ECONOMETRIC ANALYSIS OF THE IMPACT OF FINANCIAL VARIABLES ON INVESTMENT BEHAVIOR IN SUB-SAHARAN AFRICAN (SSA) COUNTRIES

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Abstract: *The objective of this paper is to propose an econometric analysis of the impact of financial variables on investment behavior in Sub-Saharan African countries. More specifically, the study estimates an investment function using cointegration techniques with a view to highlight the impact of Stock Exchange prices on the evolution of long-term investment and its determination in the short term. In order to take account of the effect on investment of the uncertainty in economic growth observed in recent years, we worked out several indicators of volatility in Stock Exchange prices of which, the real interest rate and the rate of growth of value-added.*

Keywords: *Financial assets, Investment, Risk, Uncertainty, Sub-Saharan African countries.*

1. INTRODUCTION

"God has given us two eyes to look at both supply and demand." By identifying the transmission channels between financial and real phenomena, Tobin has theoretically, but also empirically, indicated the effects of changes in the real value of financial assets on consumption and investment decisions. Thus, investment is a function of a firm's ratio of the market value of its liabilities and net worth to the replacement cost of its assets, a ratio also referred to as Tobin's q ratio. This ratio is the foundation of the theory of investment choice developed in 1969 by Tobin. When the q ratio is greater than 1(i.e. when the equipment is worth more than its replacement cost), it is in the best interest of enterprises to invest (for the increase in the stock market value will be higher than the amount invested), and to stop investing otherwise.

Contrary to most other theories of investment, Tobin's q ratio has the advantage of taking into account several factors such as the interest rate, profitability, and expectations, since these factors influence stock market prices or share prices. When the q ratio is smaller than 1, it may actually be more advantageous to acquire assets through a merger than to buy them. The recession of 1973 may be explained by the sharp fall in the q coefficient which was caused by tight monetary policies, and not by a shortfall in the supply of savings as maintained by the advocates of the new school of neoclassical economics.

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Far from being exclusively oriented towards demand, neoclassical synthesis according to Tobin, has attached too much importance to factors affecting long-term growth and to policies likely to give rise to full-employment equilibrium. The study of financial markets enabled Tobin to analyze the impact of financial events on the demand for real assets, in other words, on consumption and investment demands. Volatility is an indicator of the risk or uncertainty which confronts investors in capital markets. It is measured by previous changes in asset prices or deduced from models built to determine the prices of derivative instruments. Fluctuations in the prices of many categories of assets (financial, real-estate, etc.) have always varied from one economic region to another. If changes in asset prices in some regions of Africa (Northern Africa, Southern Africa etc.) were less significant than those recorded in Sub-Saharan African (SSA) countries, the Sub-Saharan economy was not spared by this phenomenon either.

This observation raises questions related to the existence of an eventual impact of these price changes on the real economy and to the possible implications for highlighting monetary policy. However, if we refer to works by Bario, Kennedy, and Prouve (1998), and Bri (1998) for a more explicit analysis of this issue, the exploration of asset price effects on aggregate demand up to now, has been the subject of only a few economic studies as far as sub-Saharan countries are concerned. The impact in the evolution of asset prices may be envisaged through the effects which transit by way of saving behavior. The econometric works of Poterba and Samwick (1996), Crouzille (2000) show that the positive and significant effect of the evolution of financial variables (stock prices) on the consumption decisions of households is limited in the case of North American countries, and the estimations carried out in the European context by Jaillet and Sicsic (1998) have not succeeded in highlighting significant effects. On the other hand, to our knowledge no econometric studies underlining the impact of economic variables on investment decisions in SSA countries have been carried out in recent years.

The theoretical approach envisages many transmission networks of asset prices to investment behavior. Keynes (1937) shows an asset price effect which transits via changes in Tobin's ratio, and which manifests itself by a change in the marginal profitability of capital. Then Brainard and Tobin 1968) define this quotient as the ratio of the stock market value of the enterprise to its capital stock value assessed at replacement costs. This means that any increase in the enterprise's stock market value leads to a rise in the anticipated value of expected profit flows in the future period. In this sense, the enterprise will then be willing to invest.

In a second approach, some authors such as Gertler and Hubbar (1988), Bernanke and Gertler (1989), Bernanke, Gertler and Gilchrist (1998), and Crouzille (2000) envisage an effect they develop in the context of financial accelerator models. They follow the approach of Fischer (1953) and the more recent studies by Minsky (1982), and Aglietta, Coudert and Mojon (1995) in the role of the effect of asset price changes in the analysis of activity cycles. The contribution of Bernanke and Gerttler (1989) constitutes the basic analysis for modelling the dynamic effects of the financial accelerator mechanism, insofar as it permits to highlight the median and central role of the net wealth borrowers in the dynamics of investment in when information asymmetry is present. Any reaction affecting the economy and entailing a change in the wealth of borrowers is amplified by the modifications which it implies on the conditions of access to the funding of borrowers.

The integration of the financial accelerator mechanism in modelling was proposed by Bernanke, Gertler and Gilchrist (1999) and Crouzille (2000), and the increase in interest rates

manifests itself though a collapse in the prices on asset markets, amplified by the resale of assets by indebted agents, as well as an increase in the charges linked to the borrowing rate, thus implying a reduction in projects and activity for enterprises. However, if investment is explained by using variables other than those linked to changes in production (i.e. the accelerator theory), this would permit to have a good understanting of investment behaviour.

Our preoccupation in this paper is essentially centred on the transmission mechanisms of changes in asset prices which occur through changes in Tobin's quotient.

This choice is motivated by Hubbard (1998) who observes that it is difficult to highlight the lessons drawn from financial accelerator models in the context of econometric studies using aggregate data. (In effect, with the exception of the theoretical model developed by Bernanke, Gotler and Gilchrist (1998), the theoretical implications of the financial accelerator are intended to explain the investment behaviour of a certain categories of firms which have financial constraints. If obtaining a positive impact of the changes in stock market prices on investment does not permit us to exclude *a priori* an interpretation of investment behaviour based on the financial accelerator effect, in our study we will use an interpretation based on the Tobin effect. Concurrently, we also analyze the impact of the volatility of financial variables on investment. A high volatility in stock market prices manifests itself through an increase in uncertainty in the economy. Two transmission channels may be mentioned.

On the one hand, we recognize with Dixit and Pindrich (1994) that the existence of the partial or total irreversibility of investment expenditures may compel enterprises to defer certain investment decisions in case an increase in uncertainty obtains; and according to Mittkin (1996) on the other hand, that a negative impact of uncertainty on investment may be explained by an exacerbation of information asymmetry problems on financial markets.

