CREDIT Research Paper

No. 04/05

Modelling the Long Run Determinants of Private Investment in Senegal

by

Bazoumana Ouattara

Centre for Research in Economic Development and International Trade,
University of Nottingham

The Centre for Research in Economic Development and International Trade is based in the School of Economics at the University of Nottingham. It aims to promote research in all aspects of economic development and international trade on both a long term and a short term basis. To this end, CREDIT organises seminar series on Development Economics, acts as a point for collaborative research with other UK and overseas institutions and publishes research papers on topics central to its interests. A list of CREDIT Research Papers is given on the final page of this publication.

Authors who wish to submit a paper for publication should send their manuscript to the Editor of the CREDIT Research Papers, Professor M F Bleaney, at:

Centre for Research in Economic Development and International Trade,
School of Economics,
University of Nottingham,
University Park,
Nottingham, NG7 2RD,
UNITED KINGDOM

Telephone (0115) 951 5620
Fax: (0115) 951 4159

CREDIT Research Papers are distributed free of charge to members of the Centre. Enquiries concerning copies of individual Research Papers or CREDIT membership should be addressed to the CREDIT Secretary at the above address. Papers may also be downloaded from the School of Economics web site at:
www.nottingham.ac.uk/economics/research/credit

CREDIT Research Paper

No. 04/05

Modelling the Long Run Determinants of Private Investment in Senegal

by

Bazoumana Ouattara

Centre for Research in Economic Development and International Trade, University of Nottingham

The Authors
Bazoumana Ouattara, The School of Economics Studies, The University of Manchester, Oxford Road, Manchester M13 9PL. Tel: 44(0) 161 275 4971,
Fax: 44(0) 161 275 4852, Email: osman.ouattara@man.ac.uk

November 2004

Modelling the Long Run Determinants of Private Investment in Senegal

by

Bazoumana Ouattara

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.

JEL Classification: C22 C32 E22

Keywords: Private Investment, Cointegration, Senegal

Outline

1. Introduction
2. Background Information of the Senegalese Economy
3. Model and Data Issue
4. Econometric Methodology
5. Empirical Results
6. Conclusion

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.

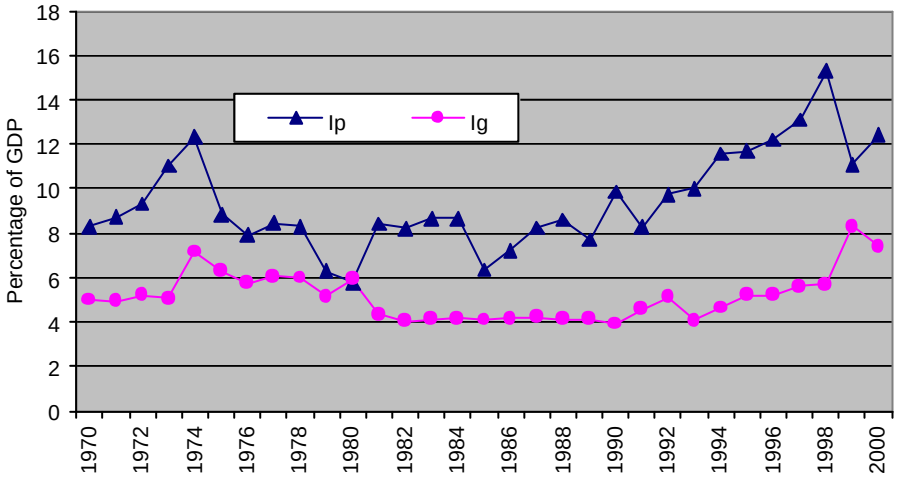
Private investment in Senegal trends, as shown by Figure (1), are characterised by four main phases during the period of 1970-2000. During the first phase, 1970-74, private investment rose from around 8 percent of GDP to over 12 percent. Public investment also increased during that period going from 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.

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)

Figure (1) Private and Public Investment Trends in Senegal 1970 - 2000



Sources: World Bank Global Development Network and IMF Statistics

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 Van 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, for some countries, aid flows tend to be associated with tax reductions.[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.

1 See Franco-Rodriguez (2000); McGillivray (2000); Mavrotas (2002); and McGillivray and Ouattara (forthcoming). In other cases, however, aid is associated with increased tax effort (Osei *et al*, 2003; McGillivray and Morrissey, 2004).

