Modelling the Long Run Determinants of Private Investment in Senegal

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Abstract

This paper investigates the determinants of private investment in Senegal over the period of 1970-2000. It first tests the variables for unit root using two, relatively, new tests namely the Dickey-Fuller generalised least square de-trending test proposed by Elliot *et al*. (1996) and the Ng-Perron test following Ng and Perron (2001). The long run private investment equation is derived using the Johansen cointegration techniques (Johansen, 1988; Johansen and Juselius, 1990) and the newly developed bounds test approach proposed by Pesaran *et al*. (2001). In both cases, the results indicate that public investment, real income and foreign aid flows affect positively private investment, whilst the impact of credit to private sector and terms of trade is negative.

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1. Introduction

In recent years, emphasis has been put on the development of the private sector in developing countries to help boost economic growth and reduce poverty. Already in the late 1980s the idea of using the development of the private sector as an alternative development strategy to boost growth in developing countries has started to emerge. For example, the International Financial Corporation created the African Enterprise Fund, and the United States via its Overseas Private Investment Corporation initiated the African Growth Fund. In the early 1990s, a strategy was introduced by the African Development Bank to help boost private investment to 25 percent of GDP (see Pfefferman and Madarassy, 1990).

In the context of Senegal, the government has adopted a comprehensive package of policy reforms aimed at creating an improved business environment in the late 1990s. The World Bank, through the International Finance Corporation, provided financial assistance to help the development of small and medium enterprises in 1997. In August 1998, the IMF concluded an Enhanced Structural Adjustment Agreement with Senegal, which was designed to promote the private sector, alleviate poverty, and strengthen governance. More recently, on April 2003, the Senegalese government submitted a new private sector development strategy letter to the World Bank. The overall objectives of the strategy is to enhance the investment climate of the country and to help achieve

and sustain steady private sector- based GDP growth of about 8 percent per annum, which in turn would create jobs.

This paper is concerned with the long run determinants of private investment in the context of Senegal. It uses cointegration techniques based on the Johansen maximum likelihood approach and the bounds testing procedure to determine the long run private investment equation. The outline of the rest of the paper is as follows. In Section 2, a brief overview of the Senegalese economy is presented. Section 3 sets out the model specification and describes the data used in this study. In Section 4 the econometric methodologies employed are described. Section 5 presents the empirical results and their interpretation. Finally, concluding remarks are given in Section 6.

2. Background Information of the Senegalese Economy

Senegal is still among the world's least developed countries. The country's per capita GDP ($532 in 1998) has stagnated over the last four decades. Since its independence to the 1970s Senegal followed an inward development strategy. From 1962 to 1973 average yearly growth was estimated at 2.3 percent. This figure jumped to 4.5 percent between 1974 and 1977. However, during 1978-84 the country experienced a series of droughts, which weaken its economy. The situation was worsened by the deteriorating terms of trade and inappropriate financial and structural policies undertaken by the

Senegalese Government. As a result, average yearly GDP growth declined to 1.7 percent over that period.

The macroeconomic imbalances generated by these shocks led the government to undertake a series of macroeconomic stabilisation and reforms in the 1980s. At the same time the government implemented structural reforms to increase production, exports and reduce unemployment in the country. To help boost private sector development the Senegalese authorities introduced labour legislation, liberalised prices and external trade. Following these measures annual GDP growth rose to 4.4 percent during the 1985-88 period. This recovery, however, was hindered by four main factors. Firstly, the loss in export competitiveness caused by the large appreciation of the CFA franc vis-à-vis the US dollar. Secondly, the substantial increase in interest rates (which went from 2.09 percent in 1979 to reach 15 percent by the late 1980s) might have contributed to the fall in domestic investment. Thirdly, the worsening terms of trade coupled with bad weather have negatively affected the export performance of the country. And finally, despite the early effort undertaken by the government to remove structural constraints hampering the development of the private sector, it was clear that the sector was facing other constraints such as monopoly of the state and some private enterprises in certain markets and lack of investment incentives, which failed to create a viable environment for the private sector.

Following the CFA franc devaluation in 1994 however, the Senegalese economy experienced a U-turn. Annual GDP grew on average at 5 percent. The

renewed growth has also been accompanied by other positive outcomes. Government revenues experienced an increase, reaching almost 20 percent of GDP, on average. This led to an improvement in the fiscal deficit. Total investment rose steadily from around 10 percent of GDP in 1990 to 16 percent in 1995 and then to almost 20 percent in 2000. Contrary to some scepticism that the devaluation would push inflation up, the evidence shows that in fact it has been pushed down to 1 percent by 1996. The post-devaluation period has also witnessed an impressive performance in key industrial and agricultural sectors as well as the service sector.