The fundamental purpose of this paper is to propose an econometric analysis of the impact of financial variables on investment behavior in SSA countries. This amounts to the question of confirming the significant impact of Tobin's quotient on investment as highlighted in recent works, and to explain the relationship between uncertainty and investment in the context of SSA countries. The purpose of this paper is twofold. Our objective is to shed some light on the asymmetry of financial markets in the context of developing countries, and then, to show the importance the Tobin q-ratio approach deserves by using it to specify our model of investment behaviour in SSA countries.

After a reminder of the theoretical and empirical framework of the effects of stock market prices on investment behaviour, a summary of the econometric literature is proposed in the first part of the study. Up to 1993, econometric studies generally concluded that Tobin's ratio has a limited impact on investment behaviour. However, the results of recent studies such as those of Bloch and Coeuré (1995), as well as Herbert and Michaudon (1999) lead us to qualify this result. We then propose and estimate, in the second part of the study, an econometric model of the impact of stock market prices and their volatility on investment. From 1993 onwards, econometric model estimations have led to a significant underestimation of investment behaviour. And yet, this period is characterized by strong economic, social, and political uncertainty, an influence which to our knowledge, has not been subjected to precise estimation.

1. THEORETICAL AND EMPIRICAL ANALYSIS OF THE IMPACT OF FINANCIAL VARIABLES ON INVESTMENT BEHAVIOUR

Concerns about questions linked to the existence of an eventual impact of price changes on the real economy, and about their implications on the implementation of monetary policy are not new (Se, Hayashi (1982), Gilchrist and Himmelberg (1995), Calmès (2004, 2005) and Eberly, Rebelo and Vincent (2008) works). In fact, developing countries and notably those of Sub-Saharan Africa, face problems of price effects on aggregate demand. There exist a vast literature on effects which transit through saving behavior and the evolution of stock market prices on the consumption decisions of households and estimation in the North American, European and African contexts. The differences in results observed in these continents are due to the structural differences of their economies.

Analyses of the effects of financial variables on investment behavior through economic experiences have been carried out in recent years for several reasons. Increasing attention is given to this research issue. That is the reason underlying the proliferation of studies dealing with these aspects.

1.1. Theoretical Approach to the Effects of Financial Variables on Investment Behavior

The analysis by Brainard and Tobin (1968) still remains the center of gravity which permits to highlight the role of movements in stock or share market prices on investment through changes in Tobin's quotient. In the neo-classical investment model, Abel (1979) proposes a formalization of this mechanism. This formalization leads to the establishment of an investment rule according to which investment is an increasing function of q (marginal quotient) which measures the marginal profitability of capital. However, a problem is associated with the estimation of this model and it is encountered when choosing an effectively real proxy of marginal q. A question arises as to which approach to use, and for which economy. In the case of SSA countries, two approaches may be used according to whether they retain Tobin's ratio as a proxy of marginal q or whether they propose to estimate the marginal profitability of capital.

According to Crouzille (2000), on the theoretical level, the model developed by Abel (1979) proposes the explicit integration of the costs involved in the installation of new capital units as in the process of capital accumulation in the framework of the Jorgenson (1963) neo-classical investment function because of the existence of internal costs. The latter are linked to the necessary break in the production process caused by the adjustment of the capital stock to its optimal level. Abel's (1979) model permit to rationalize Brainerd's and Tobin's approach in the context of inter temporal optimisation and to respond to the criticisms formulated against Jorgenson's model as concerns the ad-hoc nature of its specification and the duration of adjustment.

By choosing an analytic framework with taxes where financial decisions are taken independently of investment decisions, the objective of the enterprise is to maximize the present value of its profit over an infinite horizon under the capital accumulation constraint. If (a) is the discount rate, and (b), the rate at which capital depreciates, the maximization problem of the enterprise may be written as follows:

$$MAX \sum_0^\infty \Pi_t e^{-at} = \int_0^\infty \Pi e^{-at} \tag{1}$$

Subject to constraint $\qquad \dfrac{\partial K_t}{\partial_t} = I_t - bK_t \tag{2}$

Where Π_t is the net benefit or profit of adjustment costs. Net profits Π_t given equation:

$$\Pi_t = P_t \left[F(K_t, L_t) - g(K_t, L_t) - w_t L_t - P_t^K I_t \right] \tag{3}$$

Where $F(K_t, L_t)$ is the enterprise's production function, L_t is the necessary or used quantity of labor.

It is equal to income derived from the sale of output $(P_t F(K_t, L_t))$ net of the costs associated with the wages paid to labor $(w_t L_t)$, to the purchase of capital $(P_t^K I_t)$ and adjustment costs $P_t g(K_t I_t)$.

If I_t represents gross investment, w_t, the nominal wage rate, P_t^K, the price of investment goods, and Pt, the price of capital goods, then adjustment costs measure the loss evaluated at price P_t implied by the break in the production process due to the existence of costs (or changes) linked to the installation of new capital units, in accordance with the specification of adjustment costs initiated by Gould (1968) and Lucas (1967), and which consists of directly taking account of the function of adjustment costs in the profit function. Here, the cost function is an increasing and convex function of investment in accordance with the mathematical convexity principle. For a given capital stock, the unit installation cost is all the more important since the investment rate is important. The optimisation program and the optimality conditions linked to it may be given by:

$$X_t = \left[P_t(F(K_t, L_t) - g(K_t, I_t) - w_t L_t - P_t^K I_t + \lambda_t^K (I_t - bK_t) \right] e^{-at} \tag{4}$$

Where λ_t is the Lagrangian multiplier associated with the capital accumulation constraint, which is interpreted here as the implicit price of a unit of installed capital.

The optimality conditions linked to state variables K_t and L_t are given by:

$$\frac{\partial X_t}{\partial L_t} = 0 \Leftrightarrow P_t(F_t(K_t, L_t)) - w_t = 0 \tag{4.1}$$

$$\frac{\partial X_t}{\partial I_t} = 0 \Leftrightarrow -P_t^K + \lambda_t^K - P_t g_t(K_t, I_t) = 0 \tag{4.2}$$

$$\frac{\partial X_t}{\partial K_t} = 0 \Leftrightarrow -\frac{d(\lambda_t^K e^{-at})}{dt} \Leftrightarrow -\frac{d\lambda_t^K}{dt} + a\lambda_t^K = \left[P_t(F_K(K_t, L_t) - g_K(K_t, I_t)) \right] - b\lambda_t^K \tag{4.3}$$

$$\underset{t \mapsto \infty \, t}{Lim} (e^{-at\lambda_t^K K_t}) = 0 \tag{4.4}$$

F_Y and g_Y are the first derivatives respectively of the production function and the cost function relative to variable y, where $y = K, L$, and I

The derivation of the marginal quotient (q) is obtained from eq (4.3). This is a first order differential equation. By multiplying both sides of this equation by $(e^{-(b+a-\pi_K)t}$, we obtain

$$(q_t^* - (b + a - \rho_K)q_t)e^{-(b+a-\rho_K)^t} = \left[\frac{P_t}{P_t^K}(P_t F_K(K_t, L_t) - g_t(I_t, K_t)) \right] e^{-(b+a-\rho_K)^t} \tag{4.5}$$