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

$$\ln I_{pt} = a_0 + a_1 \ln I_{gt} + a_2 \ln RGDP_t + a_3 \ln PCRED_t + a_4 \ln Aid_t + a_5 \ln TOT_t + e_t \quad (1)$$

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. e 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).

Table (2) Summary Statistics

Variables	Mean	Median	Max	Min	Std.Dev.	Skewness	Kurtosis
InIp	2.220	2.160	2.728	1.755	0.225	0.150	2.711
InIg	1.620	1.623	2.116	1.368	0.200	0.685	2.785
InRGDP	3.685	3.685	4.047	3.313	0.227	-0.052	1.700
InPCRED	3.250	3.273	3.874	2.744	0.345	-0.023	1.832
InAid	2.362	2.443	2.906	1.510	0.372	-0.664	2.611
In TOT	4.756	4.682	4.756	4.542	0.058	-0.341	2.177

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:

$$\begin{aligned}\Delta \ln I_p = {} & b_0 + \sum_{j=1}^{n} b_j \Delta \ln I_{gt-j} + \sum_{j=1}^{n} d_j \Delta \ln RGDP_{t-j} + \sum_{j=1}^{n} m_j \Delta \ln PCRED_{t-j} \\ & + \sum_{j=1}^{n} f_j \Delta \ln Aid_{t-j} + \sum_{j=1}^{n} j_j \Delta \ln TOT_{t-j} + h_1 \ln I_{pt-1} + h_2 \ln I_{gt-1} \\ & + h_3 \ln RGDP_{t-1} + h_4 \ln PCRED_{t-1} + h_5 \ln Aid_{t-1} + h_6 \ln TOT_{t-1} + m_t \end{aligned} \quad (2)$$

where b_0 is a drift component and m_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 ($H_0 : h_1 = h_2 = h_3 = h_4 = h_5 = h_6 = 0$) is tested against the alternative ($H_1 : h_1 \neq 0,\ h_2 \neq 0,\ h_3 \neq 0,\ h_4 \neq 0,\ h_5 \neq 0,\ h_6 \neq 0$) 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 (2004a) 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, 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 $H_0 : j^*_0 = 0$ in the regression:

$$\Delta Z_t^d = j^* Z_{t-1}^d + j_1^* \Delta Z_{t-1}^d + \ldots\ldots\ldots\ldots + j^*_{p-1} \Delta Z_{t-p+1}^d + n_t \qquad (3)$$

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.

$$Z_t^d = Z_t - \hat{d}_0 - \hat{d}_1 t \qquad (4)$$

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:

---

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).

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

and

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

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:

$$\overline{Z} = d_0\overline{W} + d_1 W_t + e_t \quad (7)$$

and the OLS estimators $\hat{d}_0$ and $\hat{d}_1$ 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:

$$\Delta Z_t^d = j_0 + r Z_{t-1}^d + \sum_{j=1}^{k} b_j \Delta Z_{t-j}^d + J_t \quad (8)$$

and testing for the null hypothesis that $r = 0$ 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 $\overline{a}$, above. We then compute $Z_t^d = Z_t - \hat{d}_0$, fit the ADF regression on the newly transformed variable and perform the test of the null hypothesis that $r = 0$ 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_a^{GLS}, MSB^{GLS},

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).

$MZ_t^{GLS} = MZ_a^{GLS} \times MSB^{GLS}$, and MP_T^{GLS}).[4] 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.

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_a^{GLS} and MZ_t^{GLS} the table show the t-statistics are higher than the critical value of –8.1 (for MZ_a^{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-

4 Critical values for these tests can be obtained from Ng and Perron (2001). The software package Eviews4 was

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).

used to implement these tests (details available on request).

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

Variables	DFGLS	Ng-Perron			
		MZ_a^{GLS}	MZ_t^{GLS}	MSB^{GLS}	MP_T^{GLS}
lnIp	-1.665	-6.693	-1.707	0.254	4.063
InIg	-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-Peron (2001) critical values at the 5 percent level with only a constant are: -8.10; -1.98; 0.23; and 3.17 for MZJ, MZt, MSB, and MPt.

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

Table (4) Johansen Cointegration Test Statistics

	Maximum Eigenvalue	Trace Statistics
HO: r = 0	50.203	138.175
HO: r ≤ 1	30.609	67.972
HO: r ≤ 2	23.252	57.363
HO: r ≤ 3	18.035	34.112
HO: r≤ 4	13.854	16.077
HO: 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 maximum eigenvalue test and 102.560; 75.980; 53.480; 34.870; 20.180 and 9.160 for the trace test.