Private investment in Senegal trends, as shown by Figure (1), are characterised by four main phases during the period of 1970-2000. During the first phase, 1970-74, private investment rose from around 8 percent of GDP to over 12 percent. Public investment also increased during that period going from around 5 percent of GDP to over 7 percent. The second period which starts from 1975 to 1980 witnessed a decline in private investment from over 12 percent of GDP to around 6 percent. Public investment remained almost constant over the period. During the third period, 1981-1993, private investment fluctuated considerably between 6 and 10 percent of GDP. Public investment declined during that period to around 4 percent of GDP. Finally, the fourth phase, which corresponds to the post-devaluation period, is characterised by a substantial increase in private investment, as a share of GDP. From 11 percent in 1994 it rose to over 15 percent in 1998, before declining 11 percent in 1999 then rose to above 12 percent in 2000. Public investment also witnessed a steady increase

during that period. Table (1) presents selected macroeconomic indicators of the Senegalese Economy.

INSERT TABLE (1) HERE

INSERT FIGURE (1) HERE

3. Model and Data Issue

3.1 The Model

In modelling the determinants of investment five broad approaches are generally considered. These major strands of investment behaviour include the simple accelerator model, the liquidity theory, the expected profits theory, the Tobin's Q Theory, and the neoclassical flexible accelerator theory. The flexible accelerator model appears to be the most popular of these theories used in applied work. However, in the context of developing countries, due to data limitations and structural constraints, a variant of the flexible accelerator model has often been used in empirical research, including the literature on the determinants of private investment in these countries.

Neoclassical investment theory suggests that private investment is positively related to the growth of real GDP (Greene and Villanueva, 1991; Fielding, 1997). Similarly, it has also been hypothesised that private investment is affected positively by income level, as countries with higher income level would tend to dedicate more of their

wealth to domestic savings which would then be used to finance investment (Greene and Villanueva, 1991).

Public sector investment has also been suggested to affect private investment, although its impact remains ambiguous. Public investment can boost private investment by increasing private returns through the provision of infrastructures (Communication, transports, energy, etc.). Evidence of a complementarity between public and private saving has been found by studies such as Blejar and Khan (1984), Aschauer (1989), and Greene and Villanueva (1991). Conversely, public investment may crowd out private investment if the additional investment is financed by a deficit, which leads to an increase in the interest rate, credit rationing, and a tax burden. Empirical studies by Chhiber and Wijnbergen (1988) and Rossiter (2002) report a negative effect of public investment on private investment.

The effect of credit to the private sector on private investment is expected to be positive. Private firms in developing countries rely heavily on bank credit as a source of financing. With financial markets being generally repressed, credit policies generally affect private sector investment via the stock of credit available to firms that have access to preferential interest rates. On the empirical level, although the vast majority of studies seem to ascertain the positive impact of increases in private sector credit on private investment there are cases where these credits do not appear to have any effect on it. For example, Oshikoya (1994) found that increases in credit to the private sector were not associated with increases in private investment for Morocco, Tanzania, and Zimbabwe.

In the context of developing countries, the flexible accelerator model can be adjusted to take into account foreign aid flows. Foreign aid flows can increase private

sector investment through the conditionality attached to them. One condition attached to these flows since the 1980s is that the recipient country has to privatise some publicly-owned enterprises. Aid can also increase private investment if donors use it to provide private credit via local institutions and non-governmental organisations. Finally, aid flows tend to be associated with tax reductions in the recipient countries.[1] If this reduction is targeted at the private sector then it could boost its investment.

Finally, terms of trade are suggested to be another important determinant of investment in developing countries. This variable is often used to proxy external shocks to the economy. A negative terms of trade implies that more unit of exports are needed per unit of imports. This may worsen the current account deficit, which is an indicator for macroeconomic instability, and exert a negative effect on private investment. If the worsening terms of trade are generated by an increase in the price of imports this would tend to increase the consumer price index. If it is the effect of a reduction in export prices then export earnings will fall, which in turn will tend to reduce investment in that sector.