Where $\rho_K = \dfrac{dP_t^K}{P_t^K}, q_t^* = \dfrac{dq_t}{dt}$, et $\theta = (b + a - \rho_K)$

Integrating both sides of Eq (4.5) between t and infinity yields:

$$\int_t^\infty (q_v^* - uq_v)e^{-uv}dv = -\int_t^\infty \frac{1}{P_t^K}\left[P_v(F_K(K_v, L_v) - g_K(K_V, I_v)\right]e^{-uv}dv \tag{4.6}$$

Where $\int_t^\infty (q_v^* - uq_v)e^{-uv} = \left[q_t e^{uv} \right]_t^\infty$

By using the transferability condition and replacing the expression obtained in Eq (4.6), we get

$$q_t e^{-ut} = \int_t^\infty \left[\frac{P_v}{P_v^K}(F_K(K_t, L_v) - g_K(K_v, L_v)) \right]e^{-uv}dv \tag{4.7}$$

By multiplying both sides of Eq (4.7) by e^k, we finally get the following equation of the marginal profitability of capital:

$$q_t = \int_t^\infty \left[\frac{P_v}{P_t^K}(F_K(K_v, L_v) - g_K(K_v, L_v)) \right]e^{-u(v-t)}dv \tag{4.8}$$

From the Lagrangion optimality conditions, we derive the optimal investment rule, as well as the expression if it's main determinant, which is the marginal q. This variable is given by the expression:

$$q = \frac{\lambda^K}{P^K} \text{ or against } q_t = \frac{\lambda_t^K}{P_t^K} \tag{4.9}$$

The marginal q is defined, according to Abel (1979) and several other authors such as Bedid (1984) Birger and Cynthia (1988), Shepherd (1986), Crouzille (2000) Gabe de Bandt and Diron (2007), and Saibalghosh (2007), as the present value of the net marginal flows of

future income generated by investment in a additional unit of capital. For a homogenous adjustment cost function of degree one, the optimal investment rule is given by:

$$\frac{I}{K} = \frac{1}{\theta}(q_t - 1) + \phi \tag{5}$$

Where θ is a constant and ϕ the adjustment cost function parameter.

Optimal investment is therefore a function of the present value of the discounted flows of the marginal profits generated by investment in an additional unit of capital. However the marginal q is not directly observable and one cannot directly deduce from its expression, the function econometrically testable by the investment rule. The main shortcoming in the estimation of Abel's (1979) neoclassical model is the need to choose a real proxy of the marginal profitability of capital.

1.2. Empirical Foundations of the Impact of Financial Variables on Investment Behaviour

To approximate the preceding model, following the results of Hayashi (1982) works, two solutions are proposed by two groups of authors. In the first group, authors such as Artus (1988), Epaulard (1993), and Reiffers de Gournay (1995), retain the average quotient (q) as an approximation (proxy) of the marginal profitability of capital. Interest in this variable is due to that it is directly observable, and constitutes under certain assumption, an effective and accurate proxy of marginal q. The second group of authors including Block and Coeuré (1995), Herbert and Michaudon (1999), Bond *et al.* (2004), propose the construction of a marginal q. But the average q ratio has a limited impact, for Tobin's q theory presupposes the existence of perfect financial markets. In effect, if the stock market value of a firm does not correspond to its real value, for instance, in the presence of a speculative bubble, then the results will be distorted, thus making this technique unusable.

According to Abel (1979) and Hayashi (1982), the conditions under which equivalence may be established between marginal *q* and Tobin's ratio are those of pure and perfect competition, where the production function is linearly homogenous relative to capital and labor. In this case the functional form retained for the adjustment costs function, is quadratic and homogenous of degree one relative to I_t and K_t.

Brainard and Tobin define average q as the ratio of the stock market value of the enterprise to the value of its capital stock (K) evaluated at its replacement costs. For the adjustment cost function, they adopt the following functional form:

$$F(I_t, K_t) = \frac{1}{2}b\left[\frac{(I_t - aK_t)}{K_t}\right] \tag{6}$$

And the optimal investment rule is given by:

$$\left(\frac{I}{K}\right) = \frac{1}{b}(q - 1) + c \tag{7}$$

Where $c = a - \dfrac{1}{b}$. The higher the value of parameter *b*, the higher adjustment costs associated with the installation of a new unit of capital are.

The main empirical results obtained by the preceding authors arrive at the conclusion according to which average q has positive effect on investment, but this effect is of limited magnitude. Crouzille (2000) finds that in Abel's (1979) model the weakness of coefficients may be interpreted as significant adjustment costs and they reflect, in case there is a shock, the slowness of the capital stock adjustment process to its optimal level. Greater attention should be given to the works of Epaulard (1993) and Reffers de Gournay (1995), insofar as only these econometric studies take account of the eventual problems generated by the non-stationary nature of the times series used. These authors propose to estimate Abel's (1979) model using the Engle and Granger (1987) two-step procedure. The validity test then consists of determining the presence of a co integrating relation between the rate of capital accumulation and the average q.

In the case of European countries, Epaulard (1993) and Reiffers de Gournay (1995) do not succeed in highlighting the existence of a long-term relation over the entire 1972-1991 estimation period.

They rather obtain different co integrating relations by dividing their study periods into several sub-periods. These authors attempt to underscore a behavioural change in Tobin's ratio before and after 1983. Epaulard (1993) succeeds in finding a co integrating relation between the rate of capital accumulation and Tobin's ratio over two periods. This experience is not evident when the average q is used.

The inability of the average q to account for the effective movement of investment lead Artus and Muet (1986) to in their estimations, variables such as the growth rate of value-added, the interest rate or the profit rate. They find that the presence of these variables is intended to account for the eventual existence of outlet or financial constraints which affect investment behavior[1]. Moreover, Epaulard (1993) discards the assumption of pure and perfect competition in favor of monopolistic assumption in his empirical applications.

In spite of the fact that they use different estimation techniques, the studies by Epaulard (1993) and by Reiffers de Gournay (1995) underscore an acceleration effect parallel to tobin's ratio, with an elasticity of the rate of accumulation almost equal to unity in the two studies. If a profit rate effect is obtained in the studies by Artus (1988) and by Reiffers de Gournay (1995), the use and explanation of the effects of this variable show-some weaknesses. The introduction of a profit term and its significance in an investment equation may have several interpretations.

Obtaining an investment equation which simultaneously includes both a q ratio measure and positive term, leads to an interpretation in terms of liquidity constraints. According to Hubbard (1998) and Schiantarelli (1995), if the q ratio measure does not yield a correct estimate of the marginal q, the significance of the profit term may be explained by the correlation that exists between that measure and the future profitability of an additional unit of capital.

