THE USER COST OF CAPITAL AD BEHAVIOR OF INDUSTRIAL INVESTMENT IN MOROCCO: MEASUREMENT ISSUES AND ECONOMETRIC ANALYSIS(*)

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1. Introductory Remarks

Efforts deployed by Morocco to boost industrial investment have resulted in mitigated outcomes. In this sense, one can describe the situation as a “structural crisis of industrial investment”. Therefore, deeper analysis of investment reaction to incentive measures is needed.

“Industrial investment makes countries richer”. This idea is commonly accepted among economists who argue that speed of development closely depends on industrial investment level as well as on its structure, orientation and efficiency. Under these conditions, one can understand the willingness of Moroccan decision-makers to create conditions for an environment that is favorable to boost industrial investment.

Since the independence of Morocco in 1956, decision-makers deployed efforts to stimulate industrial investment. Undertaken policies concern tax, financial and infrastructural measures. Nevertheless, such efforts resulted in mitigated outcomes, and the situation may now be described as a “structural crisis of industrial investment”. Official statistics show that industrial investment has experienced slower increases and investment performance is still below what has been expected. Therefore, deeper analysis of investment reaction to incentive measures is needed.

How can we explain the fact that despite undertaken actions, the overall industrial attractiveness of Morocco is still weak? Contrarily to widespread idea, a scientific answer to this question is not easy. The difficulty is indisputably correlated with the complexity of investment activity. In addition to its dynamic, uncertain and irreversible characteristic, its determinants are various and even sometimes contradictory. To deal with industrial investment determinants, we center on impact of the user cost of capital, among other explanatory variables selected in line with

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economic theory and specificities of the Moroccan economy. The concept of the user cost of capital may be defined as the before-tax real rate of return on a marginal investment project. The concept includes several aspects that may explain the behavior of investment, especially aspects related to public aid, conditions of financing and tax costs.

At least, four reasons may explain the central importance of the user cost of capital in our industrial investment analysis:

- The user cost of capital is an assessment tool of incentive policies that has received attention in the recent literature. Since the pioneering paper of Jorgenson (1963), research in this area is increasing (see for example, King and Fullerton, 1984; Alworth, 1988; Mignolet, 1991, 1992, 1995a, 1995b, 1997, 1998; Auerbach, 1983,1990; Boadway, 1987; Boadway and Sahah, 1995; Mintz, 1990, 1992, 1993; McKenzie and Mintz, 1992, etc.).

- The user cost of capital itself integrates a variety of variables explaining the behavior of investment, especially public subsidies, conditions of financing and tax burden on investment income.

- On the conceptual front, the user cost of capital is an extensible concept. Thus, we will try to enrich basic theoretical models in this research area.

- On the empirical level, the user cost of capital has been advantaged in developed countries as a tool for assessing incentive policies. Modern time-series analysis will allow us to assess contribution of the user cost of capital to industrial investment, taking into account particularities of the Moroccan incentive system.

The remainder of this research paper is organized as follows. Section II presents a critical review of the literature on the user cost of capital and other determinants of industrial investment. Section III summarizes our methodological framework destined to compute the user cost of capital. Section IV tries to measure the user cost of capital in Morocco. Section V attempts to estimate impact of the user cost of capital on industrial investment, especially investment in machinery and equipment as well as investment in construction. Section VI summarizes policy implications to draw from our empirical analysis and presents our concluding remarks.

2. Critical Review of the Literature on the User Cost of Capital and other Determinants of Investment

Analysis of the concept of the user cost of capital relies mainly upon the pioneered works of Jorgensen (1963), Auerbach (1983) and specifically King and Fullerton (1984). These authors computed the user cost of capital of a marginal investment taking into account a set of burdens supported by operators: tax (marginal
effective tax rate) and nontax (real interest rate, economic depreciation rate of capital, government grants, etc.).

Even though these initial models offer relevant tools for computing the user cost of capital, they all have the shortcoming to ignore effects of other aspects on the variable under study. Among these aspects, it is important to: (i) analyze the user cost of capital in the case of foreign investment (see for example, Alworth, 1988; Pierre, 1996, Weichenrieder, 1995; Hespel, 1997 and Mignolet, 1998); (ii) introduce the notion of risk as a determinant variable for the user cost of capital; (iii) take into consideration existence of a differential in natural endowments (productivity, prices of factors of production and market structure) between territories (see for example Carlino, 1982; Moomay, 1983; Carlino and Voith, 1992 and Catin, 1991 and Mignolet, 1996); (iv) bridge the user cost of capital and costs of factors of production (see for example, McKenzie, Mintz and Scharf, 1997).

Theoretically and empirically speaking, analysis of the degree of sensitivity of investment to changes in the user cost of capital has been often subjugated to controversies. For instance, Dormant (1997), in his macroeconometric study, did not identify clear links between demand for factors of production and the relative price of capital and labor, with lower and statistically non-significant impact for the cost of capital. For the case of Canada and USA, MacKenzie and Thompson (1997) showed that changes in the magnitude of impact of the user cost of capital on investment on machinery and equipment is weak but statistically significant. Chirinko and Meyer (1997), Chirinko, Fazzari and Meyer (1999), and Bruno and Christian (2001) argued that capital stocks negatively react to changes in the user cost of capital. Finally, in the Moroccan case, Mansouri (2001, 2003a) argued that the rental cost of capital has no significant impact on overall private investment.