Bearing the above discussion in mind, our model for the private investment equation is assumed to take the following representation:

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\begin{aligned}
\ln I_{pt} = {} & \alpha_0 + \alpha_1 \ln I_{gt} + \alpha_2 \ln RGDP_t + \alpha_3 \ln PCRED_t + \alpha_4 \ln Aid_t \\
& + \alpha_5 \ln TOT_t + \varepsilon_t
\end{aligned}
\tag{1}
$$

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[1] Most fiscal response studies find that aid flows are associated with a reduction in taxation (see Franco-Rodriguez, 2000; McGillivray, 2000; Mavrotas 2002; McGillivray and Ouattara, forthcoming; among others)

where Ip is private investment; Ig represents public sector investment; RGDP is real GDP; PCRED stands for credit to the private sector; Aid is foreign aid; TOT is terms of trade. ε and t stands for the error term and time subscript, respectively.

3.2 Data

The data covers the period of 1970-2000. Data on private investment and public investment (as % GDP) has been obtained from the World Bank Global Development Network (macro time series) for the period of 1970-1994 and then complemented with private investment data from the IMF (Senegal: Statistical Appendix, June 2003) for the period of 1995-2000. Data on real GDP has been calculated by deflating GDP at market price by the GDP deflator (base 1995), both obtained from the World Development Indicators 2003 (WDI 2003). Data on credit to the private sector (as % GDP) comes form the WDI 2003. Aid is net official development assistance (obtained from the OECD-DAC online statistics), which has been expressed in percentage of GDP (obtained from the WDI 2003). Finally, the terms of trade variable comes from the World Bank Global Development Network (macro time series). Natural logs of the variables were taken for the estimation. Summary statistics of the variables are presented in Table (2).

INSERT TABLE (2) HERE

4. Econometric Methodology

4.1 Cointegration Procedure

The Johansen cointegration technique following Johansen (1988) and Johansen and Juselius (1990), and the ARDL bounds approach developed by Pesaran *et al*. (2001) are used to derive the long run private investment function for Senegal. The literature on the Johansen technique has been extensively exposed, for almost two decades now, and will not be presented here. By contrast, the ARDL approach is relatively new and it might be necessary to present the main steps in this procedure.

To implement the bounds test procedure, Equation (1) is modelled as a conditional ARDL- error correction model:

$$\Delta \ln I_p = \beta_0 + \sum_{j=1}^{n} \beta_j \Delta \ln I_{gt-j} + \sum_{j=1}^{n} \delta_j \Delta \ln RGDP_{t-j} + \sum_{j=1}^{n} \mu_j \Delta \ln PCRED_{t-j}$$

$$+ \sum_{j=1}^{n} \phi_j \Delta \ln Aid_{t-j} + \sum_{j=1}^{n} \varphi_j \Delta \ln TOT_{t-j} + \eta_1 \ln I_{pt-1} + \eta_2 \ln I_{gt-1} \qquad (2)$$

$$+ \eta_3 \ln RGDP_{t-1} + \eta_4 \ln PCRED_{t-1} + \eta_5 \ln Aid_{t-1} + \eta_6 \ln TOT_{t-1} + \mu_t$$

where β_0 is a drift component and μ_t are white noise error. The first step in the ARDL approach is to estimate Equation (2) using ordinary least square (OLS). The second step is to trace the presence of cointegration by restricting all estimated coefficients of lagged level variables equal to zero. That is, the null hypothesis of no cointegration ($H_0 : \eta_1 = \eta_2 = \eta_3 = \eta_4 = \eta_5 = \eta_6 = 0$) is tested against the alternative ($H_1 : \eta_1 \neq 0, \ \eta_2 \neq 0, \ \eta_3 \neq 0, \ \eta_4 \neq 0, \ \eta_5 \neq 0, \ \eta_6 \neq 0$) by the mean of a F-test with an

asymptotic non-standard distribution. Two asymptotic critical value bounds provide a test for cointegration when the independent variables are $I(d)$ with $0 \leq d \leq 1$. The lower bound assumes that all the regressors are $I(0)$, and the upper bound assumes that they are $I(1)$. If the computed F-statistics lies above the upper level of the band, the null is rejected, indicating cointegration. If the computed F-statistics lies below the lower level band, the null cannot be rejected, supporting the absence of cointegration. If the statistics fall within the band, inference would be inconclusive. After confirmation of the existence of a long run relationship between the variables in the model, the long run and short run models can be derived using information criteria such as the Schwartz Bayesian or the Akaike information criteria.