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.

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

Table (5) Bounds Tests for the Existence of Cointegration

F-Statistics	5% Critical Values	
	I(0)	1(1)
6.456	2.649	3.805

Table (6) Johansen Long Run Results
(Dependent Variable Inlp)

	Coefficients	Standard Errors
Inlg	0.495	0.128
InRGDP	0.286	0.109
InPRCED	-0.397	0.073
InAid	0.161	0.060
InTOT	-2.295	0.606
Constant	12.943	2.565

Table (7) Long Run Results based on the ARDL Approach
(Dependent Variable lnlp)

	Coefficients	Standard errors
Inlg	0.407	0.122
InRGDP	0.242	0.126
InPCRED	-0.526	0.071
InAid	0.165	0.066
InTOT	-1.920	0.541
Constant	10.982	2.269

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 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).[6]

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 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[7] 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).

---

6 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)

7 Ouattara (2004b) found that aid flows exert a negative significant effect on government revenue in the context of Senegal.

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.

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

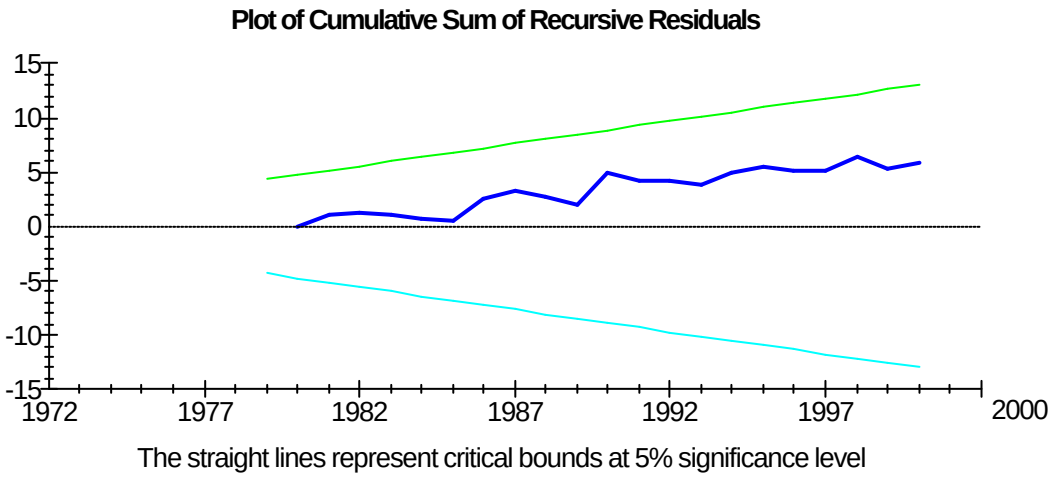
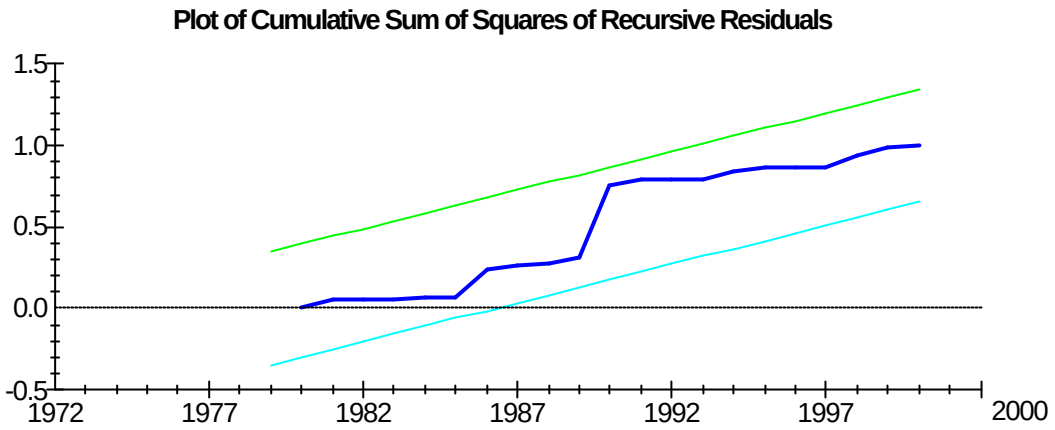


Figure (3) Plot of Cumulative Sum of Squares of Recursive Residuals



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.