Lastly, it is possible to underscore the existence a negative effect for the real interest rate on investment in the studies of Artus (1988) and Reiffers de Gournay (1995). A re-examination of the pertinence of Tobin's ratio on investment behaviour in various economic spheres would be appreciated.

Econometric studies by Bloch and Coeuré (1994, 1995), and Hubert and Michaudon (1999) propose the construction of a marginal q. They follow the methods initially developed by Abel and Blanchard (1986) by decomposing the q-ratio into three components. This procedure helps to distinguish the impact on the marginal q of anticipation linked to the future evolution of interest rates, and to changes in the return on capital. The first component is a profitability indicator, and it is measured by the after-tax profit rate discounted at a constant rate, which is the average discount rate over the period. The two other components reflect the anticipations of enterprises relative to the future fluctuations of real interest rates and to changes in the rate of return on capital around its historical average. The evolution of these three components is then formalized by an autoregressive vectorial process.

The studies by Bloch and Coeuré (1994, 1995) provide qualified results with limited impacts of Tobin's ratio on investment. These authors not only obtain a long-term relationship between the rate of capital accumulation and the marginal q, but they also arrive at the conclusion that the marginal q shows a more significant impact on investment than had been obtained until then. However, it is difficult to make any comparison between different studies as to the value of the elasticity relative to the marginal profitability of capital obtained. In fact, these studies differ in terms of the construction of the q-variable, the econometric method used, and the choice of estimation period.

The existence of a limited impact of financial variables and particularly of Tobin's ratio on investment behavior in Europe has for a long time been the main result and the center of gravity of numerous econometric studies such as those by Chang-Lee (1986), Artus (1988), Barry et al (1993), Epaulard (1995) and Reiffers de Gournay (1995). However, the results of recent studies such as those of Bloch and Coeuré (1994, 1995), Hurbert and Michaudon (1999), Crouzille (2000) and Ben Hamida (2006) call for a qualification of this conclusion, since they highlight the existence of a more significant of impact of the marginal q on investment. Even though these recent studies certainly improve on the explanation of investment behavior, it should be said that the evolution observed since a decade or so ago still remain largely unexplained (Chaton, 2001).

The objective of the present econometric study is three fold: it is a question of providing an eventual confirmation of the results obtained in recent studies. Unlike Bloch and Coeuré (1994, 1995), Herbert and Michaudon (1999), and Crouzille (2000), we will retain as an approximation (proxy) of the marginal q, the real value of stock market prices following the example of authors such as Barro (1990), Blanchard, Rhee and Summers (1993), Crouzille, Le Petit and Tarazi (2004), Gabe de Bondt, Diron (2007) and Saibal Ghish (2007). Then using the real value of stock market prices as a proxy for the marginal q, we will apply our econometric model in the case of SSA countries where appropriate economic indicators are available. Lastly, we attempt to highlight the impact of uncertainty on investment decisions. To that end, we will construct different indicator of stock on share price volatility.

2. FINANCIAL VARIABLES AND INVESTMENT BEHAVIOR: METHODOLOGICAL FRAMEWORK AND ECONOMETRIC ESTIMATION

The data used in our study consist of a panel of 11 SSA countries². The choice of these countries is justified by the existence in each these countries of a stock market. The dynamics of Regional

Securities Markets (RSMs) being different from one region to another in Africa we have, with a view to harmonization of calculations and to interpretation, considered only those countries where stock market capitalization of the RSMs exist, in spite of the large number of institutional investors. We have assumed that they behave as businesses which have free entry into the markets, and most of the firms that are present in the markets are the subsidiaries of firms quoted in European stock markets. Thus, we can capture a significant impact of Tobin's q on the dynamics of investment in that area.

The observation period goes from 1975 to 2006. The model of reference takes inspiration from that of Johansen (1988). The estimation of the impact of stock market prices on investment behavior is carried out using Johansen's approach. The latter approach consists firstly of searching for the existence of a cointegrating relation between investment and the different financial and real variables. This will lead us to highlight the existence of a long-term relation incorporating both real and financial variables. It is likely that the impact of stock market prices is significant in the short-term dynamics of investment.

In a second step, we turn our attention notably to the unusual behavior of investment since 1995. It will then be possible to arrive at conclusion that there exists a negative and significant impact of stock market price volatility on investment.

2.1. Specification of the Impact of Stock Market Prices on Investment Behaviour in SSA Countries

The objective here is to specify and to estimate the impact of the short-term and long- term models behaviour of investment, and to examine the eventual impact of uncertainty on investment decisions. The impact of these stock market prices on investment behaviour is analyzed first. The specification of a long-term relationship simultaneously integrating into the traditional accelerator effect, the real value of stock market prices and real long-term interest rates will also lead us to examine the short-term dynamics of investment behaviour.

2.1.1. Determination of Long-Term Investment Behavior

The models used to affect our tests are the following:

$$LogTAC_t = a + bLogTIR_t + cLogVRCB_t + dLogTCVA_t \tag{8}$$

$$LogTAC_t = a + bLogq_t + cLogTIR_t^1 + dLogTCVA_t \tag{9}$$

$$LogTAC_t = a + bLogq_t + cLogTIR_t^2 + dLogTCVA_t \tag{10}$$

Where

TAC = rate of capital accumulation

TIR^1 = real interest rate, which is equal to the nominal interest rate on private sector bonds minus the inflation rate of the consumer price index

TIR^2 = nominal interest rate on long-term government bonds

$TCVA$ = growth rate of value-added

q = average quotient

VRCB = real value of share (or stock) prices

Thus, we carried out cointegration tests using the TSP Eviews software package on two sets of variations integrating the logarithm of the capital accumulation rate (*TAC*), the real interest rate (*TIR*) (with two measures of the real interest rate: the real interest (*TIR*[1]) = the nominal private sector bond rate minus the inflation rate derived from the consumer price index, and *TIR*[2] = the nominal interest rate on long-term government bonds), the growth rate of value-added[1] (*TCVA*)[3] (See Appendix 1) and a proxy of Tobin's ratio.

For Tobin's variable, we alternately retain the average *q* adopted by Epaulard (1993) and Reiffers de Gournay (1995), or the log of the real value of share or stock market prices (*VRCB*). Each of the preceding models is estimated using Johansen (1988) multivariate method.

The functions are estimated using the quarterly data of 11 SSA countries over the 1975-2006 period. We use a synthesis of the existing available data published in the official reports of the RSMs of the UMOA, the Ghana Stock Exchange, the Nigeria Stock Exchange, the Nairobi Stock Exchange, the Malawi Stock Exchange, the Zambia Stock Exchange, etc.