The ARDL approach to cointegration does not require the pre-testing of the variables, included in the model, for unit root unlike other techniques such as the Johansen approach (Pesaran *et al.*, 2001). However, Ouattara (2004) argues that in the presence of I(2) variables[2] the computed F-statistics provided by Pesaran *et al.* (2001) are no more valid because they are based on the assumption that the variables are I(0) or I(1); therefore, the implementation of unit root tests in the ARDL procedure might still be necessary in order to ensure that none of the variables is integrated of order 2 or beyond.

4.2. Unit Root Procedure

To test the order of integration of variables standard tests for unit root such as the Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests proposed by Dickey and Fuller (1979) and, Phillips and Perron (1988), respectively are often used. However,

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[2] Although most economic variables are either I(0) or I(1) the existence of I(2) variables is still a possibility (see Johansen, 1995 and Paruolo, 1996).

these tests are not generally reliable in small samples, because of their poor size and power properties i.e. they tend to over-reject the null hypothesis when it is true and under-reject it when it is false, respectively (Dejong *et al*., 1992; Harris, 2003). Two new tests have been proposed, recently, to address these problems: the Dickey-Fuller generalised least square (DFGLS) de-trending test proposed by Elliot *et al*. (1996) and the Ng-Perron test following Ng and Perron (2001).

Elliot *et al*. (1996) optimise the power of the ADF test by de-trending. Assuming that we need to test the order of integration of the variable Z_t, the DFGLS de-trending test is based on testing $H_0 : \varphi_0^* = 0$ in the regression:

$$\Delta Z_t^d = \varphi^* Z_{t-1}^d + \varphi_1^* \Delta Z_{t-1}^d + \ldots\ldots\ldots\ldots + \varphi_{p-1}^* \Delta Z_{t-p+1}^d + v_t \tag{3}$$

where Z_t^d is the de-trended series. The null hypothesis of the test is that Z_t has a random walk trend, possibly with drift, as follows.

$$Z_t^d = Z_t - \widehat{\delta_0} - \widehat{\delta_1} t \tag{4}$$

There are two possible alternative hypotheses, which are: (1) Z_t is stationary about a linear time trend and (2) it is stationary with a (possibly) non-zero mean, but with no linear time trend.

Under the first alternative hypothesis, the DFGLS test is performed by first estimating the intercept and trend using the generalised least square technique. This estimation is performed by generating the following variables:

$$\left.\begin{array}{l} \overline{Z} = [Z_1, (1-\overline{\alpha}L)Z_2, \ldots, (1-\overline{\alpha}L)Z_T] \\ \overline{W} = [Z_1, (1-\overline{\alpha}L)W_2, \ldots, (1-\overline{\alpha}L)W_T] \end{array}\right\} \quad (5)$$

and

$$W_t = (1,t)' \qquad \overline{\alpha} = 1 + \frac{\overline{c}}{T} \qquad (6)$$

where T represents the number of observations for Z_t and $\overline{c}$ is fixed at -13.7.[3]

An OLS regression is performed on the following equation:

$$\overline{Z} = \delta_0 \overline{W} + \delta_1 W_t + \varepsilon_t \qquad (7)$$

and the OLS estimators $\widehat{\delta_0}$ and $\widehat{\delta_1}$ are then used to remove the trend from as Z_t above. Finally, the ADF test is performed on the transformed variable by fitting the OLS regression:

$$\Delta Z_t^d = \varphi_0 + \rho Z_{t-1}^d + \sum_{j=1}^{k} \beta_j \Delta Z_{t-j}^d + \vartheta_t \qquad (8)$$

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[3] The envelop power curve takes the value of one-half at $\overline{c} = -13.7$ when the model has a constant and a trend term, and at $\overline{c} = -7$ when it has only a constant (see Elliot *et al.*, 1996 for detail discussion).

and testing for the null hypothesis that $\rho = 0$ using the tabulated critical values provided by Elliot *et al*. (1996).

To perform the DFGLS test under the second alternative hypothesis we proceed as before but this time $\overline{c} = $ -7 in the equation of $\overline{\alpha}$, above. We then compute $Z_t^d = Z_t - \widehat{\delta_0}$, fit the ADF regression on the newly transformed variable and perform the test of the null hypothesis that $\rho = 0$ using the tabulated critical values.

