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The impact of financial constraints on investment efficiency in South Africa

Oluwaseyi Olopade • Beatrice D. Simo-Kengne • Abieyuwa Ohonba*

University of Johannesburg, South Africa

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Abstract

Shifts from firm-level investment efficiency occur due to market imperfections and information asymmetry. This translates to an increased cost of capital, which leads to over or under-investments. This study demonstrates the absence of a direct association between investment efficiency and financial constraints in African firms, complementing the efficient market hypothesis. We observed firms across different industries listed on the JSE from 2009 to 2019. Empirical results from panel data analysis reveal that financial constraints drive improved investment levels and firms in this region depend on external funds – specifically credits – to invest.

Keywords: Investment efficiency; Financial constraints; Panel data
JEL Classification Codes: E22, G30, C23

1. Introduction

Limitations are nearly inevitable in any sphere of finance, highlighting the importance of companies with limited resources making choices among different investment opportunities (Hovakimian, 2011). Financial constraints[1] have been deemed the most prominent obstacle encountered by firms (Ayyagari *et al.*, 2008). Consequently, the effect of financial constraints on investment efficiency has become an intensely researched topic in corporate finance. Some studies claim financing constraints cause firms to make losses (Islam and Luo, 2018), while others suggest that constrained firms tend to forgo several investment opportunities. Schiantarelli (1996) and Bhaumik *et al.* (2012) determined that mature firms also experience investments' high responsiveness to changes in internal funds. Conversely, Bloom and Van Reenen (2010) argue that mature firms do not face financial constraints but possible misallocation of funds and inefficient investments due to management's poor decision-making.

* Corresponding author. E-mail: aohonba@uj.ac.za.

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[1] Firms identify increasing marginal cost in production, the cost of raising capital for further investments, and restricted financing from banks as the major signals of constraints. The presence of these signals limits a firm's investment levels. Guariglia (2008) argues that a company's varying constraints may have a defined effect on investment.

Recently, researchers have shifted the focus from the effects of financial tension on firm-level investments to "optimal"[2] investment. Richardson (2006) defines optimal investment as the estimated fitted investment values derived from an investment model. In the model, investment is regressed on past investment values, total cash in the firm, size, return on assets (ROAs), and financial leverage. Applying Richardson's (2006) model of optimal investment, Naeem and Li (2019) define deviations from optimal investment as investment inefficiency. A study by Islam and Luo (2018) determined the influence of financial constraints using the positive value of residuals from the estimated investment values. According to their findings, the presence of financial constraints reflects investment inefficiency. González (2020) also examined the effects of creditor protection on investment efficiency when a firm is financially constrained versus when a firm is financially healthy on a panel data of about 34 countries. The author (González, 2020) reported firms' inefficiencies lead to over-investments and under-investments. These inefficiencies are lower in less constrained firms as creditor rights are implemented, while constrained firms suffer more inefficiencies. In this paper, we investigate whether the limited availability of internal funds is sufficient to determine investment level in a developing economy. Also, we examine how severe dependence on external funds affects deviations from optimal investment.

Expectedly, over-investment is likely to occur when a firm has abundant internal funding (Naeem and Li, 2019). Capital expenditures sponsored by external funding are expected to lead to further inefficiency as external funding costs continue to rise. Unstable external funding is associated with the implicit cost of issuing new shares since the costs are seldom explicitly determined when agencies act as an intermediary between the company and shareholders. As agency costs rise above the efficient level of investments, the firm may be said to be over-investing. Moreover, resource allocation to investments with low or negative net present value (NPV) is reflective of over-investment. Firms' limitations in terms of insufficient investment capital require efficient choices among different investment opportunities. Where these limitations exist, firms are likely to under-invest.

To test the relationship between investment and financial constraints, we studied a sample of companies listed on the Johannesburg Stock Exchange (JSE) between 2009 and 2019. We conducted segmented examinations on firms' investment responsiveness to cash flow changes. We also segmented our data based on investment inefficiencies; that is, companies that either over-invest or under-invest. We investigated whether firms' investments in a growing economy respond to internal characteristics as recorded in prior literature.

