DETERMINANTS OF PRIVATE INVESTMENT IN LDCS: THE CASE OF COLOMBIA

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TABLE OF CONTENTS

Introduction ..........................................................1
1.0 Theoretical Background...........................................2
2.0 Empirical Analysis: The Colombia Case........................10
2.1 The Accelerator Variables.........................................11
2.2 Credit to the Private Sector......................................12
   2.2.1 Domestic Sources........................................12
   2.2.2 External Sources.........................................15
2.3 The Interest Rate................................................18
2.4 The Real Exchange Rate..........................................21
2.5 Finding the Elasticities.........................................22
2.6 Discussion of Other Variables..................................25

Conclusions ..........................................................26

List of Tables

Table 1: Key Policy Instruments....................................3
Table 2: Key Performance Indicators...............................4
Table 3: Impact of Foreign Capital Inflows........................16
Table 4: Constant Elasticities......................................21
Table 5: Elasticities from the Linear Formulation..............23
ABSTRACT

This paper aims at identifying the economic indicators involved in the process of determining the speed of adjustment of actual private investment to notional demand. We test the statistical significance of indicators such as domestic and foreign credit, interest rates, exchange rate and government investment. Notional demand is derived here from the flexible accelerator principle. In spite of the simplicity of this assumption, econometric results are shown to be statistically significant. The major conclusion is, that during the period considered, private investment seems to have been constrained by the availability of domestic credit.
Introduction

The aim of this paper is to assess the importance of various variables in explaining capital formation by the private sector in LDCs. The focus will be on policy instruments developing countries can use to implement a certain development policy. It is assumed here that governments have a direct control on investments made by the public sector, but can influence private investment only indirectly by resorting to fiscal and monetary policies. The objective of this paper is to highlight the importance of the key policy instruments impacting on private investment.

By identifying the significant policy instruments affecting the behavior of investors, it would be possible to design medium-term strategies aimed at bringing about the major macroeconomic equilibria and putting the economy back on a steady growth path. The problem that LDCs have faced in recent years is indeed to restore balance of payments and government finance equilibrium without impeding growth in the medium-term. Experience has shown, however, that countries that succeeded in achieving both stability and medium-term growth are rare. One reason behind this failure might be the across-the-board cuts in expenditures and removal of incentives to invest.

The trade-off between short-term stability and medium-term growth is without doubt a difficult issue to deal with both from the theoretical and pragmatic points of view. Recent analysis of structural adjustments in LDCs has demonstrated the need to analyze this trade-off within a general equilibrium framework. This framework should integrate the financial and monetary sectors with the real side of the economy. By doing so, one can analyze the impact of various stabilization efforts
on the determinants of growth such as efficiency, capacity utilization and capital formation. This present study would feed such a framework and provide an essential linkage between fiscal and monetary instruments and capital formation by the private sector.

The choice of Colombia as a case to illustrate the present analysis stems from, the fact that Colombia experienced different development phases corresponding to different policy stances. Tables 1 and 2 summarize the evolution of key policy instruments and performance indicators over the period 1961-84. The variability in policies should allow us to test the significance of key policy instruments on private investment.

Section 1 will be devoted to the theoretical background for estimating investment functions in LDCs. The analysis will be carried out at an aggregated level because of the lack of sectoral information. However, the discussion will be general in order to allow applicability to other countries and at a sectoral level. In Section 2, we will present empirical results assessing the significance of each of the policy instruments and other variables on private investment. Finally Section 3 presents a summary of the major findings and some conclusions.

1.0 Theoretical Background

There are several ways in the economic literature to approach explaining the behavior of investors, i.e., (i) the *keynesian approach*, which emphasizes the role of the interest rate and the capital stock;
Table 1:  KEY POLICY INSTRUMENTS

<table>
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<tr>
<th>Year</th>
<th>Reserve Requirement Ratio (%)</th>
<th>Interest Rate (%)</th>
<th>Monetary Base Growth Rates</th>
<th>Exchange Rate Growth Rates</th>
<th>Claims on Government Growth Rates</th>
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Table 2: KEY PERFORMANCE INDICATORS

<table>
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<th>Year</th>
<th>GDP Growth Rate (%)</th>
<th>Inflation Rate (%)</th>
<th>Current Account into GDP (%)</th>
<th>Real Effective Exchange Rate 1/ (1980 = 100)</th>
<th>Private Investment Growth</th>
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1/ Decrease implies an appreciation (increase implies depreciation).
(ii) the accelerator models, simple and flexible, which concentrates on the technological relations between capital and output and allowing partial adjustments to achieve the desired capital stock; (iii) the liquidity theory that considers the effect of the cost of internal funds and its availability on the chosen capital/output ratio; and finally (iv) the neoclassical model which is based on the maximization of the present value of the net profits and therefore giving a central role to the production function and the rental cost of capital services.