REFERENCES

Aschauer, D.A., 1989. Does Public Capital Crowd out Private Capital. Journal of Monetary Economic., 24 (September), 171-88.

Berg, E., 1997. Sustaining Private Sector Development in Senegal: strategic Considerations. Harvard Institute for International Development Discussion Paper, No. 9, September.

Blejar, M. ,M., K., 1984. Government Policy and Private Investment in Developing Countries. IMF Staff Papers, 31 (2), 379-403.

Brown, R.L., Durbin J., Evans, J.M., 1975. Techniques for Testing the Consitency of Regression Relations Over Time. Journal of the Royal Statiscal Society, 37, 149-92.

Chhibber, A., Wijnbergen, S.V., 1988. Public Policy and Private Investment in Turkey. World Bank Working Paper Series, 27.

Dejong, D.N., Nankervis, J.C., Savin, N.E., 1992. Integration Versus Trend Stationarity in Time Series. Econometrica, 60, 423-33.

Dickey, D., Fuller, W.A., 1979. Distribution of the Estimates for Autoregressive Time Series with Unit Root. Journal of the American Statistical Association, 74 (June), 427-31.

Elliot, G., Rothenberg, T.J., Stock, J.H., 1996. Efficient Tests for an Autoregressive Unit Root. Econometrica, 64, 813-36.

Fielding, D., 1997. Adjustment, Trade Policy and Investment Slumps: Evidence from Africa. Journal of Development Economics, 52, 121-37.

Franco-Rodriguez, S., 2000. Recents Advances in Fiscal Response Models with an Application to Costa Rica. Journal of International Development, 12 (3), 429-42.

Greene, J., Villanueva, D., 1991. Private investment in developing countries : an empirical analysis. IMF Staff Papers, 38 (1), 33-58.

Hadjimichael, M., Ghura, D., Muhleisen, M., Nord, R., Ucer, E.M., 1995. Sub-Saharan Africa: Growth, Savings and Investment, 1986-93. IMF Occasional Paper 118. Washington DC.

Harris, R., Sollis, R., 2003. Applied Time Series Modelling and Forecasting. Wiley, West Sussex.

International Monetary Fund. 2003. Senegal: Statistical Appendix, June 2003. Washington.

Johansen, S., 1988. Statistical Analysis of Cointegrated Vectors. Journal of Economic Dynamics & Control, 12, 231-54.

Johansen, S., 1995. A Statistical Analysis of I(2) Variables. Econometric Theory, 11, 25-59.

Johansen, S., Juselius, K., 1990. Maximum Likeliwood Estimation and Inference on Cointegration-With Application to the Demand for Money. Oxford Bulletin of Economics and Statistics, 52, 169-210.

Mavrotas, G., 2002. Foreign Aid and Fiscal Response: Does Aid Disaggregation Matter? Weltwirtschaftliches Archiv, 138 (3), 534-59.

McGillivray, M., 2000. Aid and Public Sector Behaviour in Developing Countries. Review of Development Economics, 4 (2), 156-63.

McGillivray, M. and O. Morrissey (2004), 'Fiscal Effects of Aid' in T. Addison and A. Roe (eds), *Fiscal Policy for Development*, Palgrave/WIDER, pp. 72-96.

McGillivray, M., Ouattara, B., forthcoming. Aid Debt Burden and Government Fiscal Behaviour in Cote d'Ivôire. Journal of African Economies.

Ng, S., Perron, P., 2001. Lag Length Selection and the Construction of Unit Root Test with Good Size and Power. Econometrica, 69, 1519-54.

OECD., 2004. DAC Online Satistics. Paris.

Osei, R., T. Lloyd and O. Morrissey (2003), 'Modelling the Fiscal Effects of Aid: An Impulse Response Analysis for Ghana', *CREDIT Research Paper 03/10*.

Oshikoya, T., 1994. Macroeconomic Determinants of Domestic Private Investment in Africa: an Empirical Analysis. Economic Development and Cultural Change, 42 (3), 573-95.

Ouattara, B., 2004a. The Impact of Project Aid and Programme Aid on Domestic Savings: A Case Study of Côte d'Ivoire. Centre for the Study of African Economies Conference on Growth, Poverty Reduction and Human Development in Africa, April (2004).

Ouattara, B., 2004b. Foreign Aid and Fiscal Policy in Senegal. Mimeo University of Manchester.

Paruolo, P., 1996. On the Determination of Integration Indices in I(2) Systems. Journal of Econometrics, 72, 313-56.