This study merged the approach of two recent studies (Islam and Luo, 2018; Naeem and Li, 2019) to present a unique model that analyses the impact of financial constraints on investment performance, measured by investment level and investment efficiency. We took Islam and Luo's (2018) definition of financial constraints to define investment inefficiencies. To this end, the study used deviations from optimal investment to define whether firms in South Africa are over-investing or under-investing. We defined and determined investment variables following the method of Richardson (2006), Naeem and Li (2019), while financial constraint was measured following the popularly used KZ index. To the best of our knowledge, most studies use financial constraints as a data-segmenting feature; instead, we included financial constraints as a variable to determine the association between constraints and investment efficiency. The use of financial constraints in our regression was useful to show the direction of investment when constraints exist. Unlike other studies, this study investigated financial challenges' impact on firms' investment in a developing African country.

Our findings reveal that investment decisions are more efficient in the presence of financial constraints and less efficient in firms where finances are relaxed. This suggests that managers

[2] Hodgson *et al.* (2000) assert that in a firm's attempt to achieve optimal investment, cost of production, cost of management, risks, expected returns, as well as the restrictions confronting the firm, are to be considered.

in firms facing financial tension are more cautious of changes in the marginal cost of production and internal cash flow changes. A positive investment reaction to financial constraints is found. This association may be peculiar to firms with similar internal characteristics as South African firms.

The rest of this paper is ordered as follows. Section 2 describes the research methodology. Section 3 presents the data, data sources and model building. Section 4 assesses the effects of financial constraints on investment efficiency on the firm-level data, and Section 5 discusses these effects and concludes the paper.

2. Methodology

2.1. Corporate investment and firm financial constraints

The association between firm investment and financial constraints in South Africa is estimated by the equation below. It responds to the research question of whether the presence of financial constraints lowers investment levels.

$$\begin{aligned} Investment_{i,t} = \beta_0 + \beta_1 Fin\_Cons_{i,t-1} + \beta_2 Cash_{i,t-1} \\ + \beta_3 Sales_{i,t-1} + \beta_4 Fin\_Lev_{i,t-1} + \beta_5 Size_{i,t-1} + \beta_6 Tang_{i,t-1} \\ + \beta_7 TobinsQ_{i,t-1} + \beta_8 Div_{i,t} + \sum_{j=2}^{n} \gamma_j I_j + \sum_{k=2}^{T} \gamma_k Y_k + \varepsilon_{i,t} \end{aligned} \tag{1}$$

$Investment$ represents the firm investment calculated by dividing capital expenditures by the value of the total assets at the beginning of the financial year multiplied by 100. The main independent variable Fin_Cons is the index of the financial constraint of each firm. The rest of the variables are control variables that determine firm investment. β_i $i = 0,1,2, \dots, 8$ are the estimated coefficients, and ε represents the error term. We used the lagged value of all independent variables, excluding the dummy variable, to control for possible problems of endogeneity.

Eq. 1 is estimated using fixed effects. Fixed effects control for unique and unobserved individual features across the panel data. These features are time-invariant but vary with the cross-section units.

$$y_i = \beta' \boldsymbol{x}_{it} + a_i + e_i \tag{2}$$

Where y_i is the time-invariant dependent variable, $\boldsymbol{x}_i$ is a vector of the time-variant independent variable, a_i represents the unobserved random variable featured in each unit in the data, and e_i is the stochastic error term that does vary with the independent variables.

