Research Journal of Finance and Accounting
ISSN 2222-1697 (Paper) ISSN 2222-2847 (Online)
Vol.9, No.22, 2018

Slack and Innovation in Africa: A Curve Linear Relationship

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Abstract
In this study, we undertake the financial slack and innovation intensity linkage across industries in Africa. We reported empirical evidence based on the data of 923 non-financial firms in 10 African countries. The industry-level robust regression result shows that the association between financial slack and innovation intensity varied across industries because of the heterogeneous nature R&D spending and financial slack accumulation of firms in different industries. That is, both a U-shape and an inverted U-shape relationship between slack and innovation intensity are confirmed. We finally discussed results and policy implications in detail.
Keywords: Africa, Financial Slack, Innovation intensity, R&D investment

1. Introduction

The association of slack and innovation has remained an empirically unanswered question, and theorists continue to argue over the issue of whether slack enhances or inhibits innovation. The opponents of slack claimed that slack relaxes incentives to innovate and encourage wasteful investment in research and development (from now on innovation intensity), while the advocates of slack argued that slack resources allow individuals and units to experiment with projects that might lead to important innovation. In this study, we attempted to explore the association of slack resources and innovation intensity based on the fundamental theoretical debates and the results of prior empirical studies. Innovation and slack have given due attention by the organizational theorist recently. Amongst the dynamic changes in the marketplace, innovation has proven to be a vital component of organizational adaptation and renewal. For instance, Peters (1990) strongly argued the choice of the organization either to innovate or not. Accordingly, Peters stated that the organization must innovate or die. At the same time, theorists have used organizational slack to realize an assortment of firm's process and outcomes, such as search behavior, the goal of conflict, the political interest, effectiveness, and innovation (Nohria and Gulati, 1997). Though organizational theorists have been advocating slack as a vibrant and thrilling construct, their view of the slack has been widely mixed (Bourgeois III, 1981, Lant, 1985 for comprehensive reviews). Some scholars viewed slack as excess resources that allow a firm to enhance cooperation among competing alliance and cushion itself from unexpected situations (March, 1976, March, 1981). Others noticed slack destructively, as an inefficiency resulting from an organization's failure to redeploy resources optimally that fallouts in performance which don't meet the full potential of the available resources (Leibenstein, 1969, Williamson, 1963, Williamson, 1964). Likewise, while the advocates of slack argued that slack is vital for innovation, organization confronting growing global competition feel concerned to eliminate all forms of slack (Nohria and Gulati, 1997). This paradox exhibit the dynamic and previously undefined linkage between innovation and slack. However, despite the debates on the importance of organizational slack resources for innovation intensity, the existing literature offers no compelling the empirical answer regarding whether slack is enhancing or hindering innovation. The current study, therefore, attempted to explore the relationship between organizational slack and innovation intensity. The existing literature is limited to the relationship between slack and innovation intensity without considering the disparity in innovation intensity and slack accumulation across industries. However, investigating the slack-innovation intensity nexus across industries is imperative because the innovation intensity is heterogeneous across industries. Some industries might highly rely on competitive advantage through R&D, and some others might have a lower level of innovation. Some industries again might accumulate too much slack while others deployed it. Thus, the industry-level investigation provided a clear insight into the difference in the linkage between slack and innovation intensity in various industries. The current study contributed to the literature by investigating the slack-innovation intensity nexus across industries and by

offering a clear policy implication.

2. Slack and innovation- definition

The existing literature defined in several ways. According to Cyert and March (1963), it is the discrepancy between the resources available to the firm and the payment required to uphold the alliance. Likewise, Dimick and Murray (1978) defended slack as those resources which a firm has acquired which are not committed to the necessary operation. In crux, these are resources that the firm can use it in a discretionary way. Moreover, Nohria and Gulati (1997) explained slack as the pool of resources in a firm that is over the minimum required to produce a given level of output. For the purpose of this study, we inclined to use the definition of slack close to that of Nohria and Gulati with the significant difference that slack involves resources that are not only currently within the firm, but also those that are potentially available to the firm (for instance, debt), thus capturing the multidimensional features of organizational slack resources. Based on this definition, we viewed slack from an interior and exterior viewpoint. According to Geiger and Cashen (2002) while internal slack includes resources that are within the organization, either readily available or already immersed within the firm, the external one contains resources that are not currently within the firm and can best be thought of as availability of debt financing.