The attempts to determine empirically which theory fits the facts better has led to contradictory results (see for example, Jorgenson, (1971) and Elliot, (1973)).

In the LDCs case there are two elements that suggest the modification of the neoclassical framework. First, the assumptions this model requires are unrealistic for countries characterized by the absence of developed capital markets. Second, it requires data that are very difficult to find for LDCs, a serious problem for any empirical work.

These problems led us to use an investment model based on a more eclectic approach, which does not include directly typical neoclassical variables. It is a flexible variant of the accelerator model, (see Blejer-Khan 1984) where the speed of adjustment to


achieve the desired capital ($B$), is a function of other economic indicators, i.e.

\[
\Delta K^P_t = B (K^*_P - K^*_P - 1)
\]

where $K^*_P$ and $K^*_P$ are desired and actual private capital stock respectively.

To simplify the analysis, let us assume that the desired capital stock is proportional to the desired output level and that investment adjusts to the optimal capital stock, i.e.

\[
\text{If } I^P_t = [1 - (1 - \delta) L] K^*_P, \text{ and } K^*_P = aY^*_t, \text{ then we can derive the flexible accelerator formulation of the demand for gross investment as follows:}
\]

\[
I^P_t = B a[(1 - (1 - \delta) L) Y^*_t + (1 - B) I^P_t - 1]
\]

where $\delta$ is the depreciation rate, $L$ the lag operator, $Y^*$ the desired output.

If we additionally assume that the adaptative expectations scheme for output is formed in the following way:

\[
Y^*_t - Y^*_t - 1 = \lambda [Y^*_t - Y^*_t - 1]
\]

(where $\lambda$ is the coefficient of expectations) and that the coefficient $B$ is a linear function of other policy variables ($X^*_i$), 1/ we get our final equation (5) 2/

\[
1/ \quad B_t = b + \frac{c_i X_i^t}{(I^*_P - I^*_P - 1)}
\]

2/ This result is found easier working with the expressions

\[
\Delta I^P_t = B (I^*_P - I^*_P - 1) \text{ and } I^*_P = [1 - (1 - \delta) L] K^*_P
\]
The investment theories usually consider two different steps: the determination of the desired capital stock \((K_t^*)\) and its realization through investment. With this approach the change in the relevant variables (except in the case of the expected output) does not affect directly the desired capital stock, but the velocity at which the agents adjust the discrepancy between \(K_t^*\) and \(K_{t-1}\). Although these two processes are conceptually different, this does not pose a serious problem for an empirical analysis of the determinants of the private investment.

It should be noted that the relation with the expected output, the accelerator relationship, will tend to be weaker if there is a substantial degree of unused capacity, although this will not be critical depending on the elasticity of expectations of the private agents.

With the equation (5), we have an estimable equation, but we still need to specify the factors that affect the velocity of adjustment to achieve \(K_t^*\), the costs and constraints involved in the investment decision. Although the importance of these variables \((X_i)\) will vary according to the different characteristics of the LDCs, in what follows we will discuss what we expect to be, taking into account the investment theories, the more important variables.

For most LDCs, liquidity constitutes a severe constraint on investment, the underdeveloped character of capital markets limits the issue of stocks as a source of financing for firms. Furthermore, the
financial repression -- with often negative real interest rates -- constraints the availability of loanable funds. In this context the firm can only rely on internal sources of financing (retained earnings and depreciation allowances) and on the restricted external and domestic credit (either from national or foreign institutions).

It should be noticed that this system is biased towards the heavy indebtedness of the privileged firms with access to the credit. The specific country cases are certainly different but the role of credit is central for most LDCs; a fact that does not necessarily exclude the relevance of the interest rate in the investment decision, either altering the direct cost of borrowing or the opportunity cost of the investment. 1/

For the regression analysis, it is difficult to find a proxy for self-financing but since it tends to be correlated with the output it does not constitute a serious problem in our formulation. 2/ In the case of the credit from financial institutions, the foreign sources should be considered only for countries with consistent external indebtedness.