The estimation results of the three cointegrating vectors are given in Table 1, 2 and 3. These results show the characteristic vector, the likelihood ratios, and the critical values at the 1% and 5% significance levels relative to the trace test. We denote by *i* the number of lags considered in the short-term dynamics associated with the cointegrating relation obtained, and by *n* the number of observation. In the three cases, the results show that the values of the likelihood ratios are higher than the critical values for the null hypothesis test of plus *r* = 0 cointegrating relation at the 1% significance level. Thus the null hypothesis of absence of a cointegrating relation. However, we cannot reject the null hypothesis of more than one cointegrating relation.

Tableau 1

Nul Hypothesis	Likelihood ratio	Critical value (5% level)	Critical value (1% level)	Characteristic values
Ho : r = 0	63.02	52.10	59.17	0.270
Ho : r =1	28.77	33.94	40.08	0.153

Number of logs i = 4; Number of observations n = 78, AIC = -11.8

$$LogTAC_t = -3.41 - 0.05 LogTIR_t^1 + 0.255 LogVRCB_t + 0.073 TCVA_t \qquad (10)$$

Tableau 2

Nul Hypothesis	Likelihood ratio	Critical value (5% level)	Critical value (1% level)	Characteristic values
Ho : r = 0	73.627	52.10	59.17	0.534
Ho : r =1	33.18	33.94	40.08	0.314

Number of logs i = 5; Number of observations = 40; AIC = -15.6

$$LogTAC_t = -1.92 + 0.416 Logq_t - 0.0146 LogTIR_t^1 + 0.043 TCVA_t \qquad (11)$$

Tableau 3

Nul Hypothesis	Likelihood ratio	Critical value (5% level)	Critical value (1% level)	Characteristic values
Ho : r = 0	61.2	52.10	59.17	0.218
Ho : r =1	27.26	33.94	40.08	0.142
Number of logs i = 4; Number of observation n = 89; AIC = -13.4				

$$LogTAC_t = -3.65 - 0.037 LogTIR_t^2 + 0.252 LogVRCB_t + 0.15 TCVA_t \tag{12}$$

Estimation of equation (12) takes account of the government bond rate rather than the rate of private sector bonds. The explanatory variables introduced into the investment function are: stock market prices expressed in real terms (*TVCB*), the nominal interest rate on long-term government bonds (*TIR²*), and the growth rate of value-added (*TCVA*).

The results of these cointegration tests in the context of SSA countries lead us to retain three main conclusions.

It is possible to underscore the existence of a long-term relation between investment and set of financial and real variables over the 1975.1 – 2004.6 for an estimation taking account of the real value of share prices, and over the 1985.1 – 2006.4 for the estimation incorporating the average q in the case of SSA countries.

As concerns the three relations, we obtain positive impacts of the growth rate of value-added and negative impacts of the real interest rate on investment. The accelerator effect usually highlighted in econometric estimations of investment behavior in Europe is also found in SSA countries.

Moreover, we obtain a positive impact of the average q and of the real value of share prices on investment. Thus, an increase of 10% in the real value of share prices generates a rise of 2.5 percentage points in the rate of increase of capital.

In consequence, we think that if the impact of the real interest rate and of Tobin's ratio on long-term investment behavior has been underlined in previous economic studies (Artus (1988), Epaulard (1993), Reiffers de Gournay and Crouzille (2000), that of the real value of share or stock market prices has not been sufficiently emphasized. Likewise, the value of the long-term elasticities of the rate of capital accumulation relative to share prices and to the real interest rate combine to provide financial variables with a very strong impact on investment.

The result obtained in the long-term relation provide a confirmation of the significance or relevance of the traditional explanatory variables of investment, including the importance of financial variables underscored by the recent studies of Crouzille (2000) on investment. However, is this confirmation of the long-term relation different or identical in short-term dynamics?

2.1.2. Impact of Financial Variables on the Short-Term Dynamics of Investment

Here, we only consider the significant impacts in the results derived from equations (10), (11) and (12). We only report the meaningful (or significant) effects. We denote by ECM1 (13), ECM2 (14), ECM3 (15), the error correction models associated with the cointegrating relations

(10), (11), and (12). These models are given by the following ECM1 (13), ECM2 (14) and ECM3 (15) equations:

$$\Delta LogTAC_t = -0.0013 - 0.007 Res_{t-1} - 0.175\ \Delta logTAC_{t-3} + 0.048\ \Delta logVRCB_{t-1}$$
$$ (-0.961) (-2.71) (-2.16) (2.56)$$

$$+\ 0.055\Delta logVRCB_{t-2} + 0.06logVRCB_{t-6} - 0.004\Delta logTCVA_{t-1} - 0.124 Dum87.1 (13)$$
$$ (2.17) (3.9) (-2.61) (-7.88)$$

$R^2 = 0.63$; JB = 5.03 (p = 0.07); ARCH $N^2(2)$ = 1.51 (P = 0.18); AIC = -4.05; Breuch-Godfrey $N^2(1)$ = 0.59 (p = 0.6)

$$\Delta LogTAC_t = -\ 0.0018 - 0.151 Res_{t-1} + 0.310\Delta logTAC_{t-3} - 0.192\Delta logq_{t-2} + 0.03\Delta TCVA_{t-1} (14)$$
$$ (-1.16) (-3.98) (2.65) (-2.72)$$

$R^2 = 0.73$; JB = 1.39 (p = 0.49); ARCH N^2 (1) = 0.19 (P = 0.74); AIC = -5.44; Breuch-Godfrey N^2 (2) = 0.46 (p = 0.55)

$$\Delta LogTAC_t = -\ 0.13 - 0.092 Res_{t-1} - 0.15\Delta logTAC_{t-1} - 0.17\Delta logTAC_{t-4} - 0.005\Delta logTCVA_{t-1}$$
$$ (-1.19) (-3.59) (-2.24) (-2.29) (-2.16)$$

$$+\ 0.047\Delta logVRCB_{t-1} + 0.074\Delta logVRCB_{t-6} - 0.136 Dum87.1 + 0.121 Dum87.3 (15)$$
$$ (2.00) (3.71) (-5.91) (5.32)$$

$R^2 = 0.52$; JB = 3.65 (p = 0.23); ARCH N^2 (1) = 1.78(P = 0.169); AIC= -5.15; Breuch-Godfrey N^2 (2) = 0.56(p = 0.68)

We denote by ΔX, the first difference of the volatility of X. The t-statistic value is reported between parentheses under the value of each coefficient. The value of the cointegrating equation's residual lagged one quarter is Res_{t-1}. *Dum*84.2 and *Dum*84.3 are two dummy variables corresponding respectively to the 2nd and 3rd quarter of year 1984 and zero otherwise. They are intended to take account of perturbations generated by the events of 1984 in the short-term dynamics of investment[4]. The summary statistics presented are the values of the coefficient of determination (R^2), the Akaike information criterion (AIC), as well as the test of normality of Jorque Bera, serial correlation with the Lagrange Breuch-Goffrey tests and the absence of the ARCH effects test carried out on the regression residuals. Degrees of freedom for each test are reported between parentheses.

