The flexible accelerator model of investment: An application to Ugandan tea-processing firms

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Abstract

The study uses the flexible accelerator model to examine determinants of the level and growth of investment in machinery and equipment for a sample of tea-processing firms in Uganda. Using a dynamic panel data model, we find that, in the long run, the level of investment in machinery and equipment is positively influenced by the accelerator, firm-level liquidity, and a favourable investment climate in the country. Depreciation of the exchange rate negatively affects investment. We conclude that firm-level strategies that increase output and profitability, and a favourable investment policy climate, are imperative to the growth of the tea industry.

Key words: accelerator model; fixed asset investments; Ugandan tea-processing firms

1. Introduction

Investment or capital accumulation is widely regarded as important in raising output and income at both the firm and national level. The private sector in Uganda has responded to macroeconomic policy reforms with private investment increasing by 13% per year on average from 1986/1987 to 1997/1998 (Collier & Reinikka 2001). The sectors that have attracted most investment in recent years are manufacturing, agriculture, forestry, fishing, construction and services. Inflows of foreign direct investment into these sectors have positively influenced economic growth in the country (Obwona 1997). The formal and informal manufacturing sector has experienced an average growth rate of 6.6% per annum and constitutes about 10% of GDP. The manufacturing sector is characterised mainly by the production of simple basic consumer goods. Capital goods industries are still few in number, while textiles, apparel and especially agro-processing are seen as promising industries (Ministry of Finance, Planning and Economic Development 2003). The Ugandan government has for long believed that diversification and promotion of value-added agricultural production is crucial to achieving favourable terms of trade. But most of the country's exports are still in raw form, with little or no value addition. This is in spite of the government's Medium-Term Competitiveness Strategy (MTCS), which was aimed at creating a favourable environment for increased private investment (Ministry of Finance, Planning and Economic Development 2000), and the Marketing and Agro-Processing Strategy (MAPS), which outlined priority areas for public sector intervention in agricultural marketing and agro-processing (Ministry of Finance, Planning and Economic Development and Ministry of Agriculture,

Animal Industry and Fisheries 2003). Therefore it is important for policy makers to understand the mechanisms through which government policy would systematically have an impact on private investment in agro-processing.

Tea is one of Uganda's major export commodities and its processing requires substantially larger investment than coffee and grain processing. Competitiveness of the tea sector would benefit from growth in investment in processing because production of high-grade tea is hampered by inadequate sorting machines, low withering capacity and a lack of adequate space for sorting, bulking and packing. This study focuses on value addition in a sample of tea manufacturing firms by exploring the current rate of investment in tea-processing machinery and equipment. Machinery includes rotavens, fermenters, dryers, boilers, pre-sorters, vibroscreens and lathe machines. Equipment includes weighing scales, thermometers, density meters, infrared moisture detectors and hygrometers.

Past studies, such as those by Reinikka and Svensson (1999; 2001) and Darku (2001), on investment behaviour by private firms have been based on a sample of firms from different sectors, without accounting for unobservable sector-specific factors. Other studies, such as that by Jenkins (1998), use only macroeconomic time series data to study private investment. This paper deviates from these studies by using firm-level panel data to examine the factors that have an impact on the level and growth of investment in machinery and equipment in a single sector. In addition, the paper provides further evidence of the appropriateness of the flexible accelerator model in studying investment behaviour.

2. Models of investment behaviour: A synopsis

Investment models usually distinguish two separate elements in the investment process: the determination of a desired capital stock and the specification of an adjustment process by which the gap between existing and desired capital stock is filled (Spyros 1983). Baddeley (2002) has provided a detailed description of the four theoretical models of investment behaviour, namely the accelerator theory, the neoclassical theory of Jorgenson, the q-theory of Tobin, and the option theory. These models typically introduce the effects of determining factors such as output, finance and prices through the desired capital stock, and the adjustment of capital to the desired level is considered an independent process.

