels of the various macro variables cannot be derived using the conventional availabilities approach implied by RMSM models. Chhibber and

/1/ See Ghanem, Kharas and Myers (1984) or the 1984 CEM.
Ghanem (1984) argued that foreign borrowing in Senegal was associated with higher private consumption. The results presented here do not dispute this fact. But they do indicate that this behavior was probably desirable given the external environment in the seventies and the structure of Senegal's economy. This kind of conclusion cannot be reached using traditional tools of analysis. In a general equilibrium framework one cannot look at any particular variable and ignore all others. Therefore, we must note that, although it may have been appropriate for Senegal to raise consumption levels this increase should have been accompanied by a reduction in investment and foreign borrowing. It seems that this failure to adjust investment downwards was the main cause of deviations from the desired strategies.
Figure 37
THE IMPACT OF A 20% INCREASE IN PRODUCTIVITY IN THE URBAN TRADEABLES SECTOR ON BORROWING

Figure 38
THE IMPACT OF A 20% INCREASE IN PRODUCTIVITY IN AGRICULTURE ON BORROWING
IV. A Strategy for the Future

In this section future foreign borrowing and investment strategies are studied by running the model for the period 1984-94. Our work here is divided into five subsections. In the first subsection a base case scenario is run. The desired levels of borrowing and investment derived from this scenario imply unacceptably low levels of real per capita private consumption. Therefore we add a constraint to the model setting a minimum for per capita consumption. This constrained base scenario implies a very low rate of growth of GDP, because the extra resources going into consumption come at the expense of lower investment. The results of those runs indicated that Senegal needs to carry out major policy reforms. The nature of those reforms and their effect on desired borrowing and investment are outlined in the second subsection. In subsection 3, the impact of changes in the policies of the donor community is studied. The manner in which borrowing and investment paths should be adjusted in response to unanticipated shocks is analysed in the fourth subsection. The concluding part of the paper presents a summary of the main policy implications that can be derived from our analysis.

1. The Base Case

In the base case scenarios the Hicks neutral constants in the production functions of the various sectors are held constant at average 1977-83 levels. World price projections for Senegal's major export and import commodities were obtained from the Bank's commodity division. These
projections imply a gradual decline in the terms of trade index.\textsuperscript{1} The nominal exchange rate is assumed to remain constant at its present level. Groundnuts' producer prices are assumed to grow at the same rate as international prices, and real government consumption grows at its historical rate. Projections for amortizations and interest payments on existing debt were obtained from DRS and are the same as those used in the 1984 CEM. New concessional commitments reached a peak in 1982 and have since declined. Therefore, we assume (as did the CEM), perhaps optimistically, that they will remain constant in nominal terms at their average 1977-83 levels. The same assumption was applied to interest rate projections.

The base run showed no borrowing on nonconcessional terms. Concessional borrowing was equal to the set upper limit. Desired investment was stable at 11 percent of real GDP which remained constant in per capita terms. The results of this run reinforce previous conclusions that Senegal should refrain from nonconcessional borrowing for at least the next ten years. They also indicate that in the absence of appropriate adjustment policies the country would have to accept lower levels of investment and a stagnant per capita GDP. Another feature of this scenario is that real per capita private consumption declines at an average annual rate of around 1.5 percent reaching 65 thousand 1979 CFA's by 1994.

This decline in private consumption is unlikely to be feasible. Therefore, the base scenario was rerun after imposing the constraint that real per capita private consumption cannot fall below 73 thousand 1979 CFA's; that

\textsuperscript{1} See the 1984 CEM for a detailed description of price projections.
is 95 percent of its level in 1981. 1/ A comparison between the results of this constrained base run and the unconstrained run is presented in Figures 39-41. In the constrained base run the government continues to avoid non-concessional borrowing. The main feature of this run is the low and declining investment levels. The desired level of investment is 10.3 percent of real GDP in 1985 and falls to nearly zero by 1994. Consequently, real per capita GDP declines at an average annual rate of around 1 percent. In the presence of wage rigidities this scenario also implies unacceptably high rates of unemployment.

The above two runs indicate the "best" borrowing and investment strategies that can be undertaken given our projections for the external environment and the present structure of the Senegalese economy. Those runs have yielded unacceptable results. In one case private consumption is too low and in the other case investment and growth are too low. One way of raising both consumption and investment is to increase the level of foreign borrowing by resorting to nonconcessional sources of finance. The model results indicate that such an approach would be undesirable because the benefits do not outweigh the costs of such borrowing. This implies that the Senegalese government must undertake policy changes that would result in achieving higher growth rates without worsening the foreign debt situation.