To estimate β, the fixed effect approach permits an arbitrary correlation between the time-independent unobserved variable and the time-varying variable. The regression is executed by taking the difference of the time mean from each variable present in the model and then performing an Ordinary Least Squares on the transformed variables. Following this "within transformation", the unobserved term is eliminated, and unbiased β is estimated. The procedure is shown below:

$$y_{it} = \beta' \boldsymbol{x}_{it} + a_i + e \tag{3}$$

$$y_{it} - \bar{y}_i = \beta'(\boldsymbol{x}_{it} - \bar{\boldsymbol{x}}_i) + (a_i - \bar{a}_i) + (e - \bar{e}_i) \tag{4}$$

$$\tilde{y}_{it} = \beta' \tilde{\boldsymbol{x}}_{it} + \tilde{e} \tag{5}$$

Where $\tilde{y}_{it}$, $\tilde{\boldsymbol{x}}_{it}$, $\tilde{e}$ represent the difference between time-varying variables and the time mean values across units. In the equation, the unobserved term is eliminated since a_i is consistent over time; that is, $a_i - \bar{a}_i = 0$. Using the fixed-effects approach, unobserved heterogeneity has been accounted for. Therefore, similar slopes are generated for all units in the regression for the coefficients of the variables in the model, while the intercept varies.

Fixed effects may also be accounted for by including time and individual dummy variables. Each dummy variable can hold its distinct effect on the dependent variable. Therefore, the fixed effects model is written as:

$$y_{it} = \beta' \boldsymbol{x}_{it} + \sum_{j=2}^{n} \gamma_j I_j + \sum_{k=2}^{T} \gamma_k Y_k + e_{it} \tag{5}$$

Where y is the dependent variable, which varies across individual units and time represented by subscripts i and t, respectively, $\boldsymbol{x}$ as a vector of predictor variables, and β as their estimated coefficients. $\sum_{j=2}^{n} I_j$ denotes $(n-1)$ individual binary variables, while $\sum_{k=2}^{T} Y_k$ denotes $(T-1)$ time binary variables included in the model as $j = 2,3,4,\dots,n$ and $k = 2,3,4,\dots,T$ respectively. e_{it} is the error term.

If time effects are not considered, Eq. 3 and Eq. 6 are identical, since the intercepts in Eq. 3 are derived as unit-varying predictors, and the coefficients of binary variables in Eq. 6 are the same.

2.2. Investment efficiency and financial constraints

The interrelation between investment efficiency and firm-level financial constraints is analysed in terms of over-investing and under-investing. First, we attempted to proffer an adequate response to the question of whether financial constraints relate directly (inversely) to under-investment (over-investment). We employed the same model used in Eq. 1 by specifying investment inefficiencies.

$$\begin{aligned} OverINV_{i,t} = {} & \beta_0 + \beta_1 Fin\_Cons_{i,t-1} + \beta_2 Cash_{i,t-1} \\ & + \beta_3 Sales_{i,t-1} + \beta_4 Fin\_Lev_{i,t-1} + \beta_5 Size_{i,t-1} + \beta_6 Tang_{i,t-1} \\ & + \beta_7 TobinsQ_{i,t-1} + \beta_8 Div_{i,t} + \varepsilon_{i,t} \end{aligned} \tag{7}$$

$$\begin{aligned} UnderINV_{i,t} = {} & \beta_0 + \beta_1 Fin\_Cons_{i,t-1} + \beta_2 Cash_{i,t-1} \\ & + \beta_3 Sales_{i,t-1} + \beta_4 Fin\_Lev_{i,t-1} + \beta_5 Size_{i,t-1} + \beta_6 Tang_{i,t-1} \\ & + \beta_7 TobinsQ_{i,t-1} + \beta_8 Div_{i,t} + \varepsilon_{i,t} \end{aligned} \tag{8}$$

The dependent variables $OverINV$ and $UnderINV$ are dummy variables derived from explicit deviations from optimal investment. The explanatory variables in Eq. 7, 8 above have been described previously.

To model investment efficiency, we employed the probit model, popularly used by researchers when dichotomous dependent variables are analysed. This model transforms the binary dependent variable into a continuous variable by presenting it in its predicted probabilities of occurrence using a normal distribution function as a link function. Since the dependent variables are transformed to their probabilities, it is typical to report the marginal effects.

The test offers the advantage of applying full information maximum likelihood without eliminating missing data since our regression has lagged variables.