The formulation of the accelerator model can be traced back at least to Clark (1917). Clark (1917: 234) explained that demand for capital "varies, not with the volume of demand for the finished product, but rather with the acceleration of that demand". Because of Clark's focus on quantity as opposed to price, his model is regarded as being 'Keynesian' in spirit and has been referred to as the rigid (simple) accelerator model of investment (Akkina & Celebi 2002). The rigid accelerator model explains investment as a function of output growth only and assumes that the desired stock of capital is attained in each time period. But because the model ignores the influence on investment of uncertainty, profits, financial factors and other variables, it has over time been reformulated into the so-called flexible accelerator model of investment (Goodwin 1948; Chenery 1952; Koyck 1954; Lucas 1967; Gould 1968; Treadway 1971). The model is flexible in the sense that it allows investment to vary with other relevant variables, including those related to uncertainty and market imperfections. This is especially important when analysing investment behaviour in developing economies [see, for instance, Wai and Wong (1982), Dehn (2000), Erden and Holcombe (2005), and Shih *et al.* (2007)]. Another important feature of the flexible version is that adjustment to the desired capital stock is not considered to be instantaneous.

But Farimani *et al*. (1988) and Mickiewcz *et al*. (2004) note that, since investment in the accelerator model does not depend on the price of capital, the model lacks a solid theoretical foundation. Nevertheless, its application in empirical work is widely supported. Ouattara (2004) observes that the flexible accelerator model appears to be the most popular of all investment models used in applied work. And, since it is based largely on firm-level variables, it is further supported by Spyros (1983), who argues that an accurate theory of investment ultimately can be derived only from studies that go inside the firm to obtain appropriate data.

Jorgenson's (1963) model of investment is a neoclassical alternative to the accelerator model. Jorgenson derives the neoclassical model by assuming that firms maximise profit subject to a Cobb-Douglas production technology. Investment is considered a distributed lag function of the changes in the desired capital, where the desired capital is a function of the level of output, price of output and the user cost of capital. As such, investment becomes a function of the firm's output and the user cost of capital. The neoclassical model suffers from several restrictive assumptions, such as rational expectations (although lags have been introduced in variants of the model to capture adaptive expectations), unitary elasticity of substitution between capital and labour, exogenously determined output prices, reversible investment, malleable stock of capital (factor input ratios of equipment carried over from the previous period can be changed to minimise production costs), and constant cost of capital (discount rate). The model does not account for uncertainty and also assumes that depreciation for tax purposes is a constant fraction of the replacement cost of the firm's assets. These assumptions have tended to limit the application of the neoclassical model to developing countries. One attempt to apply the model to developing countries was made by Sundararajan and Thakur (1980).

Tobin's q-theory extends the neoclassical theory by incorporating adjustment costs to account for losses in output due to adjustment. The theory postulates that investment depends upon the ratio of the market value of a firm's assets to their replacement cost, i.e. the q-ratio (Tobin 1969). Thus firms choose investment levels to maximise the expected present value of the firm. When this ratio is corrected for effects of taxation, it is called the Q-ratio (Oulton 1981; Dorfman & Heien 1989). This model uses the shadow price of capital services, referred to as the user cost of capital, to define the optimal level of capital stock, which implies a high degree of perfection in the capital markets. As firms maximise the present value of their profits, capital stock will adjust accordingly until no more profits can be made. The increase in capital is through investment, while a decrease is through depreciation. Although this theory explicitly connects investment to the objectives of the firm, it has been criticised strongly on several grounds, for instance its great number of simplifying assumptions, such as rational expectations and efficient markets, and the possibility of generating different investment behaviour from the specification of the firm's alternative objective and production function.

The fourth category of investment models is the real options models, whose origin is in the theory of financial options. These are non-econometric investment models usually applied in the context of capital budgeting. Pioneering work on the real options approach to investment is attributed to Myers (1977). The approach is appealing insofar as it is able to explicitly account for uncertainty and management's flexibility in undertaking investment decisions, unlike the other approaches. Managerial flexibility may be exercised with regard to the timing of an investment project, and alterations to the size of a project already in progress as better market information becomes available.