2. The Effect of Domestic Policy Changes

The above analysis has indicated that structural change is a necessity. In the past Senegal has avoided structural adjustment by increasing the

1/ The year during which per capita consumption was lowest.
level of nonconcessional borrowing. In Section III it was shown that this policy has lead to a significant welfare loss, and the results of our projections exercise indicate that it should not be continued in the future. The government must undertake policy measures that would result in higher investment and growth without resorting to nonconcessional sources of foreign funds. The main elements of such a program for the future would be:

(a) reducing government consumption;

(b) measures aimed at increasing the efficiency of capital;

(c) measures aimed at getting the agricultural sector on the move again;

(d) measures aimed at reducing private consumption.

One possible policy goal is to maintain the real value of government consumption fixed at its 1984 level. The main component of government consumption is wages and salaries. Since 1983 the government has made a concerted effort to slow the growth of civil service employment.\footnote{This was done by reducing admissions to civil training schools and introducing stringent controls over actual recruitment to the civil service.} It has been successful in reducing the growth of civil servants to 2.5 percent in 1983/84. Although this progress is welcome, it is not sufficient. Past recruitment policies have resulted in a civil service structure that will make future increases in wages and salaries difficult to control. Fully 60 percent of Senegalese civil servants were under the age of 35 in 1982 and 34 percent were under 30. This means not only will net reductions due to retirement be unlikely, but also that pressure for promotions and upgrading will be substantial throughout this decade. Even with zero growth in civil service numbers
and nominal wages and salaries, the total wage bill will increase an estimated 4-5 percent per year for the rest of the decade. Therefore, in order to achieve the goal of keeping the wage bill constant in real terms, negative growth in civil service numbers will be required. This can mainly be achieved by instituting even more stringent controls on recruitment. If this approach is not sufficient it may become necessary to reduce civil servant's benefits.

1/

The constrained model was rerun under the assumption that real government consumption will remain constant. This policy change had no effect on the desired level of borrowing, but lead to a significant increase in desired investment, and to a higher GDP growth rate. The desired level of investment in this run was stable at around 10 percent of GDP (Figure 42). As a result GDP grows at an average rate of 2.3 percent rather than 2.0 percent in the constrained base (Figure 43). Private consumption remains unchanged. The results of this run simply reflect the fact that government consumption and investment are substitutes, since they are competing for limited resources. Therefore, higher growth can be achieved without further jeopardizing the country's external balance by financing new investments through reductions in government consumption.

In Section II we showed that one of the rules of a successful foreign borrowing strategy is to set the marginal cost of borrowing equal to the marginal return on investment. Our results indicate that the marginal return to capital in Senegal lies between the costs of concessional and non-

1/ Heller and Tait (1983) show that average salary levels in Senegal's civil service are a much higher multiple of per capita income than in most African countries.
concession loans (4.9 and 8.9 percent per annum). This fact explains why concessional loans are attractive for Senegal, while nonconcessional loans should be avoided. That is, the country's debt carrying capacity can be improved by raising capital productivity. Since capital productivity is higher in the tradeables sectors than in the nontradeables sectors, the country's debt carrying capacity can be enhanced by changing the pattern of new investments to favor tradeables production. 1/

The increase in government's share of gross investment during the seventies (more than 80 percent under the IVth and Vth plans) was associated with a decline in the productivity of capital. A large number of costly public sector projects failed for reasons of overly optimistic design, unrealistic market projections or management problems. 2/ Most new projects were executed through newly created government owned enterprises, and relied upon inexperienced promoters and equipment suppliers rather than on established firms familiar with the Senegalese market. Any program aiming to increase capital productivity in Senegal should include a reevaluation of the government's investment strategy. The government's share of total investment should

1/ The most promising tradeables' sector in Senegal at the moment are fisheries and tourism.

2/ Examples of public projects which foundered due to poor appraisals, unrealistic market projections or bad design are: SOABI (a prefabricated housing construction company), Dakar-Marine (the naval repair dry dock), and SNTI (the tomato canning plant). Even viable projects often had excessively high unit costs; for example, it has been estimated that the modernization of the groundnut crushing mill at Diourbel cost some 50 percent more than it should have.
decrease. 1/ Also, a strengthening of the capabilities of the institutions responsible for the choice, evaluation and execution of projects is necessary.

Apart from raising the efficiency of future government investment, steps should be taken to improve the productivity of the capital stock currently owned by public and parapublic institutions. The poor performance of those institutions (as evidenced from their large and increasing operating deficits), provides ample evidence of the low productivity of the publicly owned capital stock. Reducing the extent of direct government ownership in the economy through the sale or transfer of equity shares to private Senegalese investors is one important method of improving the efficiency of those economic entities. For those enterprises where the case for public ownership is found compelling, efficiency gains can be achieved by making managers clearly accountable for enterprise performance while providing them with greater financial autonomy.