According to Van de Ven (1986) innovation is defined as 'a new idea, that may be an amalgamation of old ideas, a system that tests the current order, a formulation, or a unique tactic which is believed a new by the individuals involved.' Moreover, Bloch (2007) defined innovation as '*application of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations.'* Furthermore, we argued that expenditure on research and development (R&D) is one of the most widely used measures of innovation inputs. According to Savrul and Incekara (2015) investment in R&D is the driver of innovation in both firm-level and macroeconomic-level. Our study, thus, used the R&D intensity believing that R&D investment is the core part of innovation. The measurement of R&D intensity of firm-level is different from the definition of R&D intensity of country level. While the firm-level R&D intensity is measured as the ratio of firm's R&D expenditure to its sales, the country level R&D intensity is measured as R&D expenditure as a percentage of the gross domestic product of a country. Consistent with the purpose of our study, exploring the association of slack and innovation of firms, we measured R&D intensity as the ratio of firm's R&D expenditure to its sales.

3. Slack and innovation- nexus

The slack has been anticipated to have three components based on financially derived data (Bourgeois III, 1981, Bourgeois III and Singh, 1983, Daniel et al., 2004, Bradley et al., 2011, Marlin and Geiger, 2015, Yidersal, 2018, Demis Hailegebreal 2018 namely available, recoverable, and potential slack. Similarly (Tan and Peng, 2003), Singh (1986) (Tan and Peng (2003), Argilés-Bosch et al., 2016), Lin et al. (2009), Huang and Li (2012), Argilés-Bosch et al. (2016) and categorized slack based on two components- absorbed and unabsorbed slack. Moreover, (George, 2005) classified it as high-discretion and low-discretion. The essence of these approaches used to operationalize organizational resources involves differentiating the available and the absorbed one. The extant literature argues it is likely that the link between resources and innovation may differ along with the different components of slack (Bourgeois III, 1981, Bromiley, 1991, Singh, 1986). We presented these arguments that highlight the expected differences in the association of varying slack components and innovation.

3.1 Available slack and innovation

The existing literature measured available slack as current assets divided by current liability and the ratio of the working capital to sales of the firm (Bourgeois III, 1981, Cheng and Kesner, 1997, Geiger and Cashen, 2002). These components of slack capture the extent to a firm has resources that are unused, but readily available (Geiger and Cashen, 2002). The argument in the management literature is that slack offers a pool of resources that ease the ups and downs of the movement of innovation (Bourgeois III, 1981, Nohria and Gulati, 1996). Because slack exists, executives are more likely to chase projects with promising results. That is, slack that exists within the firm and is readily available can impact managers to pursue promising projects. Hence, it is possible to expect that a rise in available slack leads to an increase in firm innovation. However, Nohria and Gulati (1996) argue that as slack increases the possibility for innovation decline. Hence, at a certain level of available slack, firm innovation should be topmost. That is, as it rises, selecting, supporting and terminating projects may be relaxed (Leibenstein, 1969, Jensen, 1993). Given this, slack may overcast a firm's responsiveness to environmental changes (Cheng and Kesner, 1997) As a result, a suboptimal level of innovation may become acceptable because of the existence of excess resources within the firm. It appears reasonable that slack, which is readily available, can lead executives to be more relaxed in their decision making (Geiger and Cashen, 2002). That is, it can influence managerial decision making, such that a moderate increase in available slack increase innovation intensity, but with the availability of slack beyond a certain level, innovation intensity

will diminish. Given this, we expected that the link between available slack and innovation intensity have an inverted U-shaped pattern that leads to the first hypothesis of this study.
Hypothesis 1: An inverted U-shaped relationship exists between available slack and innovation intensity

3.2 Recoverable slack and innovation

Previous studies measured recoverable slack as the selling and general administrative expenses divided by sales (Bourgeois III and Singh, 1983, Bromiley, 1991, Geiger and Cashen, 2002. Recoverable slack captures the level to which resources are rooted in the firm as excess costs, but the firm could recover it at the time of financial difficulty (Bourgeois III and Singh, 1983. This type of slack component is also absorbed slack (Singh, 1986) that the firm consumed in the form of expenses which are over the minimum requirement in the firm. For instance, a firm may hire individuals than necessary to operate effectively year round. While this may increase expenses and reduces efficiency, it does, however, provide a cushion or buffer from disruptions in output (Cyert and March, 1963). This component of slack may also support the firm to be more innovative (Nohria and Gulati, 1996). However, innovation will decrease with recoverable slack beyond a certain level. That is, only a certain level of innovation intensity can result from having an excess absorbed slack within the firm (Geiger and Cashen, 2002) and as it increases, control over the innovative project will face difficulty (Jensen, 1993) and undisciplined resource allocation will be fall (Nohria and Gulati, 1996). Therefore, excess recoverable slack may diminish firm innovation. Given this argument, we developed the second hypothesis as follows.
Hypothesis 2: An inverted U-shaped relationship exists between recoverable slack and innovation intensity