An option is defined as the right, but not the obligation, by a firm or individual to undertake a business transaction or decision. It may be real if the transaction involves a tangible asset, or financial if the transaction involves a traded asset such as a stock or bond. In short, a real option is an opportunity to

invest in a tangible asset. The investment opportunity may accrue to the firm as a result of the firm's ownership of patents, unutilised resources/capacity, reputation, and managerial competencies (Dixit & Pindyck 1994). There are different types of real options, the most common of which are: option to defer, time to build option, option to alter operating scale, option to abandon, option to switch, growth options, and multiple interacting options (Trigeorgis 1993). Dixit (1992) uses the option to defer an investment to demonstrate that uncertainty and irreversibility have an effect on the value of a firm's real options. In fact, the option to defer exists as a result of uncertainty. Also known as the option to wait, a deferral option is an American call option where one has the right to delay the start of an investment project (Copeland & Antikarov 2001). The money needed to start the project is referred to as the exercise price. According to Dixit (1992), investments may involve sunk costs, and the economic environment is often characterised by uncertainty. Moreover, a postponed investment opportunity is not necessarily a missed opportunity. Thus there is a benefit to waiting for more and better information, implying that the option to wait has a positive value.

The three common real options models include the Black-Scholes option pricing model (Black & Scholes 1973), the binomial option pricing model (Cox *et al*. 1979), and the Dixit-Pindyck model (Dixit & Pindyck 1994). Although these models are not econometric in nature and therefore would not be applicable to this study, their empirical application has been helpful in emphasising the need for econometric models to account for uncertainty in investment behaviour.

3. Conceptual framework and empirical model

In this study we employed the flexible accelerator model, in which capital is adjusted toward its desired level and therefore the firm's net investment is proportional to the change in desired capital (Latruffe 2004). The model is essentially a partial adjustment model and, just like the adaptive expectations model, it is a theoretical justification of the Koyck model[2] (Gujarati 2003). Under the partial adjustment process, capital stock is adjusted only toward a proportion of its desired stock, since the adjustment is not instantaneous. We assume that there is an optimal or desired equilibrium amount of capital stock needed to produce a given output under a given state of technology and rate of interest. The demand for capital increases when the demand for output accelerates, hence the name accelerator model (Latruffe 2004). Following Reinikka and Svensson (2001), we take the cost of instantaneous net investment as given by $C(I)$, where I is net investment and C is a cost function, with $C(0) = 0$ and, since desired capital is the stock of capital that a firm would hold if adjustment costs were momentarily removed (Chun & Mun 2005), $C'(I)$, $C''(I) = 0$ for all $I > 0$. Firms are assumed to maximise profit[3], where the profit function, $\pi = \pi(t, K)$, is concave in capital stock. That is, $\pi'_k(t, K) > 0$ and $\pi''_k(t, K) < 0$, where t is time. We also assume that firms take product and factor prices as given. At constant relative prices, investment is given by:

$$I_t = \beta(K^* - K_t) \tag{1}$$

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[2] The Koyck model is obtained by algebraically converting a distributed-lag model into an autoregressive model. The adaptive expectations model can be combined with the partial adjustment model to obtain an autoregressive model, with the first and second lags of the dependent variable as explanatory variables.

[3] In deriving the model, Bigsten *et al*. (1997) and Gunning and Mengistae (2001) assume firms maximise profit with a value function of the form $V_t(K_t) = \max\{\pi(K_t, L_t, I_t) + \tau_{t+1} E_t[V_{t+1}(K_t)]\}$, where L_t is labour, τ_{t+1} is the firm's discount factor, and the expectations operator $E_t[\cdot]$ is conditional on information available at time t.