Following the t-statistic value, we report between parentheses, the value of the critical probability (p) associated with each test. When p is small this implies that the probability of wrongly rejecting the null hypotheses is small. Following the results of these different tests, it may be said that the three error correction models do not show apparent signs of serial correlation. Moreover, there is no significant ARCH effect present. In contrast, normality of residuals tests shows quite unconclusive results. For instance, for equation (13) above, it is possible to reject the null hypothesis of normality at the 10% significance level.

In the short-term dynamics of equation (10), lagging share price changes one, two and six periods, provides significant information in the explanation of investment behavior.

The total value of the short-term elasticity of the rate of capital relative to share prices was estimated at 0.16. This indicates a positive and significant impact of share prices on investment

behavior determination, not only in the long-term, but also in the short-term dynamics. The error correction model (11) shows a significant effect of changes in the average q or investment, but it has a negative sign.

In the error correction models ECM (10) and ECM (12) the value-added growth rate is a relevant variable in the explanation of long-term investment behavior, but even though its influence in the short-term is significant, it is quite weak and has a negative sign. Thus, the strength of the feed back mechanism remains weak for error correction models ECM (10) and ECM (12). This weakness reflects a slow adjustment over the long-term, in case a shock occurs.

The results arrived at confirm the pertinence of the impact of financial variables, and more particularly, the stock market prices highlighted in some recent studies on investment behaviour, such as those of Chung, Wright, and Charoenwong (1995), and Chaton (2001). Next, we deal with the existence of a significant relationship between uncertainty and investment decisions.

2.2. Investment and Uncertainty

SSA counties have been characterized by significant uncertainty for more than a decade, both on the economic and political levels. For the reason, it is opportune to propose an estimation of the impact of uncertainty on investment behavior in these countries over our study period, which is divided into two sub-periods.

2.2.1. Investment Behaviour Since 1985

Starting from about 1987, SSA countries economies have witnessed a significant degradation in the performance of traditional estimations of investment. According to data from the African Development Bank (ADB) (from 1987 to 1992), FMI (from 1984 to 2007), investment is underestimated. To explore the factors that may explain such a phenomenon, we introduce a dummy variable *Dum91* taking on the value of 1 from the first quarter of 1991 and zero otherwise in the error correction model (12). The error correction model is given by equation (16):

$$\Delta LogTAC_t = -\underset{(-2.8)}{0.138} - \underset{(-5.1)}{0.08Res_{t-1}} - \underset{(-2.94)}{0.15\Delta logTAC_{t-4}} + \underset{(-3.30)}{0.008\Delta logTIR_{t-2}} + \underset{(3.4)}{0.060\Delta logVRCB_{t-1}}$$

$$+ \underset{(4.11)}{0.007\Delta logVRCB_{t-6}} - \underset{(-7.26)}{0.137\text{Dum }87.2} + \underset{(7.21)}{0.122Dum87.3} - \underset{(-2.25)}{0.016Dum91} \qquad (16)$$

$R^2 = 0.441$; JB = 0.2 (p = 0.95); ARCH N^2 (5) = 5.77 (P = 0.38); AIC = -8.27; Breuch-Godfrey N^2 (2) = 13.28 (p = 0.15)

A negative and significant effect of the dummy variable is obtained. In addition, the values of significant coefficients in the short-term dynamics has remained unchanged relative to those obtained in previous models, the size of feedback mechanism coefficient has strongly increased.

These results lead us to the impact of uncertainty on investment behavior in SSA countries. In fact, during the period, a significant share of investment behavior remains unexplained. SSA countries'economics are confronted with economic and political uncertainty. The wind of democracy blows in several countries and creates a situation with economic and uncertainty.

Apart from the conditions of investment financing and the influence of uncertainty, two other factors may explain the low level of private investment in SSA countries, namely the shortfall in demand, and the level of factor costs. In effect, potential domestic demand in these countries is relatively low, for their buying power remains relatively low. The impact of uncertainty on investment behavior in these countries is highly significant.

2.2.2. Impact of Financial Variables' Volatility on Investment Behavior

To explain the link between macroeconomy uncertainty and investment, we introduce an indicator of stock market prices volatility in the short-term dynamic investment model. The construction of several volatility indicators is effected. The first measure of volatility is constructed by determining a series of moving standard deviations of the log of the real value of stock prices (see Graphic 1 below).

Graphic 1: Standard Deviation of the Real Value of Stock Prices in SSA Countries
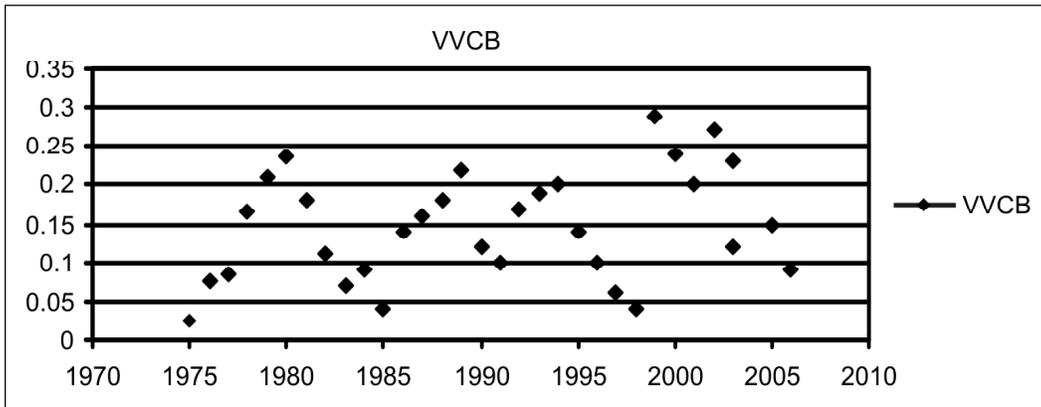
Source: Calculations by the author from $VVRCB = [(VRCB - MAVA (VRCB, 6)^2]^{1/2}$, where *VVRCB* is the standard deviation of the real value of stock prices, and *MAVA* (x, i) is the moving average of the variable x of the i preceding periods.