There is some evidence which suggest that private investment in Senegal has been more efficient than public investment. Therefore, a long run objective may be to shift investment patterns in favour of the private sector. In the short run, the prospects for a rapid increase in private investment on the scale that is required to affect the overall productivity of capital are rather dim. The main problem facing private entrepreneurs in Senegal is the lack of investible resources. This lack of resources is due to the low level of business savings as well as to the unwillingness of commercial banks to provide adequate long-term financing to projects. Government policies are partially responsible for this problem. By building

1/ It has already been reduced to 65 percent under the ongoing VIth plan.
up arrears with private firms, the government has deprived those firms from resources that they could have used for investment. On the other hand, commercial banks have made bad debts in the past and are therefore very cautious about providing more loans to the private sector. As a result, BCEAO estimates that those banks, at the moment, have some 10 billion CFA francs of excess liquidity that they are unable to lend.

The vast amount of government controls and regulations are also often cited as major impediments to private sector activities. The regulations that seem to provide the greatest disincentive for private investment are:

(a) Labor laws which make it nearly impossible for private enterprises to lay off workers.
(b) The system of administered prices which creates problems for producers who need to raise output prices in response to changes in the costs of production.

As stated earlier, the low productivity of investment in Senegal is the main cause of the country's low debt carrying capacity. We estimate that a 40 percent increase in productivity would enhance the country's debt carrying capacity to the extent that it would become desirable to undertake some nonconcessional borrowing. Whereas, this should be the government's long term objective, it is probably unrealistic to expect that the policy recommendations outlined above could lead to such a dramatic efficiency improvement in the short term. However, some results could be expected as soon as those policies are implemented. Therefore, we reran our model under the assumption that capital productivity will rise by 10 percent. As expected, this did not result in any change in the desired borrowing path. However, desired invest-
ment levels rose dramatically (Figure 44). Investment in this run averaged 14 percent of GDP. Naturally, this implied higher levels of GDP (Figure 45). In this run real GDP grew at 2.6 percent per annum. But, private consumption did not increase above its level in the constrained base run. The results of this experiment indicate the sensitivity of the calculated desired investment path to the efficiency of capital, and how even minor changes in this efficiency could have significant implications on growth and welfare.

Agriculture has traditionally played a very important role in the Senegalese economy. About 70 percent of the labor force is employed in that sector. The seventies and early eighties have witnessed a marked deterioration in this sector's performance. The growth rate of value added in the primary sector has declined from 3.0 percent in the 1960s to 2.3 percent in the 1970's and to only 1.8 percent between 1979 and 1983. One would expect that an increase in agricultural production, by making more resources available to the economy, would have an important impact on the desired borrowing and investment paths. In the short run such an increase could be achieved by developing rainfed agriculture while trying to minimize the attendant climatic risks. This can be done by assuring that the correct areas for development are very carefully chosen and that large sums are not, as in the past, imprudently invested. In the long term more weight must be given to irrigated agriculture whose cost at present is prohibitively high.

The constrained model was rerun under the assumption that agricultural production will rise by 10 percent. This lead to an increase in the desired level of investment (Figure 46). This rise was mainly due to the increased availability of resources. Naturally, higher investment implies a greater GDP growth (Figure 47), which averaged 2.3 percent for that run.
In all of the projection runs presented so far real per capita private consumption remains flat at below current levels. This contrasts with the conclusion derived in section III where private consumption was rising in our counterfactual experiments. This result can be explained by the fact that unlike the future scenarios, in the historical runs the debt overhang was relatively small. The size of the existing debt in Senegal implies that a sizable portion of the country's resources will have to be devoted to servicing the debt (see the following subsection). As a result, the desired levels of private consumption in the future are lower than historical levels. That is, had the government followed the desired borrowing path outlined in section III and refrained from accumulating nonconcessional debt the present need to decrease private consumption would probably not have arisen. Policy measures to reduce private consumption should include a reduction in government transfers to the private sector and the reform of the agricultural credit program.

3. Policies of the Donor Community

The preceding discussion has lead to two important conclusions: (1) the burden of servicing existing debt is a serious constraint on Senegal's growth in the medium term, and (2) the Senegalese economy can usefully absorb increases in concessional new commitments. The above conclusions imply that donor countries can help Senegal through its present crisis by arranging for longer term concessional reschedulings of service payments due on existing debt and by increasing the amount of concessional aid made available to it.

The combination of sharp downward swings in export earnings and rapid increases in total debt service obligations led to the 1981 rescheduling. Senegal has had to reschedule its debt service obligations every year since then. The focus of the reschedulings was short term: how to reschedule
debt service falling due during the following year. The terms of the various Paris Club agreements are almost identical: 90 percent of principal and interest due during the year are consolidated and repaid over $\frac{3}{2}$ years, including four years of grace (measured from the end of the consolidation period).

The remaining 10 percent nonconsolidated portion is repaid during the grace period. Previously rescheduled debt is excluded. Those reschedulings have only given temporary relief from immediate debt servicing requirements. They caused the stock of debt to rise very rapidly because of the removal of the natural brake on its growth, the regular amortization of principal. Therefore, we expect severe debt servicing problems to continue to reappear in the future as payments on rescheduled debt become due.