where K^* is the desired capital stock, K_t is actual capital stock in the current period, and β is a coefficient of adjustment, such that $0 < \beta < 1$. Investment is taken to be proportional to the gap between the desired and actual capital stock. That is, investment will be large if the desired capital stock is much larger than the current capital stock. If the expected future demand for output is Q^*, then $K_t^* = \gamma Q_t^*$ where $0 < \gamma < 1$. That is, desired capital stock is proportional to expected demand for output, implying a fixed proportions technology[4], and γ is determined by relative prices. Equation (1) is rewritten as

$$I_t = \beta(\gamma Q_t^* - K_{t-1}) \tag{2}$$

Demand expectations are assumed to be linear functions of current output, and thus

$$I_t = \beta(\gamma \phi Q_t - K_{t-1}) \tag{3}$$

where $0 < \phi < 1$. First-differencing of equation (3), and noting that $I_{t-1} = K_{t-1} - K_{t-2}$, implies that

$$I_t = \alpha_1 \Delta Q + (1 - \beta)I_{t-1} \tag{4}$$

where $\alpha_1 = \beta \gamma \phi$ and ΔQ is change in output. Equation (4) is the traditional flexible accelerator model, where fluctuations in sales induce investment.

Investment in the previous period can have either a positive or negative effect on current investment, depending on its magnitude, returns and the cost of adjusting the stock of capital. According to Lamont (2000), lagged investment captures the effect of investment lags such as delivery lags, planning lags and construction lags, which may cause actual investment to be negatively correlated with current returns. In addition, lags may prevent firms from immediately adjusting investment when, for instance, the discount rate changes. Therefore variations in expected investment are a large part of the variations in actual investment, a phenomenon that causes this year's investment to be chosen in the previous year.

Tybout (1983) observes that, when firms finance all investment from profits and retained earnings, they behave according to equation (4). But, due to binding shortages, they invest using current profits. Current profits represent the importance of a firm's internal liquidity. Given Uganda's weak financial sector it is assumed that firms do not have adequate access to credit and therefore use current profits to invest. Thus

$$I_t = C^{-1}(\pi_t) \tag{5}$$

If investment is constrained by availability of and/or access to financial resources, it is expected that its level will increase with firm age, A_t (Bigsten *et al.* 1997; Gunning & Mengistae 2001). Age is a measure of experience accumulated by the firm. In addition to affecting access to finance, experience

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[4] This and the assumption of constant relative prices rule out the role of factor prices in the characterisation of optimal investment behaviour.

serves to reduce uncertainty associated with a firm's output, thereby potentially increasing the firm's ability to invest (Weinberg 1994).

Blejer and Khan (1984) posit that macroeconomic factors influence firm investment through the coefficient of adjustment. For instance, interest and exchange rate policies may increase or reduce financial resources available for private sector investment, thereby affecting the speed at which firms move to their desired levels of investment. Therefore, as in Blejer and Khan (1984) and Erden and Holcombe (2005), we introduce into the model several macroeconomic factors, X_i, through the following equation:

$$\beta = b_0 + \frac{1}{I^* - I_{t-1}}\left(\sum b_i X_i\right) \tag{6}$$

Nesting (5) and (6) into (4), we get, for the jth firm, the following empirical function:

$$I_t = \alpha_0 + \alpha_1 \Delta Q + \alpha_2 I_{t-1} + \alpha_3 \pi_t + \alpha_4 A_t + \alpha_5 FR_t + \alpha_6 INTR_t + \alpha_7 INFR_t + \alpha_8 IIPGDP_t + \\ \alpha_9 M2GDP_t + e \tag{7}$$

where α_0 is a constant, FR_t is the foreign exchange rate $INTR_t$ denotes interest rate, $INFR_t$ is inflation rate, $IIPGDP_t$ is the ratio of industrial production to GDP, $M2GDP_t$ is the ratio of money supply to GDP, and e is an *i.i.d.* error term. The other mnemonics are as defined previously. The short-run version of (7) is given as

$$\Delta I_t = \alpha_0 + \alpha_1 \Delta Q + \alpha_2 \Delta I_{t-1} + \alpha_3 \Delta \pi_t + \alpha_4 A_t + \alpha_5 \Delta FR_t + \alpha_6 \Delta INTR_t + \alpha_7 \Delta INFR_t + \alpha_8 \Delta IIPGDP_t + \\ \alpha_9 \Delta M2GDP_t + e \tag{8}$$