By taking account of the statistical properties of financial asset price movements (continuous variability, independence over time, cyclical and persistent phenomena etc), a second indicator of volatility is developed by using ARCH modelling. It emerges that only the first indicator (above) has a significant impact on short-term investment behavior. The error correction model ECM (12) obtained is given by equation (17) below

$$\Delta LogTAC_t = -0.10 - 0.08Res_{t-1} - 0.15\Delta logTAC_{t-2} + 0.005\Delta logTIR_{t-2} + 0.06\Delta logVRCB_{t-1}$$
$$\quad\quad\quad (-5.7)\quad\quad (-5.3)\quad\quad\quad (-2.78)\quad\quad\quad\quad (-2.20)\quad\quad\quad\quad (2.45)$$

$$+ 0.046\Delta logVRCB_{t-2} + 0.09\Delta logVRCB_{t-6} - 0.07\Delta logVVRCB_t - 0.13Dum87.2 -$$
$$\quad (2.5)\quad\quad\quad\quad\quad (3.6)\quad\quad\quad\quad (-2.20)\quad\quad\quad\quad (-9.04)$$

$$0.156Dum87.3 \tag{17}$$

$R^2 = 0.701$; JB = 1.10 (p = 0.54); ARCH N^2 (1) = 0.003(P = 0.0.96); AIC = –8.27; Breuch-Godfrey N^2 (6) = 21.8 (p = 0.0005)

We thus highlight a negative and significant impact of stock prices volatility on investment behavior. However, even though the standard deviation of the real value of stock prices provides significant information in the explanation of investment behavior, the indicator constructed with an ARCH specification is not significant.

It appears that the introduction of share prices volatility causes a loss in significance for the dummy variable D*um*87. But, in the context of the present study, it is not possible for us to underline an uncertainty effect of greater significance either before 1987 or after this date. The year 1987 was marked by demands which strongly affect the returns on investment of economic agents. In SSA countries, to emphasize the importance of profitability calculations in investment decisions in the sense of Malinvaud (1987), uncertainty must be reconciled with the irreversibility of investments. Production capacities cannot adapt themselves instantaneously to changes in the economic situation (i.e. irreversibility), and it is costly for a firm to have excess or insufficient capacity. However, there is no change in the results obtained previously.

However, there is no, change in the results previously arrived at. We still observe the fact that share price changes still have a significant impact on short-term investment dynamics. The absence of changes in the impacts obtained in the two preceding error correction models, shows that the introduction of both volatility indicators provides information that is relevant and independent from that given by previous estimations.

The decision to invest then consists in determining an average production capacity utilization rate based on expected demand, and on the risk linked to the expectation error (i.e. uncertainty). Profitability is all the lower since expected demand is modest and uncertain. The comprehension of the investment behaviour of firms is that which explores the link between uncertainty and investment decisions. The magnitude of the impact of uncertainty affects capital expenditures which are irreversible. And yet, the business environment in SSA countries is characterized by several forms of uncertainty (about prices, market outlets, interest rates etc.), ambiguities, and hazards (corruption, opacity and lack of information etc.). browse through the complex regulations of the administrative machinerries in SSA countries, increase the costs of commercial transactions. Either these costs are passed on to the consumer through price rises, a decrease in the quality of the goods, or they keep some firms from penetrating into the markets. Similarly, when it is corrupted, the judiciary limits the capacity of firms to enforce contracts which is detrimental to the good operation of the system, and puts obstacles in the way of new market outlets.

On a purely theoretical level, two interpretations may be retained to explain the existence the negative effect of share price volatility on investment behavior.

The first interpretation may be given in terms of the new approaches to the asymmetry of information. According to Mishkm (1996) and Ghoch (2006), among to five factors which start up a period of financial instability, the increase in uncertainty and the exacerbation of the problems linked to the asymmetry of information it induces, can affect investment decisions. The second interpretation is based on the irreversibility effect. The development of irreversible investment models in the last 25 years (Mc Donald and Seigal (1986), Pundick (1988), and Dixit and Pyndick (1994) dwell notably on the effects linked to the irreversible nature of certain investment decisions in the presence of uncertainty. It is therefore necessary to extend the specification of

models which attempt to explain business investment behaviour by taking uncertainty and irreversibility into consideration (Pindyck, 1989).

For instance, in the presence of total irreversibility of certain categories of investment expenditures, a rise in uncertainty increases the opportunity cost of investing at time t in an irreversible manner.

Traditional analyses of investment decisions postulate that a project is carried out if the sum of the present value of its expected receipts exceeds it cost. But one must realize that in SSA countries, the parameters which come into the calculation of the net present value are not known with certainty. These parameters notably include the future levels of demand, the selling price, and the interest rate which serves as a discount rate. In addition to neglecting to take account of the uncertainty linked to these parameters, traditional analyses implicitly assume that the investor can only choose between carrying out the project immediately and giving it up once and for all.

Corruption, for instance, increases the cost of doing business because it acts as an additional turnover tax). According to Sullivan *et al.*, (2007), the time and money spent to obtain the favours of government officials and to browse through the complex regulations of the administrative machineries in SSA countries, increase the costs of commercial transactions.

The enterprise chooses to postpone its expenditures; which generates a reduction in current investment, for the reaction of share prices depends on the quality of the investment opportunity (Chung, Wright, and Charoenwong (1995), and on the internal and external program of the enterprise (Saibal-Ghosh, 2007).

CONCLUSION

The objective of this paper was to propose an analysis of the impact of financial variables on investment behavior in Sub-Saharan African (SSA) countries. The paper attempted to find out whether Tobin's ratio had a significant impact on investment. The proposed estimation permit to draw important conclusions: share prices impact significantly on the short-term and long-term evolution of investment in SSA countries. An investment function is thus obtained, which concurrently takes account of an acceleration effect and of the significant effects of financial variables. Exogeneity test results effectively show the strong exogeneity of the real interest rate, the real value of share prices, and the value-added growth rate (See appendix 2).

The short and long-term elasticities of the accelerator rate in relative to the real value of share prices obtained from our estimation results indicate the significant influence of the sphere of finance on real activity. This result confirms the conclusions arrived at by Herbert and Michaudon (1999) and Crouzille (2000). It also qualifies the observation usual made about the fact that financial returns are either insignificant or slow to come by in SSA countries. Moreover, the exploration of the link between uncertainty and investment has helped to highlight the existence of a negative and significant effect on investment in SSA countries where uncertainty usually prevails owing to political and economic instability. This result corroborates the observation that these countries have witnessed low levels of investment in the past two decades or so. With this in mind, a further development or extension of this study would consist of an in depth analysis of the effects underscored in this study by using an approach that uses the individual data of enterprises.

APPENDIX 1

NOTES

1. Here, the cointegrating relation includes quarterly variables over 1975.1 – 2002.7 period. The rate of capital accumulation (TAC = I/K_{-1}) is retained for the behavior of investment. The explanatory variables introduced in the investment function are: share (stock) prices expressed in real terms (TVCB), the real interest rate (TIR), and the rate of growth of value-added (TCVA).

TAC = I/KN, where I = total FBCF (or Gross Fixed Capital Formation (GFCF) of enterprises and quasi-enterprises (in volume) in thousands 1986 CFAF, and KN = net capital of enterprises and quasi-enterprise in CFAF in 1986 (net sum of capital in construction or building and net capital in plant and equipment. Sources: BEAC and BCEAO, sector of enterprises' database.