In line with what economic theory tells us about determinants of investment, in addition to the user cost of capital, we introduce the following additional variables as explanatory factors of investment: i) public investment; ii) real GDP; iii) drought cycles, to account for effects of rain falls on investment activity in Morocco; iv) investment-based real exchange rate, to account for effects of real devaluation (or overvaluation) on private investment; v) credit available to the private sector. (for theoretical discussions of these explanatory variables, see Easterly, 1994; Mourandé and Schmidt-Hebbel, 1994; Aschauer and Lächler, 1998; Mansouri, 2000, 2001, 2003a, 2003b, 2003c, 2003d).


Our methodological framework relies somewhat on the neoclassical literature on the user cost of capital. It is based on the approach developed by King and Fullerton (1984), examined and applied by Alworth (1987), Bowadway (1988), McKenzie and Mintz (1992), and Boadway and Shah (1995). However, we have made
amendments to this approach to take into account specificities of the Moroccan tax system.

The starting point in our methodological framework is an economy without any form of taxation. Neoclassical theory of investment teaches us that firms seeking to maximize the value of future investment cash-flows resort to capital until the rate of return on the additional invested unity equals the marginal cost. The user cost of capital would therefore coincide with the marginal cost of the less profitable investment.

Assuming that investment is continually indivisible and that the marginal return on capital (that is increase in returns due to investment one an additional unity of capital) will diminish when used capital increases, the state of equilibrium may be formalized as follows:

\[ R(K) = q(N + \delta) \]  

(1)

where \( R(K) \) refers to the rate of return on one marginal unit of capital and \( q(N + \delta) \) is the user cost of capital.

Therefore, in the absence of taxation, the user cost of capital is the relative price of one unit of capital with respect to production \( (q) \), multiplied by the sum of the option cost of funds devoted to capital \( (N) \) and the loss of capital value due economic depreciation \( (\delta) \). In other words, the marginal unit of capital reaches the ‘profitability threshold’ in the extent that return it generates covers exactly the decrease in the economic value of capital (that is its economic depreciation) and also satisfies debtors as well as shareholders.

The option cost of financing for a firm \( (N) \) corresponds to the minimal real rate of return that its owners (shareholders) and debtors would gain from alternative occasions of investment presenting similar characteristics. Consequently, if \( \lambda \) indicates the fraction of investment financed through borrowing, and \( (1 - \lambda) \) is the fraction of investment financed through self-financing (non-distributed profits or new issuing of new shares), the cost of option for financing will correspond to the weighted average of rates of return required on assets securities and shares. This weighted average may be written as follows:

\[ N = \lambda i + (1 - \lambda) \rho - \pi \]  

(2)
where $i$ is the nominal interest rate on debt (that is the rate required by lenders), $\rho$ is the nominal rate of return on equity (that is the rate required by shareholders), and $\pi$ is the expected inflation rate.

Consider now a domestic economy with taxation. In this real world, investors have concern about after-personal-tax rate of return. The first component of taxation, that is corporate tax $(\tau)$, reduces the nominal cost of financing through borrowing to $(i(1-\tau))$. Therefore, deductibility of interest payments reduces the user cost of capital through decreases in average option costs of financing. In such conditions, equation (2) becomes:

$$N = \lambda i(1-\tau) + (1-\lambda)\rho - \pi$$

(3)

To estimate the value of $\rho$, we take into account taxation of dividends at a rate $m_d$ as well as taxation of nominal interest income at a rate $m_i$. In a situation of equilibrium within financial markets, and in the absence of risk and imperfections other than those concerning taxes, after-tax return on self-financing has to correspond to after-tax return on debt, that is “$i(1-m_i) = \rho(1-m_d)$”. This allows us to write:

$$\rho = \frac{i(1-m_i)}{(1-m_d)}$$

(4)

if corporate tax influences directly the user cost of capital, impact of personal tax (on debtors and shareholders) holds only indirectly. This impact is felt through the option cost of financing.

The user cost of capital is also reduced because of decreases in the effective purchasing price of capital, resulting from tax depreciation, investment allowances and tax credits for investment. Nevertheless, our methodology does not account for tax economies resulting from investment depreciations and provisions. Tax credits for investment have never been accounted for in Moroccan tax dispositions.

In Morocco, firms benefit from annual deductions for depreciation that permit to reduce tax by an amount of $\tau A$, where $A$ refers to the present value of the tax depreciation allowances on one dirham of capital. The value of such tax economies obviously depends on the regime of depreciation applied (linear or digressive).

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1- We assume that expectations about inflation are perfect. Therefore, expected inflation is assumed to correspond to current inflation.
2- We suppose that investors are physical persons.
If firms opt for a regime of linear depreciation, the annual allowance is obtained through dividing the value of the asset by its life period. In these conditions, the value of $A$ may be apprehended through the following integral:

$$A = \int_0^L \frac{1}{L} e^{-\mu_L} du$$

(5)

where $\mu$ refers to the time operator taking values from 0 through $L$. In what follows, the value of $L$ (life period of investment) depends on the kind of asset to be depreciated. In line with previous works on the user cost of capital, we have chosen a value of $L = 10$ for investment on machinery and equipment and $L = 20$ for investment on construction.