While the power gains of the DFGLS test are impressive, simulations also show that the test exhibits strong size distortion (Ng and Perron, 2001). Ng and Perron (2001) propose a new test for unit root that has good size and power properties. They construct four M-test statistics that are based upon the GLS de-trended data (MZ_α^{GLS}, MSB^{GLS}, $MZ_t^{GLS} = MZ_\alpha^{GLS} \times MSB^{GLS}$, and MP_T^{GLS}).[456] These tests have similar size and power properties and simulation shows that they perform better than the DFGLS test (Ng and Perron 2001).

Ng and Perron (2001) also address the problem of sensitivity of unit root testing to choice of lag. They propose a new information criteria, the modified information criteria (MIC). The distinction between the MIC and the standard information criteria such as the Akaike and the Schwartz Bayesian criteria is that the former takes into account the fact that the bias in the sum of the autoregressive coefficients is highly dependent on the number of lags.

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[4] Critical values for these tests can be obtained from Ng and Perron (2001).
[5] The software package Eviews4 has implemented these tests.
[6] Due to economy of space the computation of these statistics are not reported here.

5. Empirical Results

Table (3) reports the unit root results. A plot of the variable against time did not indicate the presence of any trend in the variables. Therefore, in the unit root test we only considered the case where only a constant is included. Starting with the DFGLS test the results indicate that the computed t-statistics are greater than the critical values thus implying that we do not reject the null hypothesis that the variables have a unit root. However, once first differences of the variables are considered the null hypothesis of unit root can be rejected, as the t-statistics are lower than 5 percent critical values. This is an indication that the variables are I(1).

For the Ng-Perron test all four statistics are presented in the table. As it can be noticed, two sets of statistics are negative while the other two are positive. Starting with the two negative statistics MZ_{α}^{GLS} and MZ_{t}^{GLS} the table show the t-statistics are higher than the critical value of -8.1 (for MZ_{α}^{GLS}) and -1.98 (for MZ_{t}^{GLS}), thus implying that the null hypothesis that the variables have a unit root cannot be rejected. Turning to the two positive statistics MSB^{GLS} and MP_{T}^{GLS} the results show that the computed t-statistics are above the critical values of 0.233 (for MSB^{GLS}) and 3.17 (for MP_{T}^{GLS}), also implying that we cannot not reject the null hypothesis. In other words, all four statistics confirm that the variables have a unit root. Applying the Ng-Perron test on the first difference of the variables shows that in all four cases the computed statistics are lower than the 5 percent critical values, thus the null hypothesis that the variables have a unit root can be

rejected. Put differently, the Ng-Perron test confirms that the variables are also I(1).

INSERT TABLE (3) HERE

These unit root results have significant implications for the cointegration analysis. Firstly, the standard Johansen approach, which requires the variables to be integrated of order one,[7] can be implemented. Secondly, as abovementioned, to apply the ARDL bounds technique we must ensure that the variables in the model are I(0) or I(1) because the F-statistic for the existence of a long run relationship among the variables is based on this assumption. Again, these unit root results show that we satisfy this assumption and consequently we can employ the ARDL method to estimate our model.

Table (4) presents the Johansen maximum eigenvalue and trace tests to determine the number of cointegration vectors for the specification suggested by the selection criteria. The cointegration test statistics for the 6 variables, second order VAR of lnIp, lnIg, lnRGDP, lnPCRED, lnAid, and lnTOT indicate the presence of one cointegration vector. The null hypothesis that there is no cointegrating vector in the system (H0: r = 0) is rejected, but the null that there exists at most one cointegrating vector (H0: r ≤ 1) is not. Taking the maximum eigenvalue test results, for example, for H0: r = 0 the reported statistic is 50.203 which is greater than 40. 530 (the 5 percent critical value) thus suggesting that

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[7] Johansen (1995) has developed a new cointegration technique to deal with I(2) variables.

the null is rejected. However, for H0: $r \leq 1$ the reported statistic is 30.609 which is less than 34.400 (5 percent the critical value).

INSERT TABLE (4) HERE

Table (5) presents the test for the existence of a long relationship among private investment, public investment, real GDP, credit to the private sector, aid and terms of trade. It can be seen that the computed F-statistic is above the upper bound value, thus implying that these variables are bound together in the long run. This confirms results obtained with the Johansen approach. The selected model, based on the SBC criteria, is an ARDL (2,1,0,0,0,1). The model passes the standard diagnostic tests namely the serial correlation, functional form, normality, and heteroscedasticity tests.