<table>
<thead>
<tr>
<th>Year</th>
<th>Principal</th>
<th>Interest</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>94,214</td>
<td>89,247</td>
<td>183,461</td>
</tr>
<tr>
<td>1986</td>
<td>135,117</td>
<td>87,235</td>
<td>222,352</td>
</tr>
<tr>
<td>1987</td>
<td>144,254</td>
<td>80,491</td>
<td>224,745</td>
</tr>
<tr>
<td>1988</td>
<td>163,378</td>
<td>71,153</td>
<td>234,531</td>
</tr>
<tr>
<td>1989</td>
<td>153,571</td>
<td>59,878</td>
<td>213,449</td>
</tr>
<tr>
<td>1990</td>
<td>132,347</td>
<td>49,576</td>
<td>181,923</td>
</tr>
<tr>
<td>1991</td>
<td>115,939</td>
<td>41,170</td>
<td>157,109</td>
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<tr>
<td>1992</td>
<td>108,173</td>
<td>33,557</td>
<td>141,730</td>
</tr>
<tr>
<td>1993</td>
<td>84,754</td>
<td>27,586</td>
<td>112,340</td>
</tr>
<tr>
<td>1994</td>
<td>83,338</td>
<td>22,856</td>
<td>106,194</td>
</tr>
</tbody>
</table>

Source: DRS data.

Projections for service payments due on existing debt during the period 1985 – 94 are presented in the above table. This table indicates that those payments, in the absence of new commitments, will continue to grow
gradually up to 1988 when they are expected to start declining. Despite this decline the projected payments in 1994 are as high as 190 percent of the actual payments made in 1983. The weight of this projected burden can be better appreciated by noting that in the average year between 1985 and 1994 the projected total debt service payment is 290 percent the average payments for the period 1971-80. Actual debt service payments will probably be even larger, since they will include payments due on commitments entered into after 1984.

The above figures support our conclusion that past reschedulings have only brought temporary relief from immediate debt service requirements. Therefore, one method by which the donor community can help Senegal adjust to the present crises is to carry out longer term reschedulings on concessional terms. If Senegal carries out the recommendations outlined in the previous subsections its ability to service its debt in the medium and long terms will be greatly enhanced, but while the short term crisis will be ameliorated it will not disappear. Our work so far has indicated that it would not be desirable for Senegal to increase its stock of nonconcessional debt. This clearly implies that reschedulings on nonconcessional terms are not desirable. Therefore, it would be useful for Senegal to find a new formula for those reschedulings, whereby the grant element of the initial debt is increased. That is, those reschedulings should consider repayments due over a period of 3-5 years (rather than one year), have longer grace periods and lower interest costs. Such a scheme may also involve the rescheduling of some of the previously rescheduled debt.
A rescheduling scheme along the lines described above will only serve the donors' interests if it is accompanied by a serious structural adjustment program. The donors' interests are to ensure that they will get repaid without inflicting undue hardships on Senegal. This could be achieved if a realistic restructuring of the debt is linked with domestic policy reforms. If such policy reforms are not carried out and present trends continue, such a restructuring will only serve to postpone the crisis for a few years, and therefore will not necessarily be in the donors' interest.

New commitments from official sources (on concessional terms) rose from $88.3 million in 1977 to $395.5 million in 1982 then dropped to $225 million in 1983. In our projections exercise we assume that they will be equal to the average for the period 1977-83 ($360 million). Given the worsening international climate for aid this assumption may be overly optimistic.  

1/ Nevertheless, it should be stressed that our model results indicate that such funds (with their longer maturities and lower interest rates) can be usefully employed by Senegal. That is, one obvious way by which the donor community can help Senegal is by increasing the level of concessional new commitments. We reran our constrained base model under the assumption that new concessional loans will be raised to their 1982 level. The results of those runs are presented in Figure 48. As would be expected, there was an upwards shift in the desired investment path, an increase in the GDP growth rate and hence a rise in welfare.

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1/ A recent Bank report on Sub-Saharan Africa forecast a sharp decline in net capital flows to this region from $10.8 billion to $5 billion by 1987.
4. Adjustment to Transitory Shocks

In the past, Senegal has adjusted to transitory shocks by resorting to nonconcessional loans. Thus, in response to the drought of 1978 new commitments from private financial institutions were more than double their level in the preceding year. Similarly, the 1981 drought was associated with a rise in such commitments. This behavior is not necessarily desirable. In general, a country faced by an exogenous shock should choose the least cost method of adjusting to the shock. Such an adjustment may be in the form of higher borrowing or lower investment or a combination of both. The exact nature of the adjustment process will depend upon the relative magnitude of the shock and upon the relative cost of additional borrowing and foregone investment opportunities. By adjusting to past shocks through higher borrowing rather than lower investment, the Senegalese government was implicitly assuming that the marginal cost of borrowing was much lower than the marginal return on investment. Our analysis has indicated that this assumption is not correct. Whereas, the return to investment in Senegal has been above the cost of concessional loans (around 5 percent) it was below the cost of nonconcessional borrowing (9 percent). Therefore, we reached the conclusion in section III that adjustment to past shocks should have been by lowering investment rather than raising nonconcessional borrowing.