Another characteristic of most LDCs is that they import a significant share of their capital goods. For these countries, the availability of the foreign exchange (e.g. reserves$_t$/imports$_{t-1}$) and its real cost [the real exchange rate, (RER) and the import system] should be considered relevant variables.

1/ When the internal financing seems to be particularly relevant, one can try to include the total money supply.

2/ It can also affect the availability of credit through the change in financial savings.
For our estimation, we must take into account that the availability of foreign exchange tends to have a positive correlation with the changes in the real credit to the private sector and therefore reduces the necessity of incorporating the first variable. 1/ On the other side, the inclusion of the RER variable for countries with a strong dependence on the imports of capital goods is reinforced by its effect on the cost of the firm's foreign borrowing. We are conscious that besides the RER the inclusion of other elements of the import system is important but the data availability will tend to restrict this.

There are other elements which should be considered for specific cases, such as the effect of different kinds of public investment or of tax and incentive policies, but again here the data restrictions are severe. The public investment in infrastructure clearly stimulates the private investment by increasing the domestic demand and providing a better environment for the private sector but on the contrary, the noninfrastructure public investment will tend to destimulate the private one by physical crowding out and competition.

Finally, but most important, nowhere is security and political stability more influential on the private investor's decision than in LDCs. Nowhere it's more true that "... if the animal spirits are dimmed and the spontaneous optimism falters, leaving us to depend upon nothing

1/ This is not necessarily the case when the foreign exchange crisis is accompanied by a decrease in the real credit to the public sector.
but a mathematical expectation, enterprise will fade and die..." 1/
Unfortunately, this is not easy to take into account in empirical investigations.

2.0 Empirical Analysis: The Colombia Case

In this section we will apply to the Colombian case the private investment framework that we formulated in the previous section. Since the objective is to show the methodology, we will present and discuss all the results and not only those that are favorable.

Following is a list of the variables that we will be using in the testing of the private investment equation, these are available for the 1951-1981 period, which gives us enough degrees of freedom for a statistically significant analysis:

\[
\begin{align*}
IP_t & : \text{private investment} \\
\Delta GDP & : GDP_t - (1 - \delta) GDP_{t-1}, \text{ where } \delta \text{ has been assumed as 0.05} \\
\Delta CRED & : \text{Change in the real credit to the private sector (from the central bank, commercial banks and other financial institutions, line 52d in IFS)} \\
\Delta CRED F & : \text{Change in the real credit to the private sector (from the central and commercial banks only, line 32d in IFS)} \\
RER & : \text{Real exchange rate} \\
INTRA & : \text{Lending interest rate}
\end{align*}
\]

ECO.R-COLFRAME

TCF : External real capital flows (short and long term, including foreign investment)

LOTCF : Long term real external capital flows

All credit and capital variables are expressed in real terms by using the GDP deflator.

2.1 The Accelerator Variables

The first relationship to be tested is the accelerator theory, which in our model is reduced to regressing private investment \( IP_t \) against its lagged value and the change in Gross Domestic Production (\( \Delta GDP \)). The theoretical demand equation for gross private investment (equation 5) implies that investment should be regressed against the policy variables at time \( t \) and the one year lagged investment but also on the lagged values of these respectively. Empirical analysis made elsewhere and our own experimentation do not show that the expectation coefficient of output is different from unity. This means that one might consider a situation of perfect foresight where expected output is equal to the realized one. In the following, the expectation coefficient \( (\lambda) \) will set to unity. The result that we obtain, as we will see later, is one of the strongest in all the analysis, the accelerator variables are definitively relevant in explaining the private investment behavior.

\[
IP_t = 0.1906 \Delta GDP_t + 0.0061 IP_{t-1} - \]

\( (2.64) \quad (15.14) \)

\( R^2 = 0.9953; \; DW = 2.22 \)

The above equation shows that the long term incremental capital-output ratio is around 2.
We also tested the hypothesis that in periods of substantial unused capacity, the accelerator relationship tends to be weaker but we obtained only mixed evidence. This is in accordance with the results of other empirical studies, some verify this hypothesis of the weaker accelerator, even arguing that the financial policies of the last decade has tended to substitute the investment of big firms for that of smaller ones, reducing the productivity and therefore the profitability and willingness of adopting new technology. 1/ But others find the crucial role of the accelerator even under condition of unused capacity, the argument being that the Colombian investors have internalized this situation and also that they have a high elasticity of expectations (an increase in the expected output is perceived as an indicator of further movements in the same direction). 2/ These somewhat contradictory explanations demand further research, but it is also clear that our analysis of subperiods should always be taken with caution because of the limited number of observations.