Pesaran, M.H., shin, Y., Smith, R.J., 2001. Bounds testing approaches to the analysis of level relationships Journal of Applied Econometrics. Journal of Applied Econometrics, 16, 289-326.

Pfeffermann, G.P., Madarassy, A., 1990. Trends in private investment in thirty developing countries. World Bank, Washington, D.C.

Phillips, P.C.B., Perron, P., 1988. Testing for a Unit Root in Time Series Regression. Biometrica, 75, 335-446.

Rossiter, R., 2002. Strutural Cointegration Analysis of Private and Public Investment. International Journal of Business and Economics, 1 (1), 59-67.

World Bank., 2002. Global Development Network (macro time series). World Bank: Washington.

World Bank., 2003. World Development Indicators." World Bank: Washington D.C.

World Bank., 2004. African Live Database. Washington D.C.

CREDIT PAPERS

02/01 **Eric Strobl and Robert Thornton,** "Do Large Employers Pay More in Developing Countries? The Case of Five African Countries"

02/02 **Mark McGillivray and J. Ram Pillarisetti,** "International Inequality in Human Development, Real Income and Gender-related Development"

02/03 **Sourafel Girma and Abbi M. Kedir, "**When Does Food Stop Being a Luxury? Evidence from Quadratic Engel Curves with Measurement Error"

02/04 **Indraneel Dasgupta and Ravi Kanbur,** "Class, Community, Inequality"

02/05 **Karuna Gomanee, Sourafel Girma and Oliver Morrissey,** "Aid and Growth in Sub-Saharan Africa: Accounting for Transmission Mechanisms"

02/06 **Michael Bleaney and Marco Gunderman, "**Stabilisations, Crises and the "Exit" Problem – A Theoretical Model"

02/07 **Eric Strobl and Frank Walsh,** "Getting It Right: Employment Subsidy or Minimum Wage? Evidence from Trinidad and Tobago"

02/08 **Carl-Johan Dalgaard, Henrik Hansen and Finn Tarp,** "On the Empirics of Foreign Aid and Growth"

02/09 **Teresa Alguacil, Ana Cuadros and Vincente Orts,** "Does Saving Really Matter for Growth? Mexico (1970-2000)"

02/10 **Simon Feeny and Mark McGillivray,** "Modelling Inter-temporal Aid Allocation"

02/11 **Mark McGillivray,** "Aid, Economic Reform and Public Sector Fiscal Behaviour in Developing Countries"

02/12 **Indraneel Dasgupta and Ravi Kanbur,** "How Workers Get Poor *Because* Capitalists Get Rich: A General Equilibrium Model of Labor Supply, Community, and the Class Distribution of Income"

02/13 **Lucian Cernat, Sam Laird and Alessandro Turrini,** "How Important are Market Access Issues for Developing Countries in the Doha Agenda?"

02/14 **Ravi Kanbur,** "Education, Empowerment and Gender Inequalities"

02/15 **Eric Strobl,** "Is Education Used as a Signaling Device for Productivity in Developing Countries?"

02/16 **Suleiman Abrar, Oliver Morrissey and Tony Rayner,** "Supply Response of Peasant Farmers in Ethiopia"

02/17 **Stephen Knowles,** "Does Social Capital Affect Foreign Aid Allocations?"

02/18 **Dirk Willem te Velde and Oliver Morrissey,** "Spatial Inequality for Manufacturing Wages in Five African Countries"

02/19 **Jennifer Mbabazi, Oliver Morrissey and Chris Milner,** "The Fragility of the Evidence on Inequality, Trade Liberalisation, Growth and Poverty"

02/20 **Robert Osei, Oliver Morrissey and Robert Lensink,** "The Volatility of Capital Inflows: Measures and Trends for Developing Countries"

02/21 **Miyuki Shibata and Oliver Morrissey,** "Private Capital Inflows and Macroeconomic Stability in Sub-Saharan African Countries"

02/22 **L. Alan Winters, Neil McCulloch and Andrew McKay,** "Trade Liberalisation and Poverty: The Empirical Evidence"

02/23 **Oliver Morrissey,** "British Aid Policy Since 1997: Is DFID the Standard Bearer for Donors?"