3.3 Potential slack and innovation

The third components of slack, potential slack, has been operationalized in previous management literature as the ratio of debt to equity (Bourgeois III and Singh, 1983, Bromiley, 1991, Palmer and Wiseman, 1999, Geiger and Cashen, 2002). This component serves to capture the ability of a firm to secure resources with the structure of external financing, particularly the debt and equity financing. It is possible to expect that as potential slack increases, experimentation and product innovation is encouraged. This argument is attributable to the potentially available resources which help lessen anxiety and worry about the risk associated with R&D and short-term performance matters (Geiger and Cashen, 2002). However, it seems unlikely that a maximum level of potential slack (0% debt) will decrease innovation of the firm. Besides, as potential slack increases, it is difficult to imagine that undisciplined experimentation will happen since it is not currently available resources within the firm. The use of such slack involves the firm incurring future expense (in the form of cost of borrowing) and changes in analyst opinions (bond ratings), which in turn influences the future costs of debt and the value of the firm's stock (Geiger and Cashen, 2002). Given these factors, the use of potential slack will likely involve greater analysis by executives, and hence it does not appear likely that executives will be more relaxed in their decision making. For instance, Bourgeois III and Singh (1983) documented that potential slack increases political behavior in the firm. Consequently, executives may disburse more significant time and energy on the decision concerning such resource. Therefore, unlike the relationship between the available and recoverable slack and innovation (expected to fall in inverted U-shaped), the relationship between potential slack and innovation intensity within the firm is supposed to be linear, leading to the following hypothesis.
Hypothesis 3: a positive association exists between potential slack and innovation.

3.4 Industrial Heterogeneity

The existing literature is limited to the slack-innovation nexus where most previous studies lack the consideration of industry heterogeneity. According to legitimacy theory, firms are inseparable from the society, and they have no inherent right to exist- they exist only as the society confers legitimacy upon them. Thus, firms must continually legitimize their operations to retain congruence between organizational objectives and societies' purposes. However, different industrial groups have significantly different resources and capacities, shareholder pressures, the market reaction to their enhancements. Because of these heterogeneities, firms in various industries are likely to adopt different environmental strategies to gain or maintain their legitimacy. The adoption of these different strategies usually results in different economic outcomes. Firms pursuing proactive environment strategy might have more benefits than costs so that the link between resources and organization outcomes tends to be positive (Albertini, 2013, Waddock and Graves, 1997, Trumpp and Guenther, 2017, Endrikat et al., 2014) whereas firms pursuing reactive environmental strategies might have higher costs than benefits so that the link is most likely negative (Hang et al., 2017). Some previous empirical studies confirmed the idea that industrial heterogeneity influenced the link between financial resources and firms outcomes (Li and Ramanathan, 2018). That is, the relationship between financial resources and innovation varies across industries. Therefore, taking industry heterogeneity into account, we propose our fourth hypothesis.
Hypothesis 4: The relationship between slack and innovation intensity varies across industries.

4. Methodology

4.1 Variable selection and measurements

4.1.1 Outcome variable

We used the firm's innovation intensity, consistent with previous studies of Mousa and Chowdhury (2014) and Geiger and Cashen (2002) as a dependent variable. To measure the innovation intensity (R&D intensity), we divided the R&D expenditure of the firm by its total sales. That is, we measured innovation intensity as the ratio of Research and Development Expenditure to sales. This approach captures inputs into the innovation process and hence determines the level of innovation opportunities within the organization. Furthermore, this approach has been commonly and widely used in extant management literature (Hansen and Hill, 1991, Hitt et al., 1996, Hitt et al., 1997). Though R&D investment does not always motivate innovation, it favorably impacts firm innovative competence regarding new ideas, patents, knowledge, and product improvement (Bierly and Chakrabarti, 1999, Miller, 2004, Tsai and Wang, 2004). However, R&D activity encompasses several risks and uncertainties and does not guarantee innovation (Chiu and Liaw, 2009).