Inflation rate is used as a proxy for uncertainty in the macroeconomic environment, which directly affects investment (Pindyck & Solimano, 1993). Uncertainty about future interest rates, exchange rates or the duration of shocks in monetary and fiscal policies may influence firm-level decisions. If a firm is uncertain about whether a shock is transitory or permanent, it may delay investment decisions. A negative relationship has been observed between interest rate and investment (Greene & Villanueva 1991; Chetty 2004). The logic underlying this relationship is that increasing the cost of capital reduces investment by decreasing the set of projects that are sufficiently profitable to warrant investment. A firm's investment decisions are also affected by the exchange rate (Lafrance & Tessier 2001). A depreciation in the exchange rate increases the cost of imported capital and intermediate inputs, and consequently depresses investment (Athukorala & Sen 1995). We hypothesise that, since tea-processing firms in Uganda import virtually all machinery and equipment, the real exchange rate should have a significant impact on their investment decisions.

The Index of Industrial Production (IIP) is a pertinent measure of economic performance (Kouassi *et al*. 2002) and also serves as an indicator of growth in industrial output (Burhop 2005). We posit in our study that growth in aggregate IIP relative to GDP implies that growth of aggregate investment significantly influences individual firm investment through the favourable industrial sector-specific economic policies of the country. Money supply (M2) in this study is taken as the sum of money (currency outside banks, demand deposits adjusted for claims on central government) and quasi-money (time deposits, savings deposits and foreign currency deposits adjusted for claims on central

government). The ratio of M2 to GDP is used as a proxy for the size of formal financial market infrastructure or financial depth in the economy (Long 1990; Izumida 1992). We hypothesise that an increase in the financial depth of an economy positively affects a firm's investment behaviour by widening the options for investment finance.

4. Data and estimation

The data used for the study were obtained from a sample of five randomly selected tea-processing firms for a fourteen-year period from 1990 to 2003. This represents 22% of the total number of tea-processing firms in Uganda. The data consists of detailed audited accounts information on several variables, including firm profits in Uganda Shillings (USh), value of output of processed tea (sales) in USh, firm age in years, firm size as number of employees in each firm, and stock of machinery and equipment in USh. Investment is then computed as the difference in capital stock between the current period and previous period $(K_t - K_{t-1})$, while investment rate is computed as the ratio of investment to capital stock in the previous period, $\{(K_t - K_{t-1})/K_{t-1}\}$. The value of output of processed tea is used as a proxy for output. In addition, macroeconomic variables for the same time period, including consumer price index (CPI), real exchange rate, interest rate, inflation rate, index of industrial production, GDP and M2, were obtained from the archives of the research department of the central bank of Uganda. All variables were transformed into real form using the consumer price index and 1990 as the base year. Summary statistics of the variables are provided in Table 1.

The dynamic panel data model used in this study presents complications in estimation, primarily because of the presence of a stochastic explanatory variable; in both the fixed and random effects setting, the lagged dependent variable may be correlated with the error term, with or without serial correlation in the latter (Greene 2008). For instance, in the Koyck and adaptive expectations models, the lagged dependent variable is correlated with the final error term because it (the lagged dependent variable) is contemporaneously correlated with a lagged original error term that is a component of the final one. As such, ordinary least squares (OLS) estimates of these models will be both biased and inconsistent. In our partial adjustment model, however, the lagged dependent variable is not contemporaneously correlated with either the final or original error term. Therefore, OLS estimates will be consistent, but biased in small samples (Gujarati 2003) such as ours, since the stochastic variable and error term are not independent for all observations. Greene (2008) observes that, for relatively small time periods of say five to 15, the bias in estimation of the coefficient on the lagged dependent variable ranges between 15 and 60%. Moreover, in the presence of serial correlation, the estimator becomes inefficient as well. The challenge in this analysis is to determine and apply an estimator to our dynamic panel data model that will reduce the inefficiency of our parameter estimates.