2.2 Credit to the Private Sector

2.2.1 Domestic Sources: The next variable that we introduce in our analysis is the changes in net claims on the private sector (ACREDP) which we hypothesize affects the speed of adjustment to reach the desired capital. Again we obtain a pretty strong result -- that as in


the case of the accelerator will remain in most of the later regressions, the financing constraint is also a variable that affects the private investment pattern. This result is not surprising because it is related to the severe financial repression experimented by the Colombian economy for most of the periods. The monetary authority not only controlled the interest rates, imposed forced investments and subsidized credit, but curtailed severely the capacity of the banking system to expand the credit to the private sector (mainly through the reserve requirement).

$$IP_t = 0.1839 \Delta GDP + 0.8469 IP_{t-1} + 0.1249 \Delta CREDF \quad (2.68) \quad (13.25) \quad (2.03)$$

$$R^2 = 0.9958; \quad DW = 2.17$$

These results are obtained using the credit to the private sector coming from the central and commercial banks plus other financial institutions, the latter lend on a longer term basis and that's why we include the total net claims on the private sector in our analysis. But we obtain the same result when we use in our regressions the net claims of the Central Bank and commercial banks (\(\Delta CREDF\)), which is convenient because this variable is available for all LDCs.

$$IP_t = 0.2093 \Delta GDP + 0.7982 IP_{t-1} + 0.3732 \Delta CREDF \quad (3.26) \quad (12.47) \quad (3.00)$$

$$R^2 = 0.9963; \quad DW = 2.02$$
For the analysis of the subperiods, from here on, we identify 1967 as the breaking point, because of the major changes in the economic policies introduced that year.

The regressions for both sub-periods confirm the hypothesis that the credit has become an important factor affecting the investment decision only in the recent period 1/; a difference with the previous period when the internal sources of financing played a more crucial role.

1951-1967
\[
IP_t = 0.4602 \Delta GDP + 0.7346 IP_{t-1} - 0.0990
\]
\[
(7.18) \quad (3.49) \quad (-0.85)
\]
\[
R^2 = 0.9966; \quad DW = 2.43
\]

1968-1981
\[
IP_t = 0.2007 \Delta GDP + 0.7395 IP_{t-1} + 0.2697 \Delta CR\text{EDF}
\]
\[
(2.13) \quad (6.50) \quad (2.41)
\]
\[
R^2 = 0.9964; \quad DW: 2.32
\]

This result reflects the decapitalization process and the high level of indebtedness of Colombian firms, and their preference for debt sources against internal ones. 2/ For the sociedad anonima firms, in

1/ These results also hold for the variable ACRED.

2/ Furthermore, this investment has been reoriented to financial and speculative purposes versus productive ones. Diego Sandoval P "Financiación de la Industria. Manufacturera Colombiana 1945-1983" Rev. de Planeación y Desarrollo. Vol. XVI, 2 y 3, 1984.
1960, 28% of all their financial resources came from the issue of stocks, but by the end of the 1970s this percentage was reduced to 5%; during the same period the ratio debt/equity increased from 59% to 253%.1/ Since 1970, this process of indebtedness has been amplified in spite of negative dividends in real terms for several firms listed in the Stock Market (which is in its 1950 level), the reason being an inflationary context and predominant financial repression keeping interest rates down.

Having found the statistical relevance of the variable credit to explain the speed of adjustment of private investment, we continue testing the other variables suggested by our theoretical framework. We should note that for the purposes of this presentation we show the results of introducing the tested variable individually, but most of the results remain when we test different possible specifications (combinations of variables). This fact is particularly convenient because it strongly supports the validity of our conclusions.

2.2.2 External Sources: The next hypothesis to be considered is that not only the credit coming from internal sources affect investment but also that coming from foreign sources. These sources can be grouped in short and long term capital flows, and direct foreign investment. 2/ In

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1/ Restrepo, Serna y Rosas. "Inflación y el proceso de descapitalización de la Sociedad anónima Colombiana Ensayor sobre política económica."