02/24 **Öner Günçavdi, Suat Küçükçifçi and Andrew McKay**, "Adjustment, Stabilisation and the Analysis of the Employment Structure in Turkey: An Input-Output Approach"

02/25 **Christophe Muller,** "Censored Quantile Regressions of Chronic and Transient Seasonal Poverty in Rwanda"

02/26 **Henrik Hansen,** "The Impact of Aid and External Debt on Growth and Investment"

02/27 **Andrew McKay and David Lawson,** "Chronic Poverty in Developing and Transition Countries: Concepts and Evidence"

02/28 **Michael Bleaney and Akira Nishiyama,** "Economic Growth and Income Inequality"

03/01 **Stephen Dobson, Carlyn Ramlogan and Eric Strobl,** "Why Do Rates of Convergence Differ? A Meta-Regression Analysis"

03/02 **Robert Lensink and Habeab T. Mehrteab,** "Risk Behaviour and Group Formation in Microcredit Groups in Eritrea"

03/03 **Karuna Gomanee, Oliver Morrissey, Paul Mosley and Arjan Verschoor,** "Aid, Pro-Poor Government Spending and Welfare"

03/04 **Chris Milner and Evious Zgovu, "**Export Response to Trade Liberalisation in the Presence of High Trade Costs: Evidence for a Landlocked African

03/05 **Mark McGillivray and Bazoumana Ouattara,** "Aid, Debt Burden and Government Fiscal Behaviour in Côte d'Ivoire"

03/06 **José Antonio Alonso and Carlos Garcimartin,** "Poverty Reduction and Aid Policy"

03/07 **Salvador Barrios, Luisito Bertinelli and Eric Strobl,** "Dry Times in Africa"

03/08 **Sam Laird, Santiago Fernandez de Cordoba and David Vanzetti,** "Market Access Proposals for Non-Agricultural Products"

03/09 **Indraneel Dasgupta and Ravi Kanbur,** "Bridging Communal Divides: Separation, Patronage, Integration"

03/10 **Robert Osei, Oliver Morrissey and Tim Lloyd,** "Modelling the Fiscal Effects of Aid: An Impulse Response Analysis for Ghana"

03/11 **Lucian Cernat and Sam Laird,** "North, South, East, West: What's best? Modern RTAs and their Implications for the Stability of Trade Policy"

03/12 **Indraneel Dasgupta and Diganta Mukherjee,** "'Arranged' Marriage, Dowry and Female Literacy in a Transitional Society"

03/13 **Karuna Gomanee, Sourafel Girma and Oliver Morrissey,** "Aid, Public Spending and Human Welfare: Evidence from Quantile Regressions"

03/14 **Luisito Bertinelli and Eric Strobl,** "Urbanization, Urban Concentration and Economic Growth in Developing Countries"

03/15 **Karuna Gomanee, Sourafel Girma and Oliver Morrissey, "**Searching for Aid Threshold Effects"

03/16 **Farhad Noobakhsh, "**Spatial Inequality and Polarisation in India"

03/17 **Evious K. Zgovu,** "The Implications of Trade Policy and 'Natural' Barriers Induced Protection for Aggregate Demand for Imports: Evidence for Malawi"

03/18 **Normal Gemmell and Oliver Morrissey,** "Tax Structure and the Incidence on the Poor in Developing Countries"

03/19 **Alan Harding,** "Did the Tanzanian Manufacturing Sector Rebound in the 1990s? Alternative Sources of Evidence"

03/20 **Paul Mosley, Farhad Noorbakhsh and Alberto Paloni,** "Compliance with World Bank Conditionality: Implications for the Selectivity Approach to Policy-Based Lending and the Design of Conditionality"

03/21 **Evious K. Zgovu,** "Price Transmission, Domestic Relative Incentives and Inter-sector Resource Flow Analysis"

04/01 **Chris Milner and Verena Tandrayen,** "The Impact of Exporting and Export Destination on Manufacturing Wages: Evidence for Sub-Saharan Africa"

04/02 **Sam Laird, Ralf Peters and David Vanzetti,** "Southern Discomfort: Agricultural Policies, Trade and Poverty"

04/03 **Santiago Fernandez de Córdoba, Sam Laird and David Vanzetti,** "Trick or Treat? Development opportunities and challenges in the WTO negotiations on industrial tariffs

04/04 **Santiago Fernandez de Córdoba, Sam Laird and David Vanzetti,** "Blend it like Beckham – Trying to read the Ball in the WTO Negotiations on Industrial Tariffs"

04/05 **Bazoumana Outttara,** "Modelling the Long Run Determinants of Private Investment in Senegal"

SCHOOL OF ECONOMICS DISCUSSION PAPERS

In addition to the CREDIT series of research papers the School of Economics produces a discussion paper series dealing with more general aspects of economics. Below is a list of recent titles published in this series.