4.1.2 Explanatory variables

Executives often use organizational slack resources to chase innovative projects since it protects firms firm uncertain returns (Nohria and Gulati, 1996). Organizational slack not only allows executives to implement innovations (Bourgeois III, 1981, Sharfman et al., 1988) but also offers firms operating flexibility (Chiu and Liaw, 2009). Besides, organizational slack resources help estimate the attention of executives from short-term income (or cash flow) to new long-term innovative projects. In short, a close focus of firm strategic orientation on R&D investment reflects a long-term commitment of a firm to implement R&D project (Chiu and Liaw, 2009). Thus, this study argues that organizational slack offers the resources required to secure firms from environmental turmoil (Thompson, 1967) and promote existing technological abilities by navigating slack into continuous innovative projects (Geiger and Cashen, 2002). Therefore, we argue that higher firm R&D intensity more likely associated with a higher likelihood of the use of organizational slack (that is available, recoverable and potential slack) to promote the innovative projects of a firm.

We echoed Sharfman et al. (1988) and Nohria and Gulati (1997) that focused on slack resources which are (1) *recoverable*, or employable in the future, because such resources should be more readily available to funding innovative activity than absorbed, or long-term, *slack* (Bourgeois III and Singh, 1983, Sharfman et al., 1988). We also used (2) *available slack*, that shows unexploited but available resources, consistent with prior studies of Bourgeois III (1981), Bromiley (1991), Wiseman and Bromiley (1996), Cheng and Kesner (1997) and Geiger and Cashen (2002). Moreover, this study utilized (3) *potential slack*, which reveals the firm's ability to acquire external resources (Cheng and Kesner, 1997). We captured the curve linearity relationship between financial slack and innovation by using recoverable Slack Square, available Slack Square and potential Slack Square.

4.1.3 Control variables

(1) Firm size*:* Firm size has been argued to impact R&D expenditure (Baysinger and Hoskisson, 1989) as well as the firm's ability to endure the short-term turmoil (Sorenson, 2000). Thus, it is essential to control the firm size, measured as the logarithm of total assets of the firm. Furthermore, firm size is measured using the firm's overall value and or market value, which the previous studies ignored. Most empirical studies on the firm's financial outcomes such as innovations, performance, and growth considered only the effects of firm size based on its total assets on those firm's results. However, we thought that considering the firm size from the different perspective, despite asset sizes, is very important. Hence, we controlled the firm's market and total value.

Market capitalization is the market value of the firm's outstanding shares and measured as the particular share price with the number of shares outstanding. Market cap is the measure of firm size and using it very important because firm size is critical determinants of various characteristics in which investors are interested, including risk. Firms with a large market cap tend to have more assets, capital, and revenues than with smaller market cap. However, a firm with the massive market cap is not necessarily better than any other companies because a large market cap is merely an indication of the size of the firm. That is, market cap measures only the market value equity, and firms have access to debt too. That is, the market cap is limited to show the actual size of the firm. Because of this firm size needs a comprehensive measurement comprising the equity and debt financing. For doing so, enterprise value, a broad measure of firm size, has been used in our study.

Enterprise value measures the firm's total value, is a more comprehensive measure of the market capitalization of the firm. Our firm-level data source is the Osiris database. The Osiris data guide defined the enterprise value as the sum of market capitalization and net debt. The same guide further defines the net debt as the difference between total debt and cash and cash equivalents. Hence, the enterprise value, as the Osiris data guide defines it, is taken from the memo line of the spreadsheet of each firm. We controlled the enterprise value, believing that it can influence the accumulation of financial slack and the innovation intensity of firms.

(2) Growth: Firm growth may be encouraging for a firm's innovation intensity. Because the faster a firm's sales or assets are increasing, the more confident it will take its ability to secure the benefits from uncertain R&D projects the more patience it can afford to show in waiting for these benefits (Mueller, 1967). That is, the fast a growth in a firm's sales and assets, the better will be the economic reward and incentives for innovative activities. Furthermore, in this globalized world, the issue of international competition and sustainable growth raises the importance of R&D projects. Sustainable growth might be the result of sustained and skill employment growth in the economy in general and in the industry in particular. Employment growth might consist of a new skill, experience, and motivation which can influence the R&D projects of a particular firm. The opportunity to use these new skills, experiences and motivations can enhance the effectiveness of the firm by influencing the R&D projects. Thus, we controlled firms and employee growth in this study (see Table 1).