2/ It should be noticed that these variables correspond to the nonmonetary sector because otherwise they are already included in the ACREDP variable.
In this case, we include in the analysis different specifications of real capital inflow variables such as:

- LOTCF1: Long term capital flows
- FORINV: Foreign investment
- LOTCF2: LOTCF1 + FORINV
- TCF: Total capital flows LOTCF2 + short term capital flows
- TCREDF: Total credit, TCF + ΔCREDF

The results again are consistent (Table 3); in no case was the external capital flow variable statistically significant in explaining the Colombian private investment behavior. Therefore, in adding the total capital flows to the net domestic claims on the private sector.

Table 3: IMPACT OF FOREIGN CAPITAL INFLOWS

<table>
<thead>
<tr>
<th></th>
<th>$\Delta_{IP_{t-1}}$</th>
<th>$\Delta_{GDP}$</th>
<th>$\Delta_{CREDF}$</th>
<th>$R^2$</th>
<th>DW</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LTCFI</td>
<td>0.8653</td>
<td>0.1679</td>
<td>0.1333</td>
<td>0.9956</td>
</tr>
<tr>
<td></td>
<td>(-0.39)</td>
<td>(10.7)</td>
<td>(2.07)</td>
<td>(2.02)</td>
<td>0.9956</td>
</tr>
<tr>
<td>2</td>
<td>FORINV</td>
<td>0.8059</td>
<td>0.2228</td>
<td>0.0789</td>
<td>0.9960</td>
</tr>
<tr>
<td></td>
<td>(1.56)</td>
<td>(11.9)</td>
<td>(3.12)</td>
<td>(1.18)</td>
<td>0.9960</td>
</tr>
<tr>
<td>3</td>
<td>LTCF2</td>
<td>0.8442</td>
<td>0.1858</td>
<td>0.1237</td>
<td>0.9956</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(10.55)</td>
<td>(2.40)</td>
<td>(1.88)</td>
<td>0.9956</td>
</tr>
<tr>
<td>4</td>
<td>TCF</td>
<td>0.8264</td>
<td>0.1936</td>
<td>0.1265</td>
<td>0.9956</td>
</tr>
<tr>
<td></td>
<td>(0.53)</td>
<td>(10.98)</td>
<td>(2.65)</td>
<td>(2.03)</td>
<td>0.9956</td>
</tr>
<tr>
<td>5</td>
<td>TCREDF</td>
<td>0.7843</td>
<td>0.2448</td>
<td>(-)</td>
<td>0.9959</td>
</tr>
<tr>
<td></td>
<td>(2.37)</td>
<td>(10.37)</td>
<td>(3.46)</td>
<td></td>
<td>0.9959</td>
</tr>
</tbody>
</table>
the relevance of this new variable is completely attributable to the latter.

The non-significance of the external indebtedness variables in the private investors decision is quite reasonable in the Colombian case. For most of the period analyzed, the capital flows were subject to all kinds of controls (on their maturity, their maximum interest rate, etc.) and this is also applies for the direct foreign investment (specially with the regulations of the Andean Pact); therefore, in general, the capital flows have been small and unstable. In this context it is clear that Colombian private investors could not rely on the external credit as a steady source for the financing required by their projects.

The analysis for the subperiods does not show any particular insight, except that the performance of the external variables is even weaker for the 1951-1967 period which only confirms our previous result on the smaller dependency on credit by the firms during that period.

2.3 The Interest Rate

The next variable to be tested as affecting the investment's speed of adjustment is the interest rate (INTRA). The results of introducing the interest rate in the analysis, individually as well as with the other specifications, are also conclusive. The interest rate does not show to be a significant variable in explaining the private investment behavior when introduced separately in the cost of capital formula.

\[1/\] Discount rate in IFS, line 60.
This empirical finding contradicts the neoclassical hypothesis, but is consistent with the state of financial repression experienced by the Colombian economy. Since 1950 the decision has been to control the financial market, and although this was somewhat eased in 1974, shortly after, for stabilization reasons, the financial policies returned to the previous interventionist mode. Even the introduction of financial instruments such as the UPAC and CDs, which offer the highest interest rates in the financial market, did not make it possible to avoid the trend towards negative real interest rates (after taxes). 1/

In this context, for most of the period, the borrowing interest rates stimulated the indebtedness, and its increase did not change drastically the situation, because of its tax advantages against the issue of stocks (one can deduct the interest payments from the taxable income). As a footnote, it should be noted that this result could also suggest a weak response of the domestic savings to the change in the interest rates, or that the substitution effect of the interest rates on the capital-labor ratio is neutralized by its effect on the output efficiency. 2/ The analysis of subperiods basically gives us the same results, although we could not test the effects of the 1974 financial liberalization because of data constraints.