Solving equation (5) yields:

$$A = \frac{1}{LN} \left( 1 - e^{-LN} \right)$$

(6)

If firms apply a digressive depreciation regime, the allowance is computed using a constant rate for a digressive base. This rate is obtained in conformity with Moroccan tax dispositions, multiplying the rate of linear depreciation by a coefficient, noted $B$, entering with a value depending on the life period of the depreciable asset: 1.5 if the life period is included in the interval of 3-4 years, 1 if the period is included in the interval of 5-6 years and, finally, 3 if the life period is more than 6 years. Since the depreciation rate is applied on the remaining amount to be depreciated, it exists a moment, $L_s$, termed here the switchover point, after which the digressive allowance becomes less than the linear allowance. The Moroccan tax law authorizes firms to pass through the technique of linear depreciation. Following King and Fullerton (1984), we compute the switchover point according to the following formula: $L_s = \left( B - \frac{1}{B} \right) L$, where $B$ takes of a value of 3 because we assume that investment has a life of 10 years. In such conditions, the present value of tax depreciation can be written as follows:

$$A = a \int_0^{(2L/3)} e^{-(N+a)u} du + e^{-aL_s} a \int_{2L/3}^L e^{-Nu} du$$

(7)

After solving, we obtain:

$$A = \left( \frac{a}{N+a} \right) \left( 1 - e^{-\frac{2L}{3}(N+a)} \right) + \left( e^{\frac{2L}{3}} - \frac{e^{\frac{2L}{3}}}{N} \right) a \left[ \left( e^{-\frac{2N}{3}} - e^{-aN} \right) - e^{-xL} \right]$$

(8)
In spite of considerable advantages of the regime of digressive depreciation, recent empirical works have revealed that Moroccan firms which resort to this depreciation technique are rare (see, for instance, Rigar, 2003). Hence, to compute the user cost of capital, we account only for tax economies yielded through linear depreciation.

Moreover, tax laws governing investment in Morocco (investment acts and charters) have often allowed to certain firms, under certain conditions, to record allowances for tax-deductible investment. Allowance recorded at the close of each tax year should be used before expiration of the third year following the year of its constitution. The fraction effectively used in the imposed delay may be transferred to an account of tax free ordinary reserves. If not, it should be reintegrated into the tax year where it is constituted.

Formally, the tax gain from allowances due to effectively used investments in due imposed delays (3 years) may be written as follows:

\[ g = \int_{-\frac{3}{3}}^{0} \frac{1}{3} e^{-N\tau} du = \frac{\tau}{3N} \left( e^{3N} - 1 \right) \]  

(9)

Taking all these elements into consideration, the cost of one marginal unit of capital corresponds to \( q(N + \delta - \pi)(1 - \tau A - fg) \). When tax reduces return on additional investment to \( R(K)(1 - \tau) \), condition for optimization of the value of future cash-flows of an investment project becomes:

\[ R(K)(1 - \tau) = q(N + \delta - \pi)(1 - \tau A - fg) \]  

(10)

or:

\[ R(K) = C = q(N + \delta - \pi) \left[ \frac{1 - \tau A - fg}{1 - \tau} \right] \]  

(11)

On the basis of preceding formulas, we propose in what follows to estimate the user cost of capital in the Moroccan case. As already noted, two components of private investment are taken into consideration, namely investment on machinery and equipment and investment on construction.
4. Estimation of the User Cost of Capital in Morocco

4.1. Variables of the Model

As shown in our above-presented methodology, the user cost of capital includes a set of two major factors, namely non-tax and tax variables. Graph 1 presents evolution of the relative price of capital \((q)\), estimated as the implicit price index of investment in fixed capital, divided by the GDP deflator (the two price indices have both 1973 as a base year). As shown in graph 1, the relative price of capital increased somewhat until 1984, and, henceforth, started to experience some stability, except in 1994 when it reached the maximum of 1.61.

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**Graph 1:**
Relative Price of Capital in Morocco

**Graph 2:**
Real Interest Rates in Morocco
Graph 2 presents evolution of real interest rates, defined here as rates on treasury bonds with a maturity of six months, minus current inflation rate. Graph 2 clearly shows that real interest rates were negative during the seventies and early eighties, especially because of higher inflation characterizing these periods. Inflation started to become relatively stable only in the second part of 1980s, and became even “European” in the second part of 1990s (since 1996, inflation rates have never gone beyond the maximum of 3 percent). The consequence was that real interest rates became more stable. Since 1996, lending interest rates have been completely liberalized (on gradual liberalization of interest rates, see Mansouri, 2001, 2003a; Mansouri et al., 2003). 

The third non-tax variable is the economic depreciation rate of capital. As highlighted in our methodological framework, this variable is determined according to the following formula: \( \delta = \frac{2}{L} \), where \( L \) refers to the life period of investment (King and Fullerton, 1984: 29). Accordingly, \( \delta \) enters with a value of 20 percent for investment in machinery and equipment and 10 percent for investment in construction.

Return now to tax variables permitting to compute the user cost of capital. Graph 3 presents evolution of corporate tax in Morocco. We observe that before tax reform beginning in 1986, corporate tax was relatively high. Tax reform reduced the corporate tax rate to 45 percent, to which a ‘national solidarity tax’ of 10 percent must be added, yielding an overall tax rate of 49.5 percent. Henceforth, this rate was reduced many times to be stabilized at 35 percent since 1996. This tax reduction suggests that Moroccan decision-makers have the willingness to alleviate tax charges on firms (on tax reforms and other structural reforms, see Mansouri et al., 2003).