02/01 **Mark A. Roberts,** "Central Wage Setting Under Multiple Technological Equilibria: A Mechanism for Equilibrium Elimination"

02/02 **Mark A. Roberts,** "Employment Under Wage-Only and Wage-Employment Bargaining: The Role of the Government Budget Constraint"

02/03 **Mark A. Roberts,** "Can the Capital Gains Arising from an Unfunded Pensions Reform Make it Pareto-Improving?"

02/04 **Mehrdad Sepahvand,** "Privatisation in a Regulated Market, Open to Foreign Competition"

02/05 **Mark A. Roberts,** "Can Pay-As-You Go Pensions Raise the Capital Stock?"

02/06 **Indraneel Dasgupta,** "Consistent Firm Choice and the Theory of Supply"

02/07 **Michael Bleaney,** "The Aftermath of a Currency Collapse: How Different Are Emerging Markets?"

02/08 **Richard Cornes and Roger Hartley,** "Dissipation in Rent-Seeking Contests with Entry Costs"

02/09 **Eric O'N. Fisher and Mark A. Roberts,** "Funded Pensions, Labor Market Participation, and Economic Growth"

02/10 **Spiros Bougheas,** "Imperfect Capital Markets, Income Distribution and the 'Credit Channel': A General Equilibrium Approach"

02/11 **Simona Mateut, Spiros Bougheas and Paul Mizen,** "Trade Credit, Bank Lending and Monetary Policy Transmission"

02/12 **Bouwe R. Dijkstra,** "Time Consistency and Investment Incentives in Environmental Policy"

02/13 **Bouwe R. Dijkstra,** "Samaritan vs Rotten Kid: Another Look"

02/14 **Michael Bleaney and Mark A. Roberts,** "International Labour Mobility and Unemployment"

02/15 **Cihan Yalcin, Spiros Bougheas and Paul Mizen,** "Corporate Credit and Monetary Policy: The Impact of Firm-Specific Characteristics on Financial Structure"

02/16 **Christophe Muller,** "The Geometry of the Comparative Statics"

03/01 **Arijit Mukherjee,** "Licensing in a Vertically Separated Industry"

03/02 **Arijit Mukherjee and Enrico Pennings,** "Imitation, Patent Protection and Welfare"

03/03 **Arijit Mukherjee,** "Bernard vs. Cournot Competition in Asymmetric Duopoly: The Role of Licensing"

03/04 **Richard Cornes and Roger Hartley,** "Aggregative Public Good Games"

03/05 **Arijit Mukherjee and Soma Mukherjee,** "Welfare Effects of Entry: The Impact of Licensing"

03/06 **Arijit Mukherjee,** "Bertrand and Cournot Competitions in a Dynamic Game"

03/07 **Tai-Hwan Kim, Young-Sook Lee and Paul Newbold,** "Spurious Regressions with Processes Around Linear Trends or Drifts"

03/08 **Emi Mise, Tae-Hwan Kim and Paul Newbold,** "The Hodrick-Prescott Filter at Time Series Endpoints"

03/09 **Stephen Leybourne, Tae-Hwan Kim and Paul Newbold,** "Examination of Some More Powerful Modifications of the Dickey-Fuller Test"

03/10 **Young-Sook Lee,** "Intraday Predictability of Overnight Interest Rates"

03/11 **Mark A Roberts,** "Bismarckian and Beveridgean Pay-As-You-Go Pension Schemes Where the Financial Sector is Imperfectly Competitive"

03/12 **Richard C. Cornes and Mehrdad Sepahvand,** "Cournot Vs Stackelberg Equilibria with a Public Enterprise and International Competition"

03/13 **Arijit Mukherjee and Soma Mukherjee,** "Where to Encourage Entry: Upstream or Downstream"

03/14 **Tae-Hwan Kim and Christophe Muller,** "Two-Stage Quantile Regression When the First Stage is Based on Quantile Regression"

03/15 **Michael Bleaney and Manuela Francisco,** "Exchange Rate Regimes and Inflation – Only Hard Pegs Make a Difference"

03/16 **Michael Bleaney and R. Todd Smith,** "Prior Performance and Closed-End Fund Discounts"

03/17 **Richard Cornes and Roger Hartley,** "Loss Aversion and the Tullock Paradox"

03/18 **Tim Lloyd, Steve McCorriston, Wyn Morgan and Tony Rayner,** "Food Scares, Market Power and Relative Price Adjustment in the UK"