1/ This trend might have changed since 1981.

The above analysis seems to establish that even in the case of Colombia, where the financial system has been somewhat liberalized, the interest rate does not play a major role in explaining the behavior of investors as long as the real interest rate is negative. This corresponds to a situation of supply constraint market. In this situation, the interest rate does not clear the credit market but is rather fixed by the Government or determined by other market forces. The reality is perhaps between a clearing interest rate and one that is determined completely by other factors. In the case of Colombia, for example, it seems that the Certificate of deposit interest rate (i) depends on the US Treasury bill rate, (i^w) exchange rate variation (e$), the supply of credit measured by the net claims on the private sector and investment of the private sector.

\[
i = 0.786 \cdot (i^w + e$) - 22.130 \log (\Delta CRED) + 22.352 \\
(0.450) \quad (8.883) \quad (8.909)
\]

\[
\log (IP + IH) + 0.355 i_{-1} \\
(0.223)
\]

\[
R^2 = 0.823 \quad DW = 2.73 \quad 1/
\]

where IH is real housing investment.

2.4 The Real Exchange Rate

The last variable that we have to introduce in our model is the real exchange rate (RER); 2/ as usual we get unambiguous results, this time rejecting the hypothesis that the RER coefficient is significantly

1/ Numbers within parentheses are standard error deviations.

2/ Defined as the hs wholesale price index (IFS, line 63), expressed in pesos by multiplying with the exchange rate, divided by the Colombian GDP deflator.
different from zero. 1/

\[ IP_t = 0.1727 \triangle GDP + 0.8054 IP_{t-1} + 0.1574 \triangle CREDF + 0.0856 RER \]
\[
(2.43) \quad (9.13) \quad t \quad (2.02) \\
(0.69)
\]

\[ R^2 = 0.9957; \quad DW = 2.09 \]

The explanation of these results using the stylized facts of the economy, is somewhat more difficult than in the case of previous findings. The non-significance of the real effective exchange rate in explaining investment behavior might be due to the fact that the external capital flows do not affect the investor's decision in Colombia. 2/

Although Colombia has been gradually reducing its dependence on imports for the process of capital formation, this dependency is still significant (especially in machinery and equipment). It is obvious that here more research is needed, but the result obtained might be partially explained by the well known fact that after 1967, with the adoption of the crawling peg, the fluctuation of the RER was drastically reduced. Another explanation lies in the effect of the RER over the expected output, which can neutralize its effect over the cost of the capital goods (which is privileged in our analysis).

1/ We should mention again that although we present only one regression, the results have been confirmed for a variety of different specifications, including INTRA and the external capital flows. In this case we also tried the lag value of the RER.

2/ A significant effect was expected because the exchange rate movements affect the cost of capital as shown in Section 2.3.
2.5 Finding the Elasticities

In what follows we find the relevant private investment elasticities as a way to make our results comparable with other country cases as well as to verify our results. First we tried a double logarithmic specification to obtain directly the respective elasticities; this is assuming a constant elasticity for the investment equation. Empirically we had problems with this specification because variables such as the external capital flow, the interest rate and the real exchange rate were statistically not significant, neither was the credit to the private sector. In this formulation only the accelerator variables show significance and stable elasticities (Table 4).

Table 4: CONSTANT ELASTICITIES

<table>
<thead>
<tr>
<th>Period</th>
<th>IP_t - 1</th>
<th>ΔGDP</th>
<th>ΔCRDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951-1981</td>
<td>0.82</td>
<td>0.23</td>
<td></td>
</tr>
<tr>
<td>1953-1981</td>
<td>0.83</td>
<td>0.22</td>
<td></td>
</tr>
<tr>
<td>1960-1981</td>
<td>0.83</td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td>1965-1981</td>
<td>0.83</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1970-1981</td>
<td>0.80</td>
<td></td>
<td>0.13</td>
</tr>
</tbody>
</table>

(*) Non-statistically significant

Table 4 presents constant elasticities for different periods: The elasticity with respect to IP_t - 1, is stable over time but there is a declining trend in the elasticity with respect to output. It should also be noticed that the elasticity with respect to the credit variable
is significant only in the most recent period. This analysis is not valid per se but it will be somewhat useful for comparisons with the elasticities found using other formulations.