Graph 4 outlines the present value of the tax depreciation allowances on 1 dirham of capital. Data on this variable concerns two types of assets: machinery and equipment, and construction. We observe that, in terms of present value, tax economies due depreciation have evolved almost in a parallel way and decreasingly for machinery and equipment, and construction. This is mainly due to the gradual decrease in corporate tax rates, from 48 percent in 1973 to 35 percent in 2000. Moreover, such tax economies are relatively higher for investment in machinery and equipment. The reason that is behind this is that this kind of asset experiences more rapid depreciation than construction, and tax gains are distributed only over 10 years.

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3- we suppose here that expectations about inflation are perfect. Hence, it is assumed that current inflation corresponds to expected inflation.
4- concerning rates on treasury bonds with a maturity of six months, which we have selected to approximate lending interest rates, they were liberalized only in February, 2001. Henceforth, the rate of remuneration of such bonds equals the average rate on bonds with a maturity of 26 weeks, issued through adjudication, during the previous two quarters, majored with 2.5 base points.
5- in this exercise, as already noted, we account only for linear depreciation. Indeed, even though the Moroccan tax system integrates digressive depreciation, recent studies have shown that Moroccan firms tend to exclusively use the technique of linear depreciation.
in addition to tax economies due to depreciation, Moroccan firms have been authorized since 1996 to record allowances for investment over a period not more than three years. Such allowances cannot however go beyond 30 percent of investment and 20 percent of annual profits. This incentive system was introduced in 1960, but the investment act of 1973 did not take it into consideration. Its implementation was undertaken within the framework of the investment act of 1983. Nevertheless, allowances for investment concerned only firms undertaking investment in less favored regions. Since 1995, policy-makers generalized the incentive system to all firms independently of their implantation zones. The value of economies due to
investment allowances has practically remained constant over the period 1995-2000, around 0.12 for one dirham of investment.

4.2. *Computing the User Cost of Capital in Morocco*

Graph 5 presents our estimates of the user cost of capital in Morocco for the two types of investment, namely investment in machinery and equipment and investment in construction.

Reading graph 5, we can formulate the following remarks:

- First, the two line graphs tend to evolve in a parallel way. This has not to surprise us given the common elements entering in the equation of the user cost of capital, especially real interest rates, tax rates and the relative price of capital.

- Second, it seems that in spite of undertaken measures, especially through gradual decrease in corporate tax rates, the user cost of capital in Morocco remains relatively higher. In 2000, it is estimated to be around 32.47 percent for machinery and equipment and 16.75 percent for construction. In line with our methodological framework, the user cost of capital is interpreted here as the minimum rate of gross return required for investment to be achieved. Historically, graph 5 clearly exhibits two neatly different phases: until 1987, the user cost of capital was increasing, and, henceforth, it was decreasing until 2000. Three variables appear to drive fluctuations in the user cost of capital: the relative price of capital, real interest rates and tax economies due to investment allowances. The relative price of capital experienced steady increases since 1973 and became relatively stable around 1.3 since early nineties, except an observed pick in 1994. As for real interest rates,
even though they were negative during the seventies and slightly superior to zero in early eighties, its tendency was generally increasing until 1988; then, they started to be stabilized following lower inflation and gradually decreasing nominal interest rates. Finally, generalization, since 1996, of the constitution of allowances on investment for all firms independently of their implantation zones, resulted in additional tax economies of about 12 percent per one invested dirham.

- Third, we observe that the user cost of capital for machinery and equipment is higher than the user cost for construction. This is mainly due to technological factors, especially the life period of assets, with machinery and equipment depreciating more rapidly than construction. Generally speaking, as highlighted through equation (11) of the user cost of capital, rapid rhythm of economic depreciation results in higher user cost of capital.

- Finally, another important remark concerns impact of corporate tax on the user cost of capital. As already noted, this tax experienced gradual decreases until 1996. This gradual reduction of corporate tax would have to alleviate the user cost of capital, but its impact has been offset, although partly, by decreases in tax economies due to depreciation. The reason is that higher is corporate tax, more important will be depreciation allowances.


before estimating relationships between the user cost of capital and private investment in machinery and equipment as well as in construction, we propose in what follows to outline evolution over time of these two investment components.

5.1. Investment in Machinery, Equipment and Construction in Morocco

Official data on industrial investment in Morocco do not permit to provide a clear picture about real behavior of Moroccan firms in the area of capital accumulation. Existing official data concern either agreed investment (investment intentions) which is not necessarily achieved, or investment data from surveys conducted by the Ministry of Commerce and Industry, which have often non-exhaustive characteristics. To overcome these difficulties, we propose to measure industrial investment through data on machinery and equipment as well as construction, as computed through national accounts.

Graph 5 presents evolution of investment in machinery and equipment as a share to GDP during the studied period. This graph permits to observe higher investment rates during mid-seventies (1975-78). These exceptionally higher investment rates may be explained by the crowding-in effect of public investment, especially through increasing phosphate prices and expansionary macroeconomic policies conducted in
the framework of the development plan (1973-1977). In the end of seventies and early eighties, the reversal of the situation resulted in decreasing investment rates. Several factors may be behind decline in investment in machinery and equipment, notably increasing real interest rates, crisis of public finance and uncertainty about external indebtedness.

Since 1998, a relative recovery of the rate of investment in machinery and equipment may be observed. It seems that such a recovery may be due to certain measures undertaken by Moroccan policy-makers, especially in the framework of a new investment charter in 1996 and initiation of a program of industrial restructuring, aspiring to encouraging firms to renew and modernize their productive structure.