(3) Profitability: we assumed a firm acts implicitly to maximize the current net worth of its stockholders. The firm may use its fund to pay out dividends or employed them in some strategic activities. The most important strategy, in the current competitive business environment, is the promotion of innovation. Over a particular period, the firm can rely upon three sources of funds in supporting its strategic activities which are profits, debt, and equity. According to the pecking order theory, the firm's primary choice is the use of its internal sources of finance (profit) to finance its operations. Therefore, the net worth of the firm might play a crucial role in enhancing the firm's strategic activities, R&D projects. Therefore, we controlled the profitability of firms in our study. We controlled both the financial profitability (return on assets and return on equity) and the operational profitability (return on sales).

(4) Total compensation/cost of employees: from the perspective of investment theory, innovation investments are different from ordinary investments in that most of the spending consists of workers wage and salaries (Hall, 2010). According to Hall, over the last 50 years, practically, 50 percent or more of the R&D investment go to the payment of scientists and engineers. Hall added, the effort of these scientists and engineers provides intangible assets, the firm's knowledge base, from which the firm generated profit. Despite this knowledge base, the workers training in new designs, products, process, and marketing can create the specific human capital. Hall further explained that to the extent that all this knowledge is technique rather than rule it is included in the human capital of the firm's employees, and is thus lost if they are left or fired. This fact, as Hall argued, has an important implication for the conduct of R&D investment in particular and innovation investment in general. Furthermore, the diffusion of innovation theory stated that innovation refers to the process that occurs as people adopt a new idea, product, practice, philosophy, and so forth (Rogers, 2010). If the firm has employees with better motivation and commitment, the firm will easily adopt new ideas, products, practices, and philosophy. We argued that the critical strategy to motivate employees in the organization is compensation. On the other hand, the dollar amount paid to the employees as salary and other incentives may decline the amount of R&D spending of the firm. These arguments indicate it is essential to control employee compensation in our study.

(5) Banking sector development: the development of the banking sector, actually supported the finance of the firms. Firms operating in a well-developed banking sector can easily access external financing in the form of debt, in the case of limited internal finances, to support its promising projects. Particularly, a well-developed banking sector might support the firm's R&D projects, and we found it is critical to control the banking sector development (see table 1).

(6) Stock market development: According to the pecking order theory, equity financing is the last choice of firms to support their investment projects, in the case where there is a limited internal source of finance and limited access to debt financing. Like a developed banking sector, a well-developed stock market, thus, can provide equity financing for firms to support their R&D. Thus, we controlled the stock market development too in this study.

We summarized the variables description, measurements with its expected sign the Table 1. Table 1 variables and measurements

variable	Measurement	Expected sign	Sources
Dependent/outcome variables			
Innovation intensity	R&D expenditure/sales		
Explanatory variables			
Recoverable slack	Selling and general administrative expenses/sales	+	Nohria and Gulati (1996), Zhong (2011), (Geiger and Cashen, 2002)
Recoverable slack square	Selling and general administrative expenses/sales square	-	
Available slack	Current assets/Current liability (CACL)	+	
	Working capital/sales; working capital is the difference between current assets and current liabilities		Nohria and Gulati (1996), Zhong (2011), Geiger and Cashen (2002)
Available slack square	Current assets/Current liability (CACL) square	-	
	Working capital/sales square	-	
Potential slack	Debt/Equity	-	
	Debt to sales	-	Geiger and Cashen (2002), Bourgeois III and Singh (1983), Cyert and March (1963), Jensen (1993)
	Debt to assets	-	
Control variables			
Firm size	Logarithm of total assets		
	Enterprise value = Market capitalization plus net debt; where net debt is total debt less cash and cash equivalents		
	Market capitalization		
Growth	Firm growth		
	Employee growth		
Profitability	Return on Assets (ROA)		
	Return on Equity (ROE)		
	Return on Sales (ROS)		
Cost of employees	sum of salary, bonus, retirement benefits, personal expenses, social expenses		
Banking sector development	Banking sector deposit/GDP%		
Stock market development	Stock market capitalization/GDP%		

4.2 Sample and data

The Osiris database provides financial and non-financial data for a total of 1285 firms in 33 African countries among others. From this figure, we draw a sample of 923 firms in ten African countries for over ten years. We excluded the financial firms such as banks and insurance companies considering their R&D project and slack accumulation is unique. The firm-level data is obtained from the Osiris database and then organized from the financial statements of 923 firms. We extracted the banking sector and the stock market development data from the World Bank database. We included the banking sector and the stock sector development with missing values because we could not get the full (10) years' data for all sample countries.