INSERT TABLE (5) HERE

INSERT TABLE (6) HERE

INSERT TABLE (7) HERE

Tables (6) and (7) show results of the long relationship related to the Johansen and the bounds approaches, respectively. These results reveal that the estimated coefficients and their standard errors using these two different

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techniques are almost similar, except for the coefficient of TOT which appears to be slightly higher in Johansen results.

The results indicate that public investment affects positively and significantly private investment. Put differently, public investment crowds in private investment in the context of Senegal. Real income, also, affects positively and significantly private investment, as the theory predicts.

In contrast, the coefficient of credit to the private sector is negative and significant, thus implying that increases in credit to the private sector will not boost private investment as the theory suggests. This finding is consistent with the Senegalese case where there is a widespread agreement that the proliferation of donor supported lines of credit and guarantee funds has not help enhance private investment (Berg, 1997). One explanation for the negative impact credit availability in the context of Senegal could be that the institutional environment surrounding of its private sector is characterised by a lack of strong business and professional organisations. Furthermore, some domestic NGOs and banks through which credits to the private sector are channelled, also, lack of personnel with experience and expertise in credit analysis (Berg, 1997).[8]

Private investment responds positively to foreign aid flows. The estimated coefficient of aid is statistically significant. The positive impact of aid on private investment could be achieved via the conditionality attached to these

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[8] Despite the efforts from donors such as the World Bank, the West African Development Bank, Swiss and Belgian aid agencies to support lending to small and medium enterprises as well as microenterprises, Senegalese entrepreneurs have often claim that they lack access to credit Berg, 1997, p.47)

flows, which include the development of the private sector. In the early 1980s,

for example, Senegal undertook a series of reforms, to boost the private sector,

by liberalising labour legislation, prices, and external trade. Additionally, aid can

boost private investment if it used to finance a reduction in taxation towards the

private sector. Taxes have been regarded by some Senegalese entrepreneurs as

harmful to investment (Berg, 1997).

The impact of the terms of trade variable on private investment is

negative and significant. The size of its estimated coefficient suggests that

private investment in Senegal is highly sensitive to external shocks. Moreover,

as pointed out earlier, severe terms of trade can lead to macroeconomic

uncertainties and other adverse factors, which in turn will affect the overall

investment outlook and thus private investment. Senegal dependence on energy

imports and its narrow production and export base make its economy vulnerable

to terms of trade shocks, as it happened during the period of 1989-93

(Hadjimichael *et al*., 1996).

To complement this study it is important to investigate whether the above long

run relationship we found are stable for the entire period of study. In other words, we

have to test for parameter stability. The methodology used here is based on the

cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ) tests

proposed by Brown *et al*. (1975). Unlike the Chow test, that requires break point(s) to be

specified, the CUSUM tests can be used even if we do not know the structural break

point. The CUSUM test uses the cumulative sum of recursive residuals based on the first

n observations and is updated recursively and plotted against break point. The

CUSUMSQ makes use of the squared recursive residuals and follows the same procedure. If the plot of the CUSUM and CUSUMSQ stays within the 5 percent critical bound the null hypothesis that all coefficients are stable cannot be rejected. If however, either of the parallel lines are crossed then the null hypothesis (of parameter stability) is rejected at the 5 percent significance level. Figure (2) evidently shows that both the CUSUM and CUSUMSQ plots lie within the 5 percent critical bound thus providing evidence that the parameters of the model do not suffer from any structural instability over the period of study.

INSERT FIGURE (2) HERE

INSERT FIGURE (3) HERE

6. Conclusion

The paper has investigated the long run determinants of private savings in Senegal over the period of 1970-2000. It employed two relatively new methods, namely the Dickey-Fuller generalised least square (DFGLS) de-trending test proposed by Elliot *et al*. (1996) and the Ng-Perron test following Ng and Perron (2001), to address the issue of unit root faced in time series analysis. The long run estimate of the private investment function for Senegal was derived using the Johansen cointegration technique and the ARDL bounds approach. Both cointegration approaches lead to similar results in terms of the magnitude and standard errors of the variables used in the model.

The paper found evidence that private investment, public investment, real GDP, credit to the private sector, aid, and terms of trade are bound together in the long run. The evidence also suggested that private investment is positively affected by public investment, real GDP and foreign aid, whilst credit to the private sector and terms of trade affect it negatively. Moreover, a stability test suggested that the estimated parameters do not suffer from structural instability.