3. Data

3.1. Data and variables definition

The dataset is built from the annual financial statement of listed firms on the JSE compiled by Identification of Requirements for Enterprise Social Software (IRESS). This provides firm-level information from 2009 to 2019 (about 11 annual periods) of 196 private firms that traded on the stock market in South Africa. In addition to the large sample data, we could assess the interrelation of financial constraints and investment efficiency in both finance firms and non-financial operating firms. Although the share of firms in each industry varies in the dataset, we excluded companies that are listed on the JSE but do not have financial statements from 2009 to 2019, as well as firms with more than one year's omitted financial statements within the period considered.

Table 1 provides the description of all variables and their relationship with the dependent variable.

Table 1. Variable definition and expected relationship.

Symbol	Description	Measurement	Expected Association
Dependent variables			
Investment	Corporate investment	Capital expenditures divided by lagged total assets, multiplied by 100.	
	Efficient investment	Estimated investment values.	
OverINV	Over-investment	Binary variable with one for corporate investments above optimal investment and zero otherwise.	
UnderINV	Under-investment	Binary variable with one for corporate investments below optimal investment and zero otherwise.	
Independent variables			
Fin_Cons	KZ Index	Index of firms having high leverage and less available cash.	
Cash	Cash	Cash at hand of firms divided by lagged total assets.	+
Sales	Sales revenue of a firm	Net sales revenue divided by lagged total assets.	+
Fin_Lev	Financial leverage of a firm	Sum of long-term debt and short-term debt, divided by lagged total assets.	-
Size	Size of a firm	Market capitalisation to the lagged total assets value of a firm.	+
Tang	Tangibility of a firm	Ratio of property, plant and equipment to the lagged total assets.	+
TobinsQ	Tobin's Q	Market value of assets divided by book value of assets.	+
Div	Dividend paid by firm	A binary variable with one if a firm pays dividends and zero otherwise.	+
Cashflow	Cashflow of a firm	The sum of net income and depreciation.	
Capital	Total capital	The capital stock of the firm.	
Debt	Total debt	The total debt incurred by the firm.	
Cash2	Total cash available	Cash and cash equivalent.	
Dividend	Dividend paid	The value of actual dividend paid out.	
Dum_Cons	Financially constrained firms	A binary variable with one for values of the KZ Index greater than the median value and zero otherwise.	

Data source: IRESS Dataset.

Table 2 reports the means, standard deviation, minimum and maximum values of the variables employed in this study. The descriptive statistics demonstrate that South African firms make negative average investments. Also, investments are more spread out across the different firms, as shown by a higher standard deviation than the mean in both investments and investment efficiency variables. This may occur as a result of the higher number (up to the 50th percentile) of negative values of investment. A pattern of dispersion is observed in the other (independent) variables, which may suggest a disparity in the investment levels, revenue from sales, firm sizes, leverage ratios, growth opportunities, and the rate of dividend pay-outs. Therefore, we consider the median value as a better indicator of central tendency. The median values of the variables are observed to be less than the mean, which may imply the data is skewed to the right. However, the normality test indicates that the data is normally distributed.

Table 2. Descriptive statistics.

Variable	Mean	Std. Dev.	Median	Min	Max
$Investment$	-0.384	0.255	-0.354	-0.999	1.528
Fin_Cons	2529788	1.06e+07	31246.14	-2318377	2.36e+08
$Cash$	0.122	0.188	0.076	0	5.181
$Sales$	0.164	0.410	0.138	-1.144	16.196
Fin_Lev	0.287	2.168	0.152	0	94.339
$Size$	2.377	12.938	0.168	1.26e-07	393.438
$Tang$	0.486	1.307	0.413	0	56.439
$TobinsQ$	15.703	154.283	0.011	-0.095	4493.834
$Dividend$	18305.3	130490.9	0	0	2210800
Observation	**2156**				

3.1.1. Constructing investment efficiency and measurement of financial constraints

The model in this study was built by first defining optimal investment. Therefore, we employed Richardson's (2006) suggested model for efficient investment.