The results using the constant elasticity formulation are clearly weak, therefore it is not reasonable to assume constant elasticities, and the optimal specification of the investment equation could be either the simple linear formulation or a semilogarithmic one. Since we found that the semilog specification is inadequate, we decided to find the elasticities from the linear specification of our selected equation both for the mean values of the period 1951-1981 and for each subsequent five year period. For these calculations the formula is just:

\[ \eta_{IP_t} \cdot X_{zt} = \frac{\partial IP_t}{\partial X_{zt}} \cdot \frac{\bar{X}_{zt}}{\bar{IP}_t} = c_z \frac{\bar{X}_{zt}}{\bar{IP}_t} \]

where \( c_z \) is the coefficient of \( z \) from the estimated linear equation for \( x \), and \( \bar{X}_{zt} \) and \( \bar{IP}_t \) are the mean values of \( X_{zt} \) and \( IP_t \).

As we can see from Table 5, the private investment elasticities seem to be pretty stable and the elasticity with respect to the private credit results statistically significant for all the cases. A quick comparison of these elasticities with those in Table 4 will show that although they present different values both have similar trends and magnitude orders, a fact that to some extent supports the validity of the elasticities found using the linear formulation.
## Table 5: Elasticities From the Linear Formulation

<table>
<thead>
<tr>
<th>Period</th>
<th>( IP_t - 1 )</th>
<th>( \Delta GDP )</th>
<th>( \Delta CREDF )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951-1981</td>
<td>0.800</td>
<td>0.141</td>
<td>0.055</td>
</tr>
<tr>
<td>1951-1955</td>
<td>0.78</td>
<td>0.136</td>
<td>0.048</td>
</tr>
<tr>
<td>1956-1960</td>
<td>0.802</td>
<td>0.122</td>
<td>0.031</td>
</tr>
<tr>
<td>1961-1965</td>
<td>0.834</td>
<td>0.124</td>
<td>0.027</td>
</tr>
<tr>
<td>1966-1970</td>
<td>0.798</td>
<td>0.151</td>
<td>0.047</td>
</tr>
<tr>
<td>1971-1975</td>
<td>0.833</td>
<td>0.163</td>
<td>0.066</td>
</tr>
<tr>
<td>1976-1981</td>
<td>0.774</td>
<td>0.137</td>
<td>0.072</td>
</tr>
</tbody>
</table>

The value of the elasticity with respect to \( IP_t - 1 \) does not show any particular trend, but the one corresponding to the \( \Delta GDP \) experience a significant increase in the 1966-1975 period and the same is true for the one corresponding to the \( \Delta CREDF \), but during 1971-1981 period (in 1981 this elasticity was 0.07). The last fact is consistent with other results that show the increasing importance of the variable credit in the investment decision, but the evolution of the elasticity with respect to the \( \Delta GDP \), as we have already discussed, demands further research.

As a final remark, we should note that we found similar but somewhat higher elasticities using the narrow definition of credit (\( ACRED \)), in particular the elasticity with respect to this variable remains more stable during the whole period but still increases gradually from 1966 to reach its highest value in 1981 (0.10).
2.6 Discussion of Other Variables

Finally we discuss the results obtained by testing the relevance of two variables that are not included explicitly in our framework of analysis because of their weak theoretical support but which should be considered in particular cases.

The first set of variables is related to the public investment process. The aggregate variable of public investment, as we expected, does not show to be statistically significant. For a better analysis we need to disaggregate this variable into infrastructure and non-infrastructure, but data is poor. The results of the regressions with these two variables consistently reject the hypothesis that one or both of them are relevant to explaining the private investment decision in Colombia. These results also held for the two sub-periods studied, 1951-1967 and 1968-1981.

Although only approximate results, they clearly fit the recent history of public investment in Colombia. This investment has not shown dramatic changes during the analyzed period, it was 0.17 of the total investment in 1951 and it ended being 0.22 in 1981. Only during the period 1967-1975 so there was an increase in this public investment was observed, when it reached 0.30 of the total investment and around 0.05 of the GDP (against 0.03 for the rest of the period).