Table 1: Summary statistics of variables used in the model, 1990 to 2003

Variable	Mean	Std. Dev.
Output (billion Shillings)	1.629	1.619
Capital stock (million Shillings)	894.543	749.066
Profit (million Shillings)	34.160	271.754
Firm age* (Years)	33.8	4.9
Inflation rate	8.19	10.34
Exchange rate	90.54	14.67
Interest rate	20.92	1.83
Ratio of M2 to GDP	0.241	0.06
Ratio of IIP to GDP	3.41E-11	1.94E-12

* Average age in 2003
Source: Survey data

Several estimators of dynamic panel data models have been proposed in the literature. Recently, Kao and Chiang (2000) derived the dynamic OLS (DOLS) estimator, which they found to be superior to both the OLS and the fully modified OLS (FMOLS) estimators. These estimators require that the variables in the panel be co-integrated, which, according to Pedroni's (1999) co-integration test, is not the case with our data. Anderson and Hsiao (1981, 1982) propose a general approach based on instrumental variables. Their relatively computationally simple estimator controls for heterogeneity in both the fixed and random effects cases, using either the twice-lagged levels or twice-lagged first differences of the dependent variable.[5] But it has been shown that there in fact are a potentially large number of instruments that can be accommodated by this estimator, including all values of the exogenous variables (Ahn & Schmidt 1995; Arellano & Bond 1991; Arellano & Bover 1995). Consequently, Arellano and Bond (1991) and Arellano and Bover (1995) used the general approach to develop a GMM estimator that is more efficient. The estimator was further improved by Blundell and Bond (1998). For these reasons, we applied and compared the results of both the fixed effects Anderson-Hsiao (AH) estimator and the Arellano-Bover/Blundell-Bond (AB/BB) consistent GMM estimator, which allows for serial correlation in the errors.

5. Results

5.1 Investment rate

The average investment rate was found to be 18% for all tea-processing firms in the sample. This rate lies between the 1996/1997 average rate of 23% for Ugandan firms (including manufacturing, commercial agriculture, agro-processing, fishing, construction and tourism) that invested and 12% for all firms – those that did and did not invest (Reinikka & Svensson 2001). The average investment rate for tea-processing firms in Uganda can also be compared with rates of investment in African countries, which at the median value have generally been low relative to those of Europe and India. Investment rates in manufacturing for the different countries were found to be less than 10%, implying that small maintenance and replacement investments were an important part of investment activity (Bigsten 1997; Naude *et al.* 2000). Investment rates for South African manufacturing firms were found to be 17% and 10% for large and small firms respectively, which were low but also comparable with those for other African countries.

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[5] Arellano (1989) and Kiviet (1995) find the estimator based on levels as instruments to have a variance that is smaller than that for the estimator based on differences.

5.2 Determinants of level of investment

Table 2 shows the regression results obtained from the AH and AB/BB estimators when lagged explanatory variables were used. Qualitatively, we obtained almost similar results from the two estimators with respect to the accelerator principle. Both estimators provide support for the accelerator mechanism in explaining the investment behaviour of Ugandan tea firms; the coefficient on change in output is positive and statistically significant, as expected, *a priori* implying that all factors being constant, tea-processing firms indeed invest to meet increase in demand for tea. We also found from both regressions that the level of investment was negatively responsive to depreciation of the domestic currency. Ugandan tea firms import virtually all their machinery and equipment. Therefore a real depreciation in the exchange rate increases the cost of imported materials and consequently reduces investment. This result supports the assumption that tea firms are price takers in the capital goods market and foreign currency markets, implying that exchange rate is exogenous to the firms. It is also consistent with the observation by Lafrance and Tessier (2001) that exchange rate affects investment by its effect on imported capital goods.