03/19 **Piercarlo Zanchettin,** "Differentiated Duopoly With Asymmetric Costs: New Results from a Seminal Model"

03/20 **Bouwe R. Dijkstra and Daan P. van Soest,** "Environmental Uncertainty and Irreversible Investments in Abatement Technology"

03/21 **Richard Cornes and Jun-ichi Itaya,** "Models with Two or More Public Goods"

03/22 **Arijit Mukherjee and Soma Mukherjee,** "Licensing and Welfare Reducing Competition"

03/23 **Parantap Basu and Alessandra Guariglia,** "Foreign Direct Investment, Inequality, and Growth"

03/24 **Robert E. Carpenter and Alessandra Guariglia,** "Cash Flow, Investment, and Investment Opportunities: New Tests using UK Panel Data"

04/01 **Indraneel Dasgupta and Prasanta K. Pattanaik,** " 'Regular' Choice and the Weak Axiom of Stochastic Revealed Preference"

04/02 **Lars Christian Moller,** "Sharing Transboundary Rivers Fairly and Efficiently"

04/03 **Alex Possajennikov,** "Evolutionary Stability of Constant Consistent Conjectures"

04/04 **Michael Bleaney, Spiros Bougheas and Ilias Skamnelos,** "Interactions Between Banking Crises and Currency Crises: A Theoretical Model"

04/05 **Arijit Mukherjee,** "Price and Quantity Competition Under Free Entry"

04/06 **Arijit Mukherjee and Soma Mukherjee,** "Domestic vs. Foreign Competition with Licensing"

04/07 **M Emanrul Hague and Arijit Mukherjee,** "On the Revenue Implications of Trade Liberlisation under Imperfect Competition

04/08 **Erwin Amman and Alex Possajennikov,** "Evolution in Symmetric Incomplete Information Games"

04/09 **Tim Lloyd, Steve McCorriston, Wyn Morgan and Tony Rayner,** "Price Transmission in Imperfectly Competitive Vertical Markets"

04/10 **Tim Lloyd, Steve McCorriston, Wyn Morgan and Tony Rayner,** "Food Scares, Market Power and Relative Price Adjustment in the UK

04/11 **Arijit Mukherjee, Udo Broll and Soma Mukherjee,** "Entry in a Vertically Separated Industry Price VS. Quantityt Competition"

04/12 **Mark Roberts,** "Pareto-Improving Pension Reform through Technicological Innovation"

04/13 **Young–Sook Lee, Tae-Hwan Kim and Paul Newbold,** "Revisiting the Martingale Hypothesis for Exchange Rates"

Members of the Centre

Director

Oliver Morrissey - aid policy, trade and agriculture

Research Fellows (Internal)

Simon Appleton – poverty, education, household economics
Adam Blake – CGE models of low-income countries
Mike Bleaney - growth, international macroeconomics
Indraneel Dasgupta – development theory, household bargaining
Norman Gemmell – growth and public sector issues
Ken Ingersent - agricultural trade
Tim Lloyd – agricultural commodity markets
Chris Milner - trade and development
Wyn Morgan - futures markets, commodity markets
Tony Rayner - agricultural policy and trade

Research Fellows (External)

Manuela Francisco *(University of Minho)* – inflation and exchange rate regimes
David Fielding *(University of Leicester)* – investment, monetary and fiscal policy
Ravi Kanbur (*Cornell*) – inequality, public goods – Visiting Research Fellow
Henrik Hansen *(University of Copenhagen)* – aid and growth
Stephen Knowles *(University of Otago)* – inequality and growth
Sam Laird (*UNCTAD*) – trade policy, WTO
Robert Lensink *(University of Groningen)* – aid, investment, macroeconomics
Scott McDonald *(University of Sheffield)* – CGE modelling, agriculture
Mark McGillivray *(WIDER, Helsinki)* – aid allocation, aid policy
Andrew McKay *(University of Bath)* – household poverty, trade and poverty
Doug Nelson *(Tulane University)* - political economy of trade
Farhad Noorbakhsh *(University of Glasgow)* – inequality and human development
Robert Osei *(Institute of Economic Affairs, Ghana)* – macroeconomic effects of aid
Alberto Paloni *(University of Glasgow)* – conditionality, IMF and World Bank
Eric Strobl *(University of Louvain)* – labour markets
Finn Tarp *(University of Copenhagen)* – aid, CGE modelling