In order to study how Senegal should react to similar shocks in the future, we simulated a drought similar in magnitude to the one which occurred in 1981. This was done by reducing the Hicks neutral constants in the production functions of the agricultural sectors. We assumed that the drought would affect production in 1985 and 1986. The result of this run was a drop in desired investment as well as a rise in nonconcessional borrowing (see Figures 49 and 50). However, it should be noted that the model started by first
reducing investment in 1986 to zero before increasing borrowing. This reflects the fact that in the absence of policies that would enhance capital productivity the cost of additional nonconcessional borrowing will continue to be higher than the loss associated with the decline in investment.

Senegal is also vulnerable to transitory terms of trade shocks. We simulated such a shock by reducing the world price of groundnuts by 20 percent in 1985 and 1986. The result was that no increase in borrowing occurred, but there was a 10 percent decline in desired investment (Figure 51). Since we project that in the future Senegal will be dependent on the availability of concessional sources of finances a decline in the availability of such sources of finance will constitute an exogenous adverse shock. We experimented with decreasing the availability of such funds by 15 percent in 1985 and 1986. The model reacted to this shock by reducing investment by 24 percent (Figure 52), but no nonconcessional borrowing occurred.

Reaction to severe shocks is clearly an area where the donor community can help Senegal. Some shocks (like an exceptionally bad drought) may require the government to make dramatic cuts in public investment. If wages do not adjust, such cuts would lead to high levels of unemployment and hence, to social unrest. The donor community could alleviate this problem by making the amount of concessional aid available to Senegal a negative function of its revenue from groundnut exports. Thus, in drought years, Senegal could count on an increase in concessional aid. In this manner, adjustment to shocks would be partially through greater concessional borrowing and partially through lower investment.

5. A Summary of the Main Conclusions

The above analysis indicated that in the near and medium terms Senegal must avoid resorting to nonconcessional foreign borrowing. The
country should adjust to the changing economic environment by reducing investment to around 10 or 11 percent of real GDP (it was 14 percent in 1983), and by cutting real per capita private consumption to roughly 73 thousand 1979 CFAs (it was about 79 thousand 1979 CFAs in 1983). If present trends continue in the future, Senegal will face a period of declining per capita GDP. This period of decline can be avoided if the government carries out some necessary reforms. Such reforms should include a decrease in government consumption, measures to improve the efficiency of investment and policies aimed at increasing productivity in agriculture. The donor community can help Senegal through the present crisis by carrying out longer term concessional rescheduling excercises, and by increasing the level of concessional aid made available to it.

The past practice of adjusting to adverse shocks by increasing nonconcessional borrowing must be discontinued. It was shown that adjustment to severe droughts should be by means of a mixture of lower investment and higher borrowing. It was also shown that the decline in investment should be relatively greater than the increase in borrowing. Adjustment to terms of trade shocks and shocks caused by the decrease in the availability of concessional funds should be by lowering investment only. It was calculated that a 1 percent fall in the terms of trade index should lead to a 1/2 percent decline in desired investment; while a 1 percent fall in the level of concessional funds available leads to a 1.6 percent decline in desired investment.

The extent of the present crisis warrants a reevaluation of Senegal's planning process. In traditional planning models the levels of investment and consumption are chosen first. Thus, the amount of foreign borrowing becomes a residual equal to the difference between domestic expenditures and production. In the model presented here, the desired levels of
borrowing and investment are chosen simultaneously to maximize consumption. This approach is an improvement over existing tools of analysis, since it relates the level of borrowing to the country’s debt carrying capacity, and chooses the amount of investment by equating its marginal product to the marginal cost of borrowing. The Senegalese government can improve its present planning process by first setting a target for foreign borrowing. For the medium term, this target should be equal to the amount of concessional funds available. If the government carries out the policy recommendations presented here then investment targets should be at around 10 percent of GDP. Deviations from those paths in response to shocks would be in accordance to the rules set out earlier.
Figure 43
THE EFFECT OF REDUCING GVT. CONSUMPTION ON GDP

Figure 44
THE IMPACT OF HIGHER CAPITAL PRODUCTIVITY ON DESIRED INVESTMENT

Figure 45
THE IMPACT OF HIGHER CAPITAL PRODUCTIVITY ON GDP

Figure 46
THE IMPACT OF HIGHER AGRICULTURAL PRODUCTIVITY ON DESIRED INVESTMENT
Figure 50
THE IMPACT OF A DROUGHT ON DESIRED BORROWING