Concerning investment in construction, graph 6 shows that investment in this sector, in proportion to GDP, is relatively lower in comparison with investment in machinery and equipment. This remark appears to be obvious, especially because the period life for construction is longer than that of machinery and equipment.

However, during the second part of 1970s, the gap between these two kinds of investment is seen to be lower. This may be due to lower growth of investment in machinery and equipment rather than to stronger growth of investment in construction. Indeed, even though investment in machinery and equipment experienced only 11.7 percent increase over the period 1978-1983 whereas investment in construction experienced higher growth of about 68 percent during the same period, the two investment components evolved almost in a parallel way over the whole period (1973-2000). This is not surprising since the two investment components are interdependent.
we propose now to empirically estimate impact of the user cost of capital, among other explanatory variables, on investment in machinery and equipment as well as on investment in construction.

### 5.2. Reaction of Investment to the user Cost of Capital and other Explanatory Variables: An Empirical Analysis

Since the user cost of capital aggregates information on tax and non-tax incentives available to firms, empirical analysis of its impact on investment aims at assessing effects of such incentives on capital accumulation. Since the user cost of capital is only a partial factor that may explain investment activity, we have introduced other explanatory variables selected in line with economic theory as well as specificities of the Moroccan economy (for further details, see Easterly, 1994; Morandé and Schmidt-Hebbel, 1994; Aschauer and Lächler, 1998, Mansouri, 2000, 2001, 2003a, 2003b, 2003c, 2003d). In addition to the user cost of capital ($U_CK$), selected explanatory variables of investment are as follows:

- public capital stock ($Kg$) computed following Easterly’s formula according to which initial year capital stock in the two sectors can be “determined as a ratio to GDP in that year, with the ratio given by the average over the period of the ratio of investment to GDP divided by the sum of the average rate and the depreciation rate” (see Easterly, 1994 : 264). Assuming an annual depreciation rate of 5 percent, capital stocks for the subsequent years are determined as previous year’s capital stocks multiplied by (1 minus the depreciation rate).
investment-based exchange rate \((\lambda I)\) computed, as in Mansouri (2003a), as the price index for imported investment goods, divided by the implicit price index of gross fixed capital formation;

Accordingly, equation of the ratio \((ime)\) to GDP of investment in machinery and equipment may be written as follows:

\[
ime_t = a_0 + a_1 UCK_t + a_1 \log(Kg_t) + a_2 \log(\lambda I_t) + \varepsilon_t
\]

In line with economic theory and recent empirical findings for developing countries, the signs of coefficients associated with the variables \(UCK\) and \(Kg\) are ambiguous. Indeed, while economic theory predicts that increasing user cost of capital would negatively affect private investment, recent empirical works have argued that investment is insensitive to interest rates and other determinants of the cost of investment. Concerning public capital stock, its impact would depend on the degree of substitutability or complementarity with private investment. If public investment completes rather than competes with private investment, capital accumulation in the public sector would crowd-in private investment. In the adverse case, private investment would be crowded-out by public investment (on this issue, see Khan and Reinhart, 1990, Greene and Vellanueva, 1991; Aschauer and Lächler, 1998; Mansouri, 2001, 2003a). as for impact of investment-based real exchange rate, its expected impact would be negative, especially in a context where an important fraction of machinery and equipment is imported from abroad. In such a context, real devaluation, that is a jump in \(\lambda I\), will result in increasing prices of investment goods, denominated in local currency.

Before estimating equation (12), we have conducted unit root and cointegration tests. ADF stationarity tests reveal that all variables of equation (12) are integrated of order 1, suggesting that variables may be cointegrated\(^6\). Johansen cointegration tests show that variables are effectively cointegrated and that the cointegrating vector is unique\(^7\). In the cointegrating equation, public capital stock is seen to exert positive and

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\(^6\) ADF test shows that investment in machinery and equipment (in proportion to GD) is seen to be non-stationary in level (number of lags = 0; the absolute value of t-statistic of the coefficient associated with the lagged-one period of the dependent variable in the ADF equation is estimated to be around 3.43, largely less than the absolute value of Mackinnon critical value (3.60) at 5 percent of significance). The user cost of capital in the sector of machinery and equipment is seen to be also non-stationary in level (number of lags = 1; the absolute value of t-statistic of the coefficient associated with the lagged-one period of the dependent variable in the ADF equation is estimated to be around 2.18, largely less than the absolute value of Mackinnon critical value (2.97) at 5 percent of significance). Similarly, the natural logarithm of public capital stock is seen to be non-stationary in level (number of lags = 1; t-statistic = -2.39; Mackinnon critical value at 5 percent level = -3.58). The natural logarithm of investment-based real exchange rate is also not integrated of order 0 (number of lags = 0; t-statistic = -2.65; Mackinnon critical value at 5 percent level = -2.98). In all cases, the number of lags has been chosen so as Akaike information criterion is minimized, and intercept and trend are introduced in the ADF equation if they are statistically significant. Moreover, all ADF tests show that the four variables are integrated of order 1.