4.3 Estimation

The empirical model used in this study is specified as follows.

$$Y_{it} = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_1^2 + \beta_5 X_2^2 + \beta_6 control + \delta_i + \mu_j + \varepsilon_{it}$$

Where Y_{it} is R&D expenditure to sales, X_1 is available slack, X_2 , is recoverable slack and , X_3 is potential slack, control is the vector of the control variables, δ_i is country fixed effect, μ_j is industry fixed effects and ε_{it} is the error term. X_1^2 & X_2^2 are available Slack Square and recoverable Slack Square used to capture curve-linear relationship between innovation intensity and slack resources.

Our data set is panel consisted of 923 firms in ten African countries over the last ten years. We employed the OLS robust regression to deal with the heteroscedasticity problem. The country-level and industry-level descriptive statistics revealed that there exists a heterogeneous nature of countries and industries regarding R&D spending and slack resource accumulation across countries and industries. We employed the correlation analysis and the Variance Inflation Factor (VIF) to check the presence of multicollinearity problem. Both the correlation and the VIF result show multicollinearity is not the issue so that we can retain all explanatory in the model of the study. Based on the heterogeneous nature of R&D spending and slack accumulation across industries, we employed the industry-level OLS robust regression because, with different level of R&D expenditure and slack collection across industries, it might be vague to run an overall regression to provide a clear policy implication. Furthermore, the overall regression was employed to test hypotheses one, two and three.

5. Sample distribution

Panel 'A' of Table 2 presents the sample distribution of firms across countries. We used 923 firms in 10 African countries, in this study, based on the availability of data. 295 firms or 32 percent of the total firms is Egyptian firms, and 222 or 24 percent of the firms included in this study are South African firms. 14 percent of the sample firms of Nigerian. Relatively small Ugandan, Tanzanian and Zambian firms are involved in this study. 1 percent and 2 percent of sample firms used in this study are Ugandan, Tanzanian and Zambian firms. 3, 6, 8 and 9 percent of the total sample firms are Ghanaian, Tunisian, Moroccan and Kenyan firms. Panel B of Table 2 presents the sample distribution of firms across industries. We classified firms in 10 industry groups (see panel B of Table 2). We found that large firms are engaged in services delivery and manufacturing. While 16 percent of firms included in this study are involved in services, 15 percent of them are manufacturers. 11 percent of the sample firms are taking part in the construction. This result is as expected. In Africa, next to service, manufacturing is the most critical industry because countries in Africa are in the era of industrialization. Hence, it is expected, in Africa that most firms engaged in manufacturing. Furthermore, African countries, nowadays, are trying to construct different infrastructures. That is why large firms are involved in construction. While 6 percent of firms engaged in agriculture, 9 percent of them are energy and food and beverage firms. Only 2 percent of sample firms are involved in healthcare, and this shows that health care in Africa is the last choice of firms as a business operation. Again 4 percent of firms are in the industry category of IT and telecommunication. This figure also shows that information technology and telecom is at its lowest stage and in most African countries, the government owns the telecom industry. The rest of the firm, 5 percent, 9 percent and 8 percent of the sample firms engaged in hotel and tourism, media and entertainment, trade and investment and transport respectively.

Table 3 presents the mean value of the industries controlled and the mean value of the variables, including explanatory and control variables, used in this study.