This stability certainly contributed to reduce the statistical significance of the public investment in infrastructure explaining the private investment, since its links with the growth of the GDP are too close. Furthermore the relative moderate public investment in the Colombian case has clearly avoided any important physical or financial
crowding out of the private investment. 1/ However, for other particular country cases these effects can be so important that the variables that reflect these effects should be included in the formal framework of analysis.

Finally a brief comment on the results of testing the variable money supply/GDP (M2GDP). These results show that the impact of this variable is not statistically different from zero in any specification for the period 1951-1981. Additionally, we could not find enough evidence that this variable played a more central role in the 1950-1967 period, when the firm's self-financing was more significant, because although the sign of M2GDP's coefficient was the expected one (except from the 1968-1981 period) its t statistic was too low to show any statistical significance.

Conclusions

In this paper we presented a flexible framework to identify and assess the factors affecting the behavior of the private investment in LDCs. This analytical framework was applied to the Colombian case both as a methodological exercise as well as to gain further knowledge on the Colombian investment behavior.

The econometric results are in general encouraging. They present not only acceptable statistical properties, (a good fit of the equation, few auto correlation problems, stability and statistical significance for the estimated coefficients in a variety of

1/ Although for the most recent period (1981-1982) some studies find some crowding out by the public investment (mainly oriented to use imported goods).
specifications), but also they fit some basic stylized facts of the Colombian economy. 1/

The variables that show to be statistically significant in the private investment equation were the accelerator variables (ΔGDP_t and IP_t - 1) and only credit to the private sector as a policy instrument.

The only conclusive result of the analysis of subperiods is that the credit variable has become important only since the end of the 1960s. The other variables tested: external capital flows (short and long term debt and foreign investment), the interest rates and the real exchange rate are not significant factors affecting the behavior of the Colombian private investors. The same results were found while testing variables that are not explicitly included in our equation, such as the public investment variables and the money supply/GDP ratio.

In the estimation of the elasticities we had to reject the constant elasticity assumption and also the semilog formulation, but using the linear formulation we get pretty stable and reasonable elasticities. The private investment elasticities for the mean values are 0.80 with respect to IP_t - 1, 0.141 with respect to ΔGDP and 0.055 with respect to ΔCREDF. The elasticities for subperiods show upward trends for the period 1966-1975 in the case of the ΔGDP variable and since 1971 for ΔCREDF; (in 1981 this elasticity gets its maximum value, 0.07). Finally, it should be pointed out that although these

elasticities are somewhat low, they are higher if we use the variable ACRED in the regressions.

Our analysis show that during the period 1950-1981 the private investment experienced a very slow speed of adjustment, in part attributable to the condition of financial repression. In this context while the investment was somewhat constrained by the availability of credit (specially since the 1960s), the interest rate did not play a significant role, although even in this situation the accelerator link was functioning. Besides we have also shown that it did not depend on the foreign sector (either the capital flows or the real exchange rate).

A straightforward, although simplistic because this ignores problems related to high debt/equity ratios, policy implication from the Colombian experience would be to remark the necessity to develop the capital markets and to improve the financial intermediation (avoiding adjusting the private credit variable for stabilization purposes).

These conclusions are valid for the global period but there are some short run departures of this trend that cannot be easily taken into account with the current specification of this framework (such as the recent increase in the public investment and in the lending interest rates), although further research using quarterly data is recommended.

In conducting monetary policy in LDCs, it is of paramount importance to assess the impact of financial reforms on investment and hence on medium-term growth. The present analysis suggests that investment does not depend on the interest rate especially in periods of high inflation. This observation should not imply that governments could increase interest rates indefinitely without jeopardizing investment opportunities, but it supports the argument that in most
LDCs, investment is rather constrained by the availability of credit when interest rates are controlled by governments. In such a case, there should be room to increase the real interest rate in order to encourage domestic resources mobilization without hampering growth and increase efficiency of resource allocation.

From the modelling point of view, the results obtained justify the use of a closure rule such as private investment in real assets is constrained by private savings, net changes in claims on the private sector and net foreign borrowing. The credit market is always in equilibrium for fixed interest rates because demand for credit is assumed to be infinitely elastic. The major implication of such a modelling approach would be that increasing interest rates will have positive effects on financial savings and hence on investment.