The main policy conclusions that may be inferred from these results are: firstly, in view of the positive impact of public investment on private investment, triggering off public sector resources to the end of capital accumulation is a useful channel to boost private sector development in Senegal; secondly, the results suggest that increasing aid flows to Senegal has a significant beneficial effect on private investment, suggesting that if private investment is to help reduce poverty donors should increase aid disbursements to the country-aid can be used to reduce taxes, provide training to entrepreneurs and private credit channelling agencies, develop institutions, and/or boost public sector investment (with World Bank loan, the government has adopted a road, rail, sea and air transport development plan in recent years); thirdly, given the negative effects of external shocks, the Senegalese government needs to expand its production and export base in order to make its economy less vulnerable to these external shocks.

A useful extension of the present study would be to empirically examine the effect of private investment on economic growth, unemployment and poverty reduction in the context of Senegal.

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Table (1) Selected Macroeconomic Indicators of Senegal 88-2000

	88-93	94	95	96	97	98	99	2000
GDP Growth *(annual %)*	1.1	2.9	4.7	5.2	5.0	5.7	5.1	5.5
(% of GDP)								
Investment	13.4	16.2	16.9	17.4	18.7	19.6	21.3	21.9
Public	4.4	5.0	5.2	5.2	5.6	5.8	8.3	7.4
Private	9.1	11.1	11.7	12.2	13.1	15.3	11.1	12.4
Domestic Savings	6.8	9.6	11.3	11.7	13.2	14.9	14.2	15.5
Curr. Acc. Balance *(excluding grants)*	-9.4	-6.9	-6.6	-7.2	-7.4	-6.2	-7.3	-6.7
Inflation (CPI)	-0.6	32	8.4	2.8	1.8	1.1	2.0	2.0

Source: African Live Database-World Bank (July 2004).

Table (2) Summary Statistics

Variables	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis
lnIp	2.220	2.160	2.728	1.755	0.225	0.150	2.711
lnIg	1.620	1.623	2.116	1.368	0.200	0.685	2.785
lnRGDP	3.685	3.685	4.047	3.313	0.227	-0.052	1.700
lnPCRED	3.250	3.273	3.874	2.744	0.345	-0.023	1.832
lnAid	2.362	2.443	2.906	1.510	0.372	-0.664	2.611
lnTOT	4.756	4.682	4.756	4.542	0.058	-0.341	2.177

Table (3) Tests of Unit Root Based on De-trending and the Ng-Perron MIC

Variables	DFGLS	Ng-Perron			
		MZ_{α}^{GLS}	MZ_{t}^{GLS}	MSB^{GLS}	MP_{T}^{GLS}
lnIp	-1.665	-6.693	-1.707	0.254	4.0.63
lnIg	-0.909	-5.739	-1.474	0.257	4.877
lnRGDP	-2.136	-6.340	-1.717	0.271	4.068
lnPCRED	-1.390	-1.747	-0.928	0.531	13.932
lnAid	-1.250	-3.222	-1.256	0.390	7.585
lnTOT	-2.530	-2.781	-1.438	0.191	2.255
DlnIp	-4.872	-14.500	-2.682	0.185	1.728
DlnIg	-3.847	-13.476	-2.565	0.190	1.936
DlnRGDP	-3.548	-15.469	-2.771	0.179	1.621
DlnPCRED	-3.502	-14.069	-2.604	0.427	1.920
DlnAid	-6.228	-15.746	-2.777	0.176	1.661
DlnTOT	-3.866	-13.721	-2.608	0.190	1.805

The null hypothesis for both tests is that the variable has a unit root. The DFGLS critical value at 5 percent level is -3.428. Ng-Perron (2001) critical values at the 5percent level with only a constant are: −8.10; -1.98; 0.23; and 3.17 for MZα, MZt, MSB, and MPt.

Table (4) Johansen Cointegration Test Statistics

	Maximum Eigenvalue	Trace Statistics
H0: r = 0	50.203	138.175
H0: r ≤ 1	30.609	67.972
H0: r ≤ 2	23.252	57.363
H0: r ≤ 3	18.035	34.112
H0: r ≤ 4	13.854	16.077
H0: r ≤ 5	2.223	2.223

Critical values at the 5 percent level are 40.530; 34.400; 28.270; 22.040; 15.870; and 9.160 for the maximal eigenvalue test and 102.560; 75.980; 53.480; 34.870; 20.180; and 9.160 for the trace test.