Investment inefficiency is then derived as the deviation from efficient investment. Hence, an imprudent managerial decision leading to excessive cash flow is termed over-investment, while expenditure on positive NPV projects with less cash flow (lower than expenditure on optimal investment) is known as under-investment.

$$Inefficiency_{i,t} = Investment^*_{i,t} - Investment_{i,t} \tag{9}$$

Where $Inefficiency_{i,t}$ is the deviations from efficient investment, and $Investment_{i,t}$ is the actual observed investment value.

$$UnderINV_{i,t} = (Investment^*_{i,t} - Investment_{i,t}) > 0 \tag{10}$$

$$OverINV_{i,t} = (Investment^*_{i,t} - Investment_{i,t}) < 0 \tag{11}$$

Guided by the work of Kaplan and Zingales (1997) and Lamont *et al.* (2001), we used the KZ index to identify firms that face financial constraints. From the original KZ index, Lamont *et al.* (2001) established an augmented model that depends on the firm's characteristics. They applied Kaplan and Zingales' (1997) regression output and then built the index as a linear combination of firms' considered features. The stylised version is a five-factor model that ascertains a firm's financial health. The factors are accounting ratios and are presented in the equation below:

$$\begin{aligned} KZ_{i,t} = -1.002\frac{Cashflow_{i,t}}{Capital_{i,t}} + 2.083 \times TobinQ_{i,t} + 3.139\frac{Debt_{i,t-1}}{Capital_{i,t-1}} - 39.368\frac{Dividend2_{i,t}}{Capital_{i,t-1}} \\ - 1.315\frac{Cash2_{i,t-1}}{Capital_{i,t-1}} \end{aligned} \tag{12}$$

Several studies have employed the KZ index to measure and determine the extent of companies' constraints (Guariglia, 2008; Hovakimian, 2011; Li, 2011; Naeem and Li, 2019), allowing for an unbiased report since both internal and external constraints are included.[3]

4. Empirical results

Q1. Do financial constraints influence investment?

We attempted to test the hypothesis that financial constraints may lead to proficient investment decisions in South African firms. In Table 3, Model 1 reveals a one-point increase in Fin_Cons will increase $Investment$ in South African firms, although this impact is by a small degree of about 6.53e-10, at 5% significant level, all things remaining constant. This finding supports

[3] To ascertain the association between financial constraints and investment efficiency-cash flow sensitivity, we constructed a dummy variable Dum_Cons , which is 1 for values in the KZ index greater than the median value and 0 otherwise. This separates firms with higher financial distress from firms with manageable internal resources.

Hovakimian's (2011) assertion that the presence of liquidity constraints enhances management performance in projects' internal fund allocation. Similar to Model 2 and 3, investment values are negative and significant in Model 1.

For robustness tests, constrained firms are selected using the Kaplan-Zingales index *(*KZ index) below the median value while unconstrained firms have their KZ index at and above the median value. Model 2 and 3 illustrate negative investment values of 0.357 and 0.368 in constrained and unconstrained firms, at 1% significant level respectively. This shows a general decline in investments across firms excluding the financial constraint variable but as a segmenting feature in the model.

From the output above, we observe that South African firms are experiencing declining investment levels. Financially healthy firms tend to rely on sales and financial leverage to promote investment levels. However, constrained firms' investment decisions rely on cash and financial leverage.

The first three models are robust. In the estimation, we compared the random effects regression and fixed effects regression using the Hausman test. The Hausman test p-value of 0.000 rejects the null hypothesis of random effect as the best fit model. Hence, we deemed the fixed effects as the best model.

The normality test indicates that the joint normality test on the panel residuals is normally distributed with insignificant skewness and kurtosis with p-values of 0.184 and 0.163, respectively. Further on, a heteroscedasticity test was exerted on the regression using the Likelihood ratio test. We reject the null hypothesis of non-constant dispersion among independent variables, given a high p-value of 1.000.