\(^7\) Johansen cointegration test shows that in the unique case where Eigen value equals 0.68, the likelihood ratio amounts to 57.77, going beyond 1 percent critical value which is estimated to be around 54.46. In the cointegrating equation as well as in the VAR considered to conduct Johansen test, intercept is statistically significant. The selected number of lags in the VAR equals 1.
statistically significant impact on investment in machinery and equipment while investment based real exchange rate is seen to have negative and statistically significant impact on this kind of private investment. As for our central variable, that is the user cost of capital ($UCK$), its impact is seen to be negative and relatively statistically significant. However, because variables are integrated of order 1 and there is a cointegrating vector, to examine short and long-run effects of variables on the ratio to GDP of investment in machinery and equipment, we have specified an error-correction model. Estimates and tests have yielded the following empirical results:

$$\Delta ime_t = -0.02 \Delta UCK_t + 0.21 \Delta \log(Kg_t) - 0.18 \Delta \log(Kg_{t-1}) - 0.03 \Delta \log(\lambda I_t) - 0.36 ECT_{t-1}$$  \hspace{1cm} (13)

\[ \begin{array}{c} 
(-0.63) \\ 
(4.67) \\ 
(-4.05) \\ 
(-2.17) \\ 
(-2.41) 
\end{array} \]

$R^2 = 0.71$; adjusted $R^2 = 0.65$; F-statistic $= 13.04$ (prob. $= 0.00001$); Durbin-Watson $= 2.01$; Residual Normality Test : Jarque-Bera $= 0.88$ (prob. $= 0.64$); White Heteroskedasticity Test : F - statistic $= 2.50$ (prob. $= 0.09$), number of observations $X R^2 = 16.46$ (prob. $= 0.11$).

The error correction model in equation (13) shows that the user cost of capital does not exert any statistically significant short-term impact on investment in machinery and equipment, even though tests indicate that its overall impact is negative and statistically relatively significant (Wald test: F-statistic $= 2.95$; probability $= 0.07$; $\chi^2 = 5.91$; probability $= 0.052$). Its impact is however exerted in the long-run (Wald test: F-statistic $= 5.80$; probability $= 0.025$; $\chi^2 = 5.80$; probability $= 0.016$) while its short-term impact is weak and statistically non-significant (Wald test: F-statistic $= 0.39$; probability $= 0.53$; $\chi^2 = 0.39$; probability $= 0.53$). All these tests indicate, contrarily to the widespread idea, that the negative impact of the user cost of capital on investment is exerted only in the long-run while its short-run effect is lower and turns to be statistically non-significant.

To try different model specifications, we have tried to express capital accumulation in machinery and equipment in terms of stocks. In this framework, we have followed the measurement methodology examined and applied to the Moroccan case by Gray (1990). Applying this methodology, we have computed machinery and equipment capital stocks according to the following formula:

$$Kme_t = \frac{(1+d)}{(r+d)} Ime_t$$  \hspace{1cm} (14)

where $d$ refers to the economic deprecation of capital (estimated to be around 10 percent for machinery and equipment, computed as $d = \frac{1}{L}$, where $L = 10$ is the life period of capital), $r$ is the moving average of the rate of real economic growth over three years, and $Ime$ is investment in machinery and equipment.
Considering capital stock in machinery and equipment as the relevant dependent variable, this variable will depend on the same explanatory factors as in equation (12). Since all variables, according to ADF test, are integrated of order 1, cointegration relationships, interpreted as long-run equilibrium relationships, are possible. Effectively, Johansen test indicates that cointegration holds and the cointegrating vector is unique. In the cointegrating equation, public capital stock is seen to exert statistically significant crowding-in effects on machinery and equipment capital stocks, as proportions to GDP. Investment-based real exchange rate is seen to negatively affect machinery and equipment capital stocks, although this impact is statistically significant only at 8 percent level of significance. As for our central variable, that is the user cost of capital ($\text{UCK}$), its impact in the cointegration equation is seen to be negative but turns out to be less statistically significant (at 11 percent level). Since there is a cointegrating vector, relationships between machinery and equipment capital stocks and their main determinants should be conducted on the basis of an error-correction model. In the cointegrating equation, impact of public capital stock is seen to be positive and statistically very significant while impact of investment-based real exchange rate turns to be negative but not statistically very significant. As for the user cost of capital, which is the central variable in our research paper, its impact is seen to be negative but statistically not very significant. Our error-correction model may be written as follows:

$$
\Delta \left( \frac{Kme_t}{Y_t} \right) = -0.07 \Delta UCK_t + 0.27 \Delta \log \left( Kg_t \right) - 0.023 \Delta \log \left( \lambda I_t \right) - 0.96 ECT_{t-1}
$$

$$
(-0.83) \quad (1.66) \quad (-1.50) \quad (-4.80)
$$

$R^2 = 0.55$; adjusted $R^2 = 0.49$; F-statistic = 9.01 (prob. = 0.0004); Durbin-Watson = 2.02; Residual Normality Test : Jarque-Bera = 0.21 (prob. = 0.90); White Heteroskedasticity Test : F - statistic = 0.35 (prob. = 0.93), number of observations X R$^2 = 3.66$ (prob. = 0.89).

Equation (15) shows that public capital stock still exerts positive, although not very significant effects on capital accumulation in machinery and equipment, suggesting that public investment in Morocco is relatively concentrated in activities that complete rather than substitute for private investment. Investment-based real exchange rate is seen to continue to depress investment in machinery and equipment, although its impact is not statistically very significant (with 14 percent level of

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8- ADF test shows that capital stock (as a proportion to GDP) in the sector of machinery and equipment is seen to be non-stationary in level (number of lags = 1; the absolute value of the t-statistic of the coefficient associated with the lagged-one period of the dependent variable in the ADF equation is estimated to be around 2.27, largely less than the absolute value of Mackinnon critical value (2.98) at 5 percent of significance). The number of lags is selected so as Akaike information criterion is minimized. ADF test shows that the time-series is integrated of order 1.