Table 2: Determinants of level of investment by tea firms

Variable	Anderson-Hsiao			Arellano-Bover/Blundell-Bond		
	Coefficient	z-statistic	p-value	Coefficient	z-statistic	p-value
Constant	1.16E + 09 (4.83E + 08)	2.40	0.016	-1.11E + 09 (1.33E + 09)	-0.84	0.402
ΔOutput	0.463 (0.247)	1.87	0.061	0.260 (0.131)	1.99	0.046
Investment$_{t-1}$	-0.059 (0.095)	-0.62	0.535	-0.156 (0.152)	-1.02	0.307
Profit	-0.544 (0.472)	-1.15	0.249	0.373 (0.194)	1.92	0.055
Age				4.71E + 08 (4.11E + 08)	1.15	0.252
Forex. rate	-1.45E + 07 (6182124)	-2.34	0.019	-7.26E + 06 (3628004)	-2.00	0.045
Interest rate	-536.751 (1137.801)	-0.47	0.637	2029.779 (2291.257)	0.89	0.376
Inflation rate	-1124.028 (2657.209)	-0.42	0.672	-7.89E + 06 (7607117)	-1.04	0.299
[IIP/GDP]				2280.03 (1128.454)	2.02	0.043
[M2/GDP]	4196.384 (2456.783)	1.71	0.088			
Number of obs. = 65; Number of groups = 5; Wald Chi-Sq (7) = 58.53; Prob > Chi-Sq = 0.0000				Number of obs. = 60; Number of groups = 5; Wald Chi-Sq (8) = 15.66; Prob > Chi-Sq = 0.0475		

Dependent variable is level of investment. Figures in parentheses are standard errors

That the coefficient on the lagged investment is not significant means that tea firms have not been able to significantly adjust their capital stock to the desired level. Both estimators also show that inflation rate and interest rate are not significant determinants of the level of investment. And, similar to the finding by Reinikka and Svensson (2001), age does not enter significantly into the investment equation.

Profit is used to proxy *firm-level liquidity constraints*. Whereas the AH estimator finds it not to be a significant predictor of the level of investment, the AB/BB estimator does. Since profits are a rough indication of the availability of internal funds, firms with good investment opportunities are able to fund their investment with internal funds. In addition, given the fact that there are costs associated with

raising external funds, firms have sufficient reason to use internal funds to finance investment. In the long run, if taken as retained earnings, profits play a key role in funding investment. Based on the importance of profit in investment behaviour, we find results from the AB/BB estimator to be more plausible than those obtained from the AH estimator.

The equation estimated with the AH estimator includes the ratio of M2 to GDP, i.e. [M2/GDP], while the one estimated using the AB/BB estimator includes the ratio of the index of industrial production to GDP, [IIP/GDP]. Both variables are positive and significant, as expected *a priori*. That the ratio of M2 to GDP is significant means that a larger financial market infrastructure leads to higher investments by the firms. The index of industrial production may be indicative of the positive influence of favourable investment policies for the manufacturing sector that have been pursued by the country through the Uganda Investment Authority (UIA). Growth in gross domestic investment signifies a favourable investment climate for individual firms.

5.3 Determinants of growth in investment

Table 3 summarises the results of the short-run investment model. From the AH estimator, we find that the accelerator model does not explain investment behaviour in the short run. However, the model appears to hold when estimated using the more efficient AB/BB estimator. Change in sales represents demand-influenced forces and has an implication for capacity expansion, whereby an increase in sales may result in the need for more tea-processing capacity, hence inducing further acquisition of capital. Change in lagged investment is investment growth in the previous period. From both estimators we obtain a negative and significant coefficient, suggesting that investment growth in the previous period has a negative influence on investment growth in the current period. We posit that investment growth in the previous period increases the supply capacity of tea firms, which in turn dampens investment growth in the subsequent period. Growth in macroeconomic factors does not seem to affect investment in the short run.

5.4 Elasticities

To better understand the importance of the significant variables in our model, we provide their elasticities in Table 4 with respect to the level of investment. The magnitudes of the elasticities obtained from the AH estimator are twice those obtained from the AB/BB estimator. From both estimators it is clear that, in the long run, investment is mostly responsive to foreign exchange rates; from the AB/BB estimator, a 1% depreciation of the Uganda shilling would lead to an 8% decline in the level of investment, whereas a 1% growth in output would increase the level of investment by about 0.5%. The estimated elasticity with respect to profit is small.