TVCB = VCB/PPIB, where VCB = Industrial share price index (Sources: BEAC and BCEAO) data in statistical reports) and PPIB = GDP price deflator or base 1988 = 100 (sources BEAC and BCEAO, database of enterprise sector).

TI = rate of inflation;

TIR^1 = TR – TI, where TR is the yield on private sector bonds;

TIR^2 = TR2 – TR, where TR2 is yield on government bonds

(Sources: financial statistics of IMF, BEAC, BCEAO)

TCVA = where VA is value-added in terms of volume

(Sources: BEAC and BECEAO)

Unit Root Tests Results

The sequential tests strategy proposed by Jobert (1992) is used to identify the degree of integration of time-series, and whether the series are stationary or not. The synthesis of unit root tests results is presented in Table 6 over the 1975.1 – 1991.4 period, for series in levels (N), and in first differences (D).

Moreover, we reported the t-statistics of the coefficient respectively for the equations: (1) model with a constant and a deterministic trend; (2) model with a constant; and (3) model with neither a constant nor a trend, as well as the number of lags retained (i)

Note: The t-statistic values related to the constant and to the trend are only reported when they are significant.

Table 4
Unit Root Tests Result

	1		2		3	
	N	D	N	D	N	D
TAC*	(-2.10 ; 3)	(-5.2 ; 3)	(-1.1 ; 3)	(-5.6 ; 3)	(0.7 ; 3)	(-3.98 ; 3)
TVCB*	(-1.15 ; 1)	(-9.2 ; 1)	(-1.2 ; 1)	(-7.7 ; 1)	(-1.7; 1)	(-9.1 ; 1)
TVA*	(-4.18 ; 4)	(-7.81 ; 4)	(-5.02 ; 4)	(-4.18 ; 4)	(-0.30 ; 4)	(-5.2 ; 4)
TIR^1*	(-2.2 ; 4)	(-3.99 ; 4)	(-0.8 ; 4)	(-5.02 ; 4)	(-0.30 ; 4)	(—5.2 ; 4)
TIR^2*	(-1.4 ; 4)	(-4.8 ; 4)	(-1.2 ; 4)	(-4.98 ; 4)	(-0.65 ; 4)	(-6.11 ; 4)
Lq**	(-1.72 ; 0)	(-8.01 ; 0)	(-0.59 ; 0)	(-4.98 ; 0)	(-1.1 ; 0)	(-6.20;0)

*The critical values for N = 87 at the 1%, 5% and 10% levels, for models 1, 2 and 3, are the following: (-5.042; -4.33) for model 1 (-4.28; -2.45; -2.4) for model 2, and (-3.53; -1.67; -1.57) for model 3.

** The critical values for N = 40 at the 1%, 5% and 10% levels for the three models are respectively: (-4.12; -4.37; -3.18) for model 1, (-3.68; -2.77; 2.49) for model 2, and (-2.60; -1.79; -1.66) for model 3.

APPENDIX 2

Strong Exogeneity Tests

Given the results of strong exogeneity tests, it may be said that the real interest rate, the real value of share prices, and the growth rate of value-added are strongly exogenous.

The nature of the function is determined by the procedure adopted by Engel *et al.*, (1990) and by Bonnel *et al.* (1995) in carrying out strong exogeneity tests. The estimated equation was the investment function, which is an equation for the determination of the real interest rate or the real value of share prices, for the long-term equation of the real value of share prices and of the real interest rate is not usual.

The results of exogeneity tests on the cointegrating equation (16) and the error correction model ECM (16) are the equation Ex (1), Ex (2) and Ex (3) below:

$$\Delta R = \underset{(0.66)}{-0.06} + \underset{(5.2)}{0.46 \Delta R_{t-1}} - \underset{(-1.82)}{0.113 \Delta R_{t-2}} - \underset{(-2.9)}{0.33 \Delta R_{t-4}} + \underset{(0.99)}{0.092 \Delta R_{t-5}} + \underset{(3.25)}{0.61 Res_{t-1}}$$

$$+ \underset{(1.8)}{4.18 \Delta TAC_{t-1}} \qquad\qquad\qquad \text{Ex1}$$

$R^2 = 0.288$; White F = 0.88 (p-value = 0.62)

$$\Delta VCB_t = \underset{(0.18)}{0.0014} + \underset{(3.30)}{0.292 \Delta VCB_{t-1}} \qquad\qquad\qquad \text{Ex2}$$

$R^2 = 0.082$; White F = 0.0776 (p-value = 0.95)

$$\Delta TVA_t = \underset{(-0.78)}{-0.049} + \underset{(1.68)}{2.98 \Delta VCB_{t-2}} + \underset{(2.56)}{0.129 \Delta TVA_{t-1}} - \underset{(-6.62)}{0.5 \Delta TVA_{t-4}} + \underset{(-1.92)}{6.77 \Delta TAC_{t-3}}$$

$$- \underset{(-3.12)}{9.72 \Delta TAC_{t-4}} - \underset{(-1.83)}{0.26 \Delta R_{t-4}} + \underset{(-2.02)}{0.29 \Delta R_{t-5}} \qquad\qquad\qquad \text{Ex3}$$

$R^2 = 0.312$; White F = 0. 725 (p-value = 0.80)

By considering R*es*(Ex (1))$_{t-1}$, R*es* (Ex(2))$_{t-2}$, R*es* (Ex(3))$_{t-3}$ as the quarterly lagged values of the residuals of equations Ex(1), Ex(2) and Ex(3), we do not observe the significance of residuals. Thus the strong exogeneity hypothesis of the rate of growth of value-added, of the real value of share prices, and of the real interest rate is accepted. (See equation 18)

$$\Delta TVC_t = 0.02 - \underset{(-4.90)}{0.038} (TAC + 4.035 + 0.087 TIR - 0.416 TVCB - 0.118 TVA)_{t-1}$$
$$\underset{(2.1)}{}$$

$$- \underset{(-2.73)}{0.22 \Delta TAC_{t-1}} + \underset{(-2.19)}{0.089 \Delta R_{t-4}} + \underset{(1.81)}{0.0402 \Delta VCB_{t-2}} - \underset{(-7.16)}{0.137 Dum84} - \underset{(-2.8)}{0.012 Dum91}$$

$$- \underset{(-3.12)}{0.10 VVB_{t-1}} + \underset{(2.26)}{0.064 \Delta VCB_{t-8}} + \underset{(1.12)}{0.005 Res (Ex1)} + \underset{(1.74)}{0.004 Res (Ex2)}$$

$$- \underset{(-0.09)}{0.0002 Res (Ex3)} \qquad\qquad\qquad\qquad\qquad (18)$$

$R^2 = 0.379$; White F = 0. 698 (p-value = 0.78)

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