9- Johansen cointegration test shows that in the unique case where Eigen value equals 0.68, the likelihood ratio amounts to 52.33, going beyond 5 percent critical value which is estimated to be around 47.21. In the cointegrating equation as well as in the VAR considered to conduct Johansen test, intercept is statistically significant. The selected number of lags in the VAR equals 1.
significance). This suggests that machinery and equipment capital stocks may decline in reaction to real devaluation.

The overall causality going from public capital stock to private machinery and equipment capital stocks is seen to be strong (Wald test: F-statistic = 11.85; probability = 0.0003; $\chi^2 = 23.70$; probability = 0.000007). The short-term causality is however somewhat lower (Wald test: F-statistic = 2.74; probability = 0.11; $\chi^2 = 23.74$; probability = 0.10). Thus, impact of public capital stock on machinery and equipment capital stocks is exerted mainly in the long-run (Wald test: F-statistic = 23.07; probability = 0.000008; $\chi^2 = 23.07$; probability = 0.000002).

As in the case of equation (13) where capital accumulation in machinery and equipment is expressed in flows, the user cost of capital is seen to not exert any short-term effects on machinery and equipment when capital accumulation is expressed in stocks, as highlighted through the lower t-statistic of the coefficient associated with $\Delta UCK$ in equation (14). Our correction model indicates that the negative effect of the user cost of capital on machinery and equipment capital stocks has likely hold only in the long-run.

Similar estimation and test methodologies are examined and applied to analyze reaction of investment in construction to the selected explanatory variables. More specifically, investment (in flow terms) in construction, as a ratio $(ic)$ to GDP, is regressed on its user cost of capital $(UCK)$, public capital stock $(Kg)$ as well as on investment-based real exchange rate $(\lambda I)$, as measured by Mansouri (2001, 2003a). ADF stationarity tests and cointegration tests show that all variables are stationary in first differences, cointegration holds and the cointegrating vector is unique. The cointegrating equation shows that public capital stock is seen to positively affect investment in construction, suggesting that this investment component reacts positively to crowding-in effects of public investment. Impact of investment-based real exchange rate is seen to be negative but statistically not very significant, suggesting that real devaluation does not influence construction in a context where major intermediate and investment goods are made locally. The estimated correction model may be written as follows:

\[\]
Our empirical results in equation (16) indicate that the user cost of capital does not significantly influence investment in construction, especially in the short-run (Wald test: F-statistic = 0.62; probability = 0.44; \( \chi^2 = 0.62; \) probability = 0.43). In conformity with implications of cointegration theory, the coefficient associated with the error-correction term \( (\text{ECT}_{t-1}) \) is negative and statistically very significant. Since the user cost of capital is not statistically very significant in the initial cointegrating equation, even the long-run impact of the user cost of capital on investment in construction turns to be not very significant. This suggests that tax and non-tax incentive policies in Morocco do not impact investment in this sector, especially in the short-run. By contrast, as highlighted in the cointegrating equation as well as in the error-correction model (equation 16), public capital stock, as measured, exert crowding-in effects on investment in construction. This suggests that investment in this sector is interested in physical and social infrastructure rather than in incentive policies, especially in the short-run. Indeed, in equation (16), the overall causality going from public capital stock to investment in construction is statistically very significant (Wald test: F-statistic = 6.13; probability = 0.008; \( \chi^2 = 12.26; \) probability = 0.002). short-term causality also holds (Wald test: F-statistic = 3.38; probability = 0.08; \( \chi^2 = 3.38; \) probability = 0.066). in the long-run, since the coefficient associated with public capital stock in the cointegrating equation is positive and statistically significant and the coefficient associated with the error-correction term in equation (16) is negative and statistically very significant, public capital stock is seen to crowd-in investment in construction in the long-run as well (Wald test: F-statistic = 7.20; probability = 0.014; \( \chi^2 = 7.20; \) probability = 0.0073). finally, as expected, investment-based real exchange rate is seen to exert no statistically significant impact on investment in construction. Contrarily to investment in machinery and equipment where major intermediate and investment goods are imported, investment in construction often uses locally produced goods. Consequently, impact of investment-based real exchange rate turns to be not significant in determining investment in this sector.

To try multiple specifications of our model, we have resorted to the measurement of capital accumulation in the construction sector in terms of stocks, using the same formula above (see equation 14) where investment in machinery and equipment \((\text{Ime})\) is replaced by investment in construction \((\text{Ic})\). The selected rate of economic depreciation for investment in construction is 5 percent against 10 percent for investment in machinery and equipment. As in the case of the other variables, the
construction capital stock \((Kc)\) as a proportion to GDP \((Y)\) is seen to be integrated\(^{12}\) of order 1. Johansen cointegration tests show that cointegration holds and that the cointegration vector is unique\(^{13}\). In the initial cointegrating equation, impact of the user cost of capital on construction capital stock (as a ratio to GDP) is seen to be negative but statistically non-significant. Impact of investment-based real exchange rate is seen to be positive but turns to be statistically non-significant. By contrast, impact of public capital stock is positive and statistically very significant (at 2 percent level of significance), suggesting that capital stock in the construction sector is sensitive to crowding-in effects of capital accumulation in the public sector. The error-correction model may be written as follows:

\[
\Delta \left( \frac{Kc_t}{Y_t} \right) = -0.31 \Delta UCK_t + 2.24 \Delta \log \left( Kg_t \right) - 3.44 \Delta \log \left( Kg_{t-1} \right) + 1.44 \Delta \log \left( Kg_{t-2} \right) + 0.10 \Delta \log \left( \lambda I_t \right) - 0.51 \Delta \log \left( \lambda I_{t-1} \right) - 0.72 \cdot ECT_{t-1} + 0.68 \Delta \left( \frac{Kc_{t-1}}{Y_{t-1}} \right)
\]

\[\text{(17)}\]

\[
\begin{array}{cccc}
\text{(-0.65)} & \text{(2.50)} & \text{(-2.57)} & \text{(1.96)} \\
\text{(-0.44)} & \text{(-1.92)} & \text{(-3.86)} & \text{(4.65)}
\end{array}
\]

\(R^2 = 0.80\); adjusted \(R^2 = 0.72\); F-statistic = 9.53 (prob. = 0.00008); Durbin-Watson = 1.98; Residual Normality Test: Jarque-Bera = 1.07 (prob. = 0.59); White Heteroskedasticity Test: F-statistic = 0.74 (prob. = 0.72), number of observations X \(R^2\) = 14.88 (prob. = 0.53).

Our error-correction-model (equation 17) shows that the user cost of capital has no short-term statistically significant impact on capital stock in the construction sector. Since impact of the user cost of capital in the cointegrating equation is not statistically significant, its long-run effect is seen to be non-significant as well even though the coefficient associated with the error-correction term \((ECT_{t-1})\) is negative and statistically very significant. This suggests that incentive measures in Morocco do not influence capital accumulation in the construction sector. By contrast, positive causality going from public capital stock to construction capital stock is seen to hold in the long as well as short run (Wald test: F-statistic = 8.19; probability = 0.0014; \(\chi^2 = 24.58\); probability = 0.000019). The short-run causality exists because the coefficients associated current and lagged values of Kg in equation (17) are statistically relatively significant and their sum is positive (Wald test: F-statistic = 2.37; probability = 0.09;

12- ADF test shows that capital stock (as a proportion to GDP) in the sector of construction is seen to be non-stationary in level (number of lags = 1; the absolute value of the t-statistic of the coefficient associated with the lagged-one period of the dependent variable in the ADF equation is estimated to be around 2.35, largely less than the absolute value of Mackinnon critical value (2.98) at 5 percent of significance).

13- Johansen cointegration test shows that in the unique case where Eigen value equals 0.68, the likelihood ratio amounts to 57.26, going beyond 1 percent critical value which is estimated to be around 54.46. In the cointegrating equation as well as in the VAR considered to conduct Johansen test, intercept is statistically significant. The selected number of lags in the VAR equals 1.
\( \chi^2 = 7.11; \) probability = 0.067). Similarly, long-run causality holds because the coefficient associated with the error-correction term is negative and statistically very significant (Wald test: F-statistic = 14.90; probability = 0.0012; \( \chi^2 = 14.90; \) probability = 0.00011). Finally, concerning investment-based real exchange rate, its short-term impact on capital stock in the construction sector is seen to be negative but statistically non-significant (Wald test: F-statistic = 6.20; probability = 0.074). Since impact of this variable is not statistically significant in the initial cointegrating equation, its long-run impact is seen to be non-significant even if the coefficient associated with the error-correction model (equation 17) is negative and statistically very significant in conformity with implications of the cointegration theory.

6. Policy Implications and Concluding Remarks

Contrarily to a widespread idea, the user cost of capital is seen to not exert significant effects on capital accumulation in the sector of machinery and equipment as well as in the sector of construction, independently of the methodology used to measure capital accumulation (flows against stocks). This suggests that incentive policies in Morocco do not significantly influence investment activity. In this sense, our empirical results give support to previous studies for developing countries where the user cost of capital does not surprisingly determine capital accumulation in the private sector.

By contrast, public capital stock is seen to crowd-in private investment in machinery and equipment as well as in construction, independently of the methodology used to measure capital accumulation in these two sectors (flows against stocks). This suggests in line with other empirical works (see for example, Faini, 1991, 1994; Mansouri, 2001, 2003a, 2003b, 2003c), that public investment, especially in physical and social infrastructure, would be the best policy to boost capital accumulation in the private sector.

Our empirical results also show that impact of investment-based real exchange rate may influence investment in sectors where intermediate and investment goods are imported rather than produced locally. In the construction sector where goods required for investment are domestically available, investment-based real exchange rate is seen to have no significant impact on investment whereas this variable is crucial in determining investment activity in the sector of machinery and equipment where goods required for capital accumulation are almost imported from abroad. Real devaluation is seen to crowd-out investment in machinery and construction while it exerts no significant impact on investment in construction. This suggests that Moroccan policy-makers should work for an exchange rate policy that is favorable for investment, especially within sectors that need imported technology.

Stronger inferences from time-series data can be drawn if data are available for a longer time. Indeed, unit root and cointegration tests are particularly sensitive to the
number of observations. Moreover, results of these tests may also change because of structural changes in the Moroccan economy. Our paper uses available statistical data over about twenty eight years, a period which is not quite long enough to run stronger tests and to account for structural changes. In future works, we will try to collect further data to enlarge the period sample and specific methodologies will be examined and applied to render quarterly the available data.

- **References**


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