Figure 51
THE IMPACT OF A TEMPORARY DROP IN GROUNDNUT PRICES ON DESIRED INVESTMENT

Figure 52
THE EFFECT OF A TEMPORARY REDUCTION IN CONCESSIONAL LOANS ON DESIRED INVESTMENT
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Appendix 1

The Kharas-Glick Model

Assume a small, open economy producing a traded and a nontraded good \( Q_{Tt} \) and \( Q_{Nt} \) respectively where \( t = 1, 2 \) indexes the time period with factors of production, labor and capital, which are mobile between sectors. In the first period, the availability of factors is determined by an initial endowment \( (L_1, K_1) \). In the second period, the aggregate labor force is held fixed, while capital may increase through investment \( (K_2 = K_1 + I) \). It is assumed that only the traded good is invested, but that capital is used in the second period production of both goods.

Perfect competition amongst producers implies that factors of production are allocated across sectors to equate their value marginal products. Therefore, the assumption of fixed aggregate labor implies that it is possible to express output of each good as a function of the aggregate availability of capital and of the relative price of the nontraded good in terms of the traded good, \( P_t \):

\[
Q_{Nt} = Q_{Nt} (K_t, P_t) \tag{1}
\]

\[
Q_{Tt} = Q_{Tt} (K_t, P_t) \tag{2}
\]

The country may borrow any amount \( D \) at a world interest rate, \( i \), fixed in terms of traded goods, subject only to the provision that the discounted value of the credit line extended is zero. That is, the first period borrowing must be followed by repayment of all principal and interest in the second period.
The intertemporal maximization problem can be construed as choosing levels of consumption, investment, and debt that maximize discounted utility:

\[ W = u_1 (C_{11}, C_{N1}) + u_2 (C_{12}, C_{N2})/(1 + \delta) \]  

subject to the intertemporal credit constraint

\[ (C_{T1} + I - Q_{1}) + (C_{T2} - Q_{2})/(1 + i) = 0 \]

where \( C_{Tt} \) and \( C_{Nt} \) are consumption levels of traded and nontraded goods; \( U_t [\cdot] \) is a stationary utility function; and \( \delta \) is the pure rate of time preference.

In combination with the home goods equilibrium condition,

\[ C_{Nt} = Q_{Nt} \quad t = 1, 2 \]

the intertemporal credit constraint (4) implies (given the absence of any initial stock of debt) that total discounted expenditures equals discounted income (valued in terms of traded goods) over the two periods, and hence that

\[ C_{T1} = Q_{T1} + D - I \]  

\[ C_{T2} = Q_{T2} - (1 + i) D \]
To characterize the equilibrium a specific functional form of the utility function is assumed:

\[ U_t = C_t^{1-b} / (1-b) : C_t = C_{T_t}^a C_{N_t}^{1-a}, \quad b > 0, \quad 0 < a < 1 \]  \hspace{1cm} (8)

where \( C_t \) represents an index of aggregate consumption, and \( a \) is the share of traded goods. The parameter \( b \) is the Arrow-Pratt measure of relative risk aversion. Maximization of (3) with respect to \( C_{T_t} \) and \( C_{N_t} \) subject to the budget constraint yields the familiar first-order condition that the marginal rate of substitution between traded and nontraded goods in each time period should equal the real exchange rate:

\[ \left( \frac{\delta u_t}{\delta C_{N_t}} \right) / \left( \frac{\delta u_t}{\delta C_{T_t}} \right) = p_t \]  \hspace{1cm} (9)

Using the specific functional form for \( u_t \), equation (8), gives an expression for the relative consumption of the two goods,

\[ C_{T_t} / C_{N_t} = p_t^a / (1-a) \]  \hspace{1cm} (10)

Substitution of (6) and (7) into (3) and maximization with respect to \( D \) and \( I \) then yields the first order conditions for debt and investment which are presented in the text.
Appendix 2

Equations of The Senegal Model

A. Objective Function

(1) Maximize \( W = \sum_{t=1}^{T-1} \frac{u_t^{1-b}}{(1 + \delta)^t (1 - b)} + \frac{u_T^{1-b}}{\delta (1 + \delta)^T (1 - b)} \)

where:

(2) \( u_t = PC_t^{(agr)} \theta^{(agr)} PC_t^{(tr)} \theta^{(tr)} PC_t^{(nt)} \theta^{(nt)} / pop_t \)

\( b \) and \( \delta \) are the Arrow-Pratt measure of relative risk aversion and the pure rate of time preference. The second term in equation (1) is derived from the terminal conditions discussed at the end of this appendix. \( PC_t^{(agr)} \), \( PC_t^{(tr)} \) and \( PC_t^{(nt)} \) are the quantities of agricultural goods, tradeables and nontradeables that are privately consumed. The \( \theta \)s are coefficients of the utility function which satisfy the condition:

\( \sum_j \theta(j) = 1 \)

and \( pop_t \) is population at time \( t \).
B. Production Functions

(3) \( Q_t(j) = q_t(j) L_t(j)^{\beta(j)} K_t(j)^{1-\beta(j)} \quad j = tr, nt \)

(4) \( Q_t(j) = q_t(j) L_t(j)^{\beta(j)} N_t(j)^{1-\beta(j)} \quad j = agr, gn \)

(5) \( Q_t(fish) = Q_t(fish) \)

Cobb-Douglas production functions exhibiting constant returns to scale are used. Production in the urban sectors (tr and nt) is a function of labor and capital, while in the rural sectors (agr and gn (groundnuts and groundnut oil)) it is a function of labor and land. Output of fish and fish products is treated as exogenously determined (equation (5)). The technical efficiency coefficients \( q_t(j) \) are allowed to vary in order to reflect the realizations of the various states of nature.

C. Export Supply

(6) \( X_t(gn) = Q_t(gn) \)

(7) \( X_t(fish) = Q_t(fish) \)
(8) \[ X_t^{tr} = \lambda_t \left( E_t \cdot WP_t^{tr} \right) \]

All output of groundnuts and fish is exported (equations (6) and (7)). A portion of the output of tradeables is also exported. The amount of tradeable's exports is a function of their world price (equation (8)); \( E_t \) is the nominal exchange rate and \( WP_t^{tr} \) is the world price of tradeables. The export supply equation includes a scale variable \( \lambda_t \) which is allowed to vary reflecting changes in world demand. It is assumed that the other agricultural sector (agr) only produces import substitutes.

D. Intermediate Demand

(9) \[ \text{IMD}_t(j) = \sum_i Q_t(i) \cdot a(j, i) \]

Equation (9) determines the amount of good \( j \) which is used as an input in the production of other goods; the \( a(j, i) \)'s are coefficients from an aggregated input/output table. It is assumed that gn and fish are not used as inputs in the production of other goods and that their production does not use any intermediate inputs. That is,

(10) \[ a(j, k) = a(k, j) = 0 \quad k = \text{gn, fish} \]
E. Price Determination

(11) \( P_t (j) = (1 + T(j)) E_t w_t (j) \quad j = \text{tr, agr, fish} \)

(12) \( P_t (\text{gn}) = P_t (\text{gn}) \)

(13) \( \frac{P_t (j)}{P_t (i)} = \frac{\theta u_t}{\theta PC_t (j)} / \frac{\theta u_t}{\theta PC_t (i)} \quad i, j = \text{tr, agr, fish} \)

Using a small country assumption prices of all tradeable goods (excluding groundnuts) are equal to world prices plus import tariffs \((T(j)), equation (11)\). Groundnut prices are fixed by the government, equation (12). Nontraded goods prices and hence the real exchange rate is determined endogenously in the model. At an optimum the marginal rates of substitution between the consumption goods is equal to their price ratio (equation (13)).

(14) \( PV_t (j) = P_t (j) - \sum_i P_t (i) a(t, j) \)

Equation (14) is a definition of value added prices \((PV_t (j))\).
F. Goods' Markets Clearing Conditions

\[ (15) \quad MP_t^{(agr)} + Q_t^{(agr)} = PC_t^{(agr)} + IMD_t^{(agr)} \]

\[ (16) \quad MP_t^{(tr)} + Q_t^{(tr)} = PC_t^{(tr)} + IMD_t^{(tr)} + X_t^{(tr)} + GC_t^{(tr)} + c I_t \]

\[ (17) \quad Q_t^{(nt)} = PC_t^{(nt)} + IMD_t^{(nt)} + GC_t^{(nt)} + (1 - c) I_t \]

where \( MP_t^{(j)} \) and \( GC_t^{(j)} \) are imports and government consumption of good \((j)\) respectively, and \( c \) is the constant share of tradeables in gross investment. Since groundnuts and fish are only used for export there is no need to specify separate market clearing conditions for them.

G. Factor Markets Clearing Conditions

\[ (18) \quad I_t = \left(1 + \frac{v_J}{2 K_t} \right) J_t \]
\[ K_t(j) = K_{t-1}(j) + \left( \frac{\partial Q_{t-1}(j)}{\partial K_{t-1}(j)} - \frac{\partial Q_{t-1}(i)}{\partial K_{t-1}(i)} \right) J_t \]

\[ i, j = tr, nt \]

\[ N_t(j) = N_{t}(j) \]

\[ j = gn, agr \]

\[ L_t(s) = (1 + n(s)) L_{t-1}(s) \]

\[ s = \text{rural, urban} \]

\[ L_t(\text{urban}) = L_t(tr) + L_t(nt) \]

\[ L_t(\text{rural}) = L_t(gn) + L_t(agr) \]