Table (5) Bounds Tests for the Existence of Cointegration

F-statistics	5% Critical values	
	I(0)	I(1)
6.456	2.649	3.805

Table (6) Johansen Long Run Results (*Dependent Variable lnIp*)

	Coefficients	Standard errors
lnIg	0.495	0.128
lnRGDP	0.286	0.109
lnPCRED	-0.397	0.073
lnAid	0.161	0.060
lnTOT	-2.295	0.606
Constant	12.943	2.565

Table (7) Long Run Results Based on the ARDL Approach (*Dependent Variable lnIp*)

	Coefficients	Standard errors
lnIg	0.407	0.122
lnRGDP	0.242	0.126
lnPCRED	-0.526	0.071
lnAid	0.165	0.066
lnTOT	-1.920	0.541
Constant	10.982	2.269

Figure (1) Private and Public Investment Trends in Senegal 1970-2000
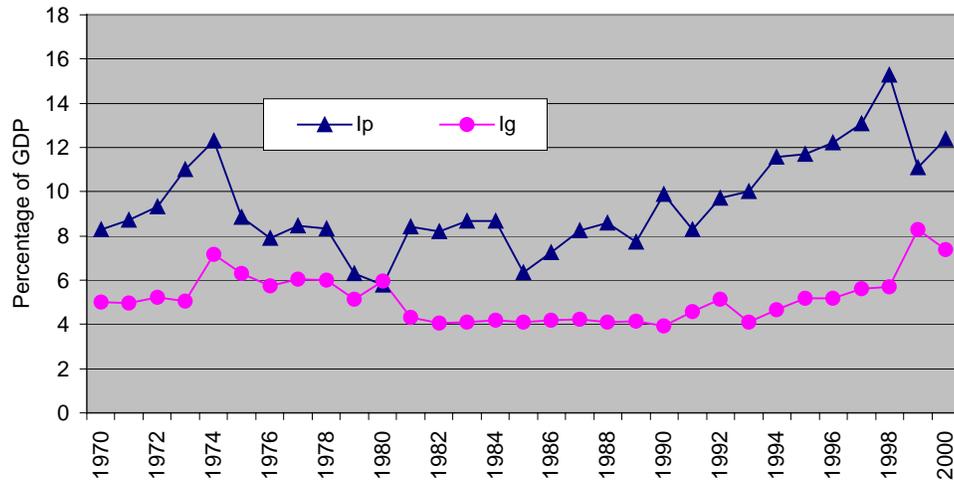
Sources: World Bank Global Development Network and IMF Statistics.

Figure (2) Plot of Cumulative Sum of Squares of Recursive Residuals

Plot of Cumulative Sum of Recursive Residuals

The straight lines represent critical bounds at 5% significance level
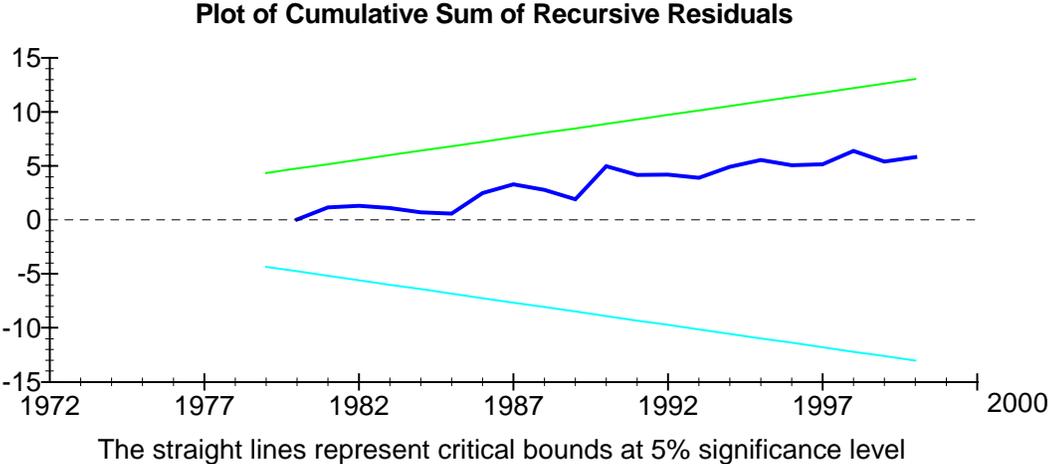
Figure (3) Plot of Cumulative Sum of Squares of Recursive Residuals

Plot of Cumulative Sum of Squares of Recursive Residuals

The straight lines represent critical bounds at 5% significance level