Table 3: Determinants of growth in investment by tea firms

Variable	Anderson-Hsiao			Arellano-Bover/Blundell-Bond		
	Coefficient	z-statistic	p-value	Coefficient	z-statistic	p-value
Constant	8.75E + 07 (6.50E + 07)	1.35	0.178	9.27E + 08 (1.63E + 09)	0.57	0.569
ΔOutput	-0.130 (0.242)	-0.54	0.589	0.266 (0.152)	1.75	0.080
ΔInvestment$_{t-1}$	-0.398 (0.117)	-3.40	0.001	-0.356 (0.135)	-2.64	0.008
ΔProfit	-0.151 (0.280)	-0.54	0.588	0.238 (0.202)	1.18	0.240
Age				-2.80E + 08 (4.77E + 08)	-0.59	0.557
ΔForex. rate	-8626361 (7583905)	-1.14	0.255	-1.02E + 07 (6768567)	-1.50	0.133
ΔInterest rate	566.917 (3314.292)	0.17	0.864	-561.499 (1996.042)	-0.28	0.778
ΔInflation rate	608.384 (1205.169)	0.50	0.614	2120.98 (2787.433)	0.76	0.447
Δ [IIP/GDP]				1522.042 (1303.077)	1.17	0.243
Δ [M2/GDP]	1106.274 (2804.206)	0.39	0.693			
Number of obs. = 65; Number of groups = 5; Wald Chi-Sq (7) = 60.99; Prob > Chi-Sq = 0.0000				Number of obs. = 60; Number of groups = 5; Wald Chi-Sq (8) = 13.66; Prob > Chi-Sq = 0.0912		

Dependent variable is change in investment. Figures in parentheses are standard errors

Table 4: Elasticities of significant variables in the long-run model

	Anderson-Hsiao	Arellano-Bover/Blundell-Bond
ΔOutput	0.86	0.48
Profit		0.16
Forex. rate	-16.34	-8.18
[IIP/GDP]		9.7E-16
[M2/GDP]	1.3E-05	

6. Conclusions

This study has found that the average investment rate in machinery and equipment by Ugandan tea-processing firms is about 18% and is relatively close to the average investment rates for all Ugandan firms, as revealed elsewhere. Also, the study has found the flexible accelerator model to be appropriate in explaining the investment behaviour of Ugandan tea-processing firms when estimated using the Arellano-Bover/Blundell-Bond estimator as opposed to the Anderson-Hsiao estimator. In the long run, the level of investment in fixed assets is positively and significantly influenced by change in output, level of firm level liquidity, and a favourable investment climate in the country. In addition, long-run investment in fixed assets by these firms is negatively but significantly affected by the level of depreciation of the real exchange rate.

The long-run results are consistent with the short-run horizon findings with respect to the effect of the accelerator. But economy-wide variables are found not to be important in the short run. Increased investment in agro-processing machinery and equipment in the tea industry may lead to improved value-addition and productivity, which in turn should boost the competitiveness of processed tea exports. At the firm level, policy incentives specific to the growth of the tea sector may be put in place to target key constraints to investment in fixed assets by firms, such as level of gross sales and net

revenue. We claim that these results can be weakly generalised to other agro-processing firms in other sectors, such as coffee, cotton, tobacco and non-traditional agricultural exports. Therefore the inferences made above are of significant importance to government's efforts to attract foreign direct investment through the implementation of appropriate marketing and agro-processing strategies to support the expansion and competitiveness of Uganda's value-added agricultural exports.

A potential caveat on our results is that they could be biased because of our small sample size. Moreover, we have used a dynamic specification of the model and therefore have lost several observations. More informative results and inferences could be obtained by applying the model to a larger sample of firms. And, given that the lagged dependent variable is not significant in the long-run equation, it might be reasonable to estimate a non-dynamic specification.

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