\[ w_t(\text{urban}) = PV_t(tr) \frac{\partial Q_t(tr)}{\partial L_t(tr)} = PV_t(nt) \frac{\partial Q_t(nt)}{\partial L_t(nt)} \]

\[ w_t(\text{rural}) = PV_t(agr) \frac{\partial Q_t(agr)}{\partial L_t(agr)} = PV_t(gn) \frac{\partial Q_t(gn)}{\partial L_t(gn)} \]
Where J is the net addition to the capital stock, n (s) is the rate of growth of the labor force and w (s) is the wage rate. Equation (18) states that the net addition to the capital stock is less than gross investment due to installation costs which are an increasing and convex function of investment. Capital goods in this model are putty-clay. Equation (19) states that the distribution of new investment between the two urban sectors is a function of each sector's profit share during the preceding period. The amount of land available for groundnuts and for other agricultural activities is fixed, equation (20). The urban and rural labor forces grow at different rates (equation (21)) and both labor markets clear, equations (22) and (23). Labor is paid its value marginal product and wage rates are equalized within each market, equations (24) and (25).

H. Debt and Debt Service

\[
(26) \quad B_t = B_{C_t} + B_{N_t}
\]

\[
(27) \quad D_t = D_{t-1} + B_t
\]

\[
(28) \quad D_{N_t} = D_{N_{t-1}} + B_{N_t}
\]

\[
(29) \quad D_{SC_t} = D_{SC_{t-1}} + (1_c_t B_{C_t})
\]
(30) \[ DSN_t = in_t DN_t \]

(31) \[ DS_t = DSN_t + DSC_t \]

(32) \[ BC_t < BC_t \]

Where BC and BN are borrowing on concessional and nonconcessional terms, D is the total stock of debt and DN is the stock of nonconcessional debt. DSC, DSN and DS are the cost of servicing concessional and nonconcessional debt and total debt service cost, respectively. The average interest cost of concessional and nonconcessional debt are denoted by ic and in. Equations (26), (27) and (28) are simply definitions of total borrowing, the total stock of debt and the stock of nonconcessional debt. Equations (29)–(31) describe the cost of servicing concessional and nonconcessional debt, and total debt service cost. Equation (32) sets an upper limit on the amount of concessional loans made available to Senegal.

I. The Balance of Payments Constraint

(33) \[ \sum_{j} w_{P} (j) X_t (j) + B_t = \sum_{j} w_{P} (j) MP_t (j) + DS_t \]
Equation (33) simply states that total export proceeds plus new borrowing should be equal to the total import bill plus debt service.

J. The Interaction Between the Public and Private Sectors

\[ T_t = T + \sum_j T(j) E_{wp}(j) MP_t(j) \]

\[ GS_t = T_t + (E_{wp}(gn) - P_t(gn) X_t(gn)) + B_t - \]

\[ \sum_j P_t(j) GC_t(j) - E_{ds} - (cP_t(tr) + (1-c) P_t(nt)) I_t - \]

\[ \sum_j T(j) E_{wp}(j) X_t(j) \]

\[ PS_t = \sum_j PV_t(j) Q_t(j) - \sum_j P_t(j) PC_t(j) - T_t \]

Tax revenue is assumed to consist of a lump sum portion \( T_t \) and import tariffs, equation (34). Under the assumption that all borrowing and investment is carried out by the government, equation (35) defines net government transfers to the private sector (GS). Note that the second term on the right hand side of (35) represents the government's net revenue from
groundnut exports while the last term represents export subsidies. Equation (36) is a definition of private savings, under the assumption that all production is carried out in the private sector. The structure of the model ensures that $GS_c = -PS_c$.

I. Terminal Conditions

(37) $J_T = gK_{T-1}$

(38) $B_T = (\pi + g)D_{T-1}$

The second term in the objective function together with equations (37) and (38) determine the terminal conditions. It is assumed that a steady state is reached at the $T$th period. Such a state is defined as a situation when output, consumption and debt (all in real terms) are growing at the same rate with no change in relative prices or in per capita utility. If the growth rate of these real variables is equal to that of the labor force ($g$), then the discounted sum of per capita utility from the $T$th period to infinity is given by:

(38) \[
\frac{u_T}{(1 + \delta)^T} + \frac{u_T}{(1 + \delta)^{T+1}} + \ldots
\]

= \frac{u_T}{\delta (1 + \delta)^T}
Raising $u_t$ to the power of $(1-b)$ and dividing it by the same constant we obtain the second term in the objective function. If international inflation is equal to $\pi$, then equations (37) and (38) specify the amounts of borrowing and investment that are required to allow such a steady growth state. The sensitivity of our conclusions to changes in the terminal conditions is studied in the text. Finally, it should be noted that the existence of a solution to the optimization problem requires that $(g + \pi)$ be less than the interest rate on nonconcessional borrowing.
Bibliography