Table 3. Regression results for investment and investment inefficiency.

Variables	**Eq.1 Investment**	**Constrained Investment**	**Unconstrained Investment**	**Eq.2 OverINV**	**Eq.3 UnderINV**
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Fin_Cons	6.53e-10**			-1.31e-07***	1.31e-07***
	(2.43)			(-3.50)	(3.50)
Cash	0.001	0.082**	0.014	0.106**	-0.106**
	(0.02)	(2.07)	(0.47)	(2.27)	(-2.27)
Sales	0.075***	0.053	0.078***	-0.249***	0.249***
	(3.96)	(1.63)	(4.29)	(-4.75)	(4.75)
Fin_Lev	0.173***	0.173***	0.123***	-0.105***	0.105***
	(23.36)	(15.00)	(9.76)	(-3.17)	(3.17)
Size	-0.003***	-0.003***	0.001*	-0.013**	0.013**
	(-9.44)	(-7.69)	(1.72)	(-2.30)	(2.30)
Tang	-0.314***	-0.318***	-0.438***	0.007	-0.007
	(-21.90)	(-14.18)	(-21.04)	(0.28)	(-0.28)
TobinsQ	-3.14e-5*	-3.21e-05	2.08e-05	-1.69e-05	1.69e-05
	(-1.95)	(-1.68)	(0.20)	(-0.07)	(0.07)
Dividend	0.038***	0.009	0.011	-0.012	0.012
	(3.52)	(0.40)	(1.00)	(-0.69)	(0.69)
Constant	-0.298***	-0.357***	-0.368***		
	(-59.36)	(-10.61)	(-6.42)		
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	1673	862	812	1673	1673
Firms	192	124	129	192	192
Within R-squared	0.344	0.295	0.505		

Note. Figures displayed are estimates, and standard errors are in brackets. *, ** and *** represent significance at the 10%, 5% and 1% level of significance, respectively.

Q2. Do constrained firms invest inefficiently (over-invest or under-invest)?

In the probit model of over-investment, the log-likelihood is maximised and converges after nine iterations. The Wald test of the validity of the coefficients presents a p-value of 0.000. This p-value led us to conclude that at least one of the regression coefficients in the over-investment model is not equal to zero. With the coefficient tested as valid, the main predictor variable Fin_Cons is observed to have an inverse marginal impact on over-investment, with a strong statistical significance at 1%; the magnitude of this effect is minimal but adequate.

The under-investment model mirrors the over-investment model by presenting similar outputs with different associations. We found that constrained firms are more likely to under-invest; that is, these companies may invest in profit-guaranteed projects with less than the optimal amount necessary for investing.

5. Conclusion

This study investigated the association between financial constraints and corporate investment in South African firms. The study further examined the impact of financial constraints on optimal investment and investment inefficiencies.

Our findings indicated that firms that venture inefficiently are largely unconstrained firms. In addition, we found evidence to suggest that the extent of the tangibility of the firms' assets does not translate to investment efficiency. In constrained firms, profit retention is difficult, and internal funds remain ineffectual as capital for further investments. Furthermore, there are limited growth opportunities as the replacement cost of assets in a constrained firm is more expensive than the market value of their assets. Hence, they are negatively perceived by investors. Moreover, their dividend pay-out behaviour does not improve their level of investment. Less constrained firms do not depend on their internal funds to invest, and they exhibit low investment-cash flow sensitivity. However, deviations from optimal investments respond differently as financial constraints are efficient in determining the direction of investment.

South African firms depend more heavily on external funding than internal funds through reinvested profits. An inability to retain profits reveal weaknesses in the internal and external policies are being adopted. Internal policies, such as the cost of labour and inefficient management, affect firm profit. Firm revenue is also impacted by high income and company taxation, which may stunt their expansion capabilities. Therefore, we recommend that managerial training and other non-monetary incentives be employed to sensitise managers and agents to make practical and profitable choices for the firm. Also, tax policies may be reviewed to assist local firms in attaining optimal investments.

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