Table 2 Sample distribution

Panel A			Panel B		
Country	Number of firms	Mean	Industry	Number of firms	Mean
Egypt	295	0.32 (0.47)	Agriculture	58	0.06 (0.24)
south Africa	222	0.24 (0.43)	Construction	106	0.11 (0.32)
Nigeria	127	0.14 (0.34)	Energy	80	0.09 (0.28)
Kenya	84	0.09 (0.29)	Food and Beverage	86	0.09 (0.29)
Morocco	71	0.08 (0.27)	Health care	19	0.02 (0.14)
Tunisia	52	0.06 (0.23)	Hotel and tourism	44	0.05 (0.21)
Ghana	30	0.03 (0.18)	IT and telecom	35	0.04 (0.19)
Zambia	18	0.02 (0.14)	Manufacturing	136	0.15 (0.13)
Tanzania	16	0.02 (0.13)	Media and entertainment	50	0.05 (0.23)
Uganda	8	0.01 (0.09)	Service	151	0.16 (0.37)
			Trade and investment	85	0.09 (0.29)
			Transport	73	0.08 (0.27)
Total	923	1.0		923	1.0

6. Descriptive statistics

6.1 Country-level descriptive statistics

Table 3 presents the descriptive statistics across countries. Firms in Zambia, South Africa, and Egypt reported a relatively higher research and development expenses to sales ratio. While an average R&D expenditure to sales ratio of Zambian firms is 0.0212, the average R&D expenditure to sales ratio of firms in South Africa and Egypt is 0.0165 and 0.0134 respectively over the last ten years. Relatively, Nigerian, Kenyan, and Ugandan firms reported the lowest R&D expenses to sales ratio of -0.000167, -0.00002, and -0.000021 respectively. These figures revealed that firms in Nigeria, Kenya, and Uganda are less concerned about innovative activities. On average, African firms reported the research and development expenses to sales ratio of 0.0085 (0.85%) which is even less than 1 percent. This figure indicates the fact that, research and development investment is not highly concerned by firms in Africa or the level of research and development is left behind.

Firms in Ghana reported a relatively higher selling and general administrative expenses to sales ratio followed by firms in firms in South Africa, Tanzania, and Kenya. To be exact, the average selling and general administrative expenses to sales ratio of firms in South Africa, Tanzania, and Kenya are -0.6161, -0.3122, -0.2746, and -0.2687 respectively. Egyptian and Moroccan firms reported the lowest selling and general administrative expenses to sales ratios of -0.15402, and Morocco and -0.1788 respectively. African firms recorded an average selling and general administrative expenses to sales ratio of -0.24 over the last ten years.

Firms in Morocco reported the highest average current ratio of 38.19 from 2007 to 2016. This figure shows that firms in Morocco are not efficient in facilitating their short-term financing, and it might affect their short-term investments. To the contrary, Ugandan firms reported the lowest average current ratio of 0.5048, indicating that unlike firms in Morocco, Ugandan firms efficiently facilitated their short-term financing over the last ten years. However, this figure also might be an alarm for Ugandan firms because the firms will face a problem of meeting their short-term obligations. The average current ratio of African firms for the last ten years is 5.1244.

Egyptian, Moroccan and Tunisian firms reported a relatively higher working capital to sales ratio of 0.4685, 0.4127, and 0.3486 respectively. These figures show that firms in these countries can pay costs associated with generating new sales. Contrariwise, firms in Ghana, South Africa, and Tanzania reported the lowest working capital ratio. To be exact, Ghanaian, South African, and Tanzanian firms' average working capital to sales ratio is 0.1407, 0.14087, and 0.1543 respectively. These figures might indicate that firms in these countries have a

higher current liability compared with their assets. It might also show that firms in these countries used their working capital efficiently to generate more new sales. The argument concerning working capital is that having too much and too little working capital is not good for the firm. The Risk-averse investors have argued that firms must use a little working capital as possible considering too small working capital may cause a cash crunch which leads to borrowing at unfavorable terms. On the other hand, risk taker investors feel using too much working capital will make the firms to generate more new sales and boost performance. Based on these arguments, we recommend the future researchers to investigate whether too little or too much working capital is good or bad.

Nigerian and South African firms reported an average debt to equity ratio of 2.9521 and 2.5324 respectively. These figures indicated that the higher debt to equity ratios are of firms in Nigeria and South Africa. These figures revealed that firms in Nigeria and South Africa are highly leveraged or their financing strategy has more relied on debt financing rather than equity financing. Contrarily, the lowest debt to equity ratio is of Tanzanian, Kenyan, and Ghanaian firms. Firms in Tanzania, Kenya, and Ghana reported an average debt to equity ratio of 0.0363, 0.0453, and 0.0709 respectively. These figures roughly indicated two critical situations. One, firms in these countries have limited access to credit. Two, firms in these countries have better access to equity financing. As a whole, firms in Africa reported an average debt to equity ratio of 1.4712 during the study period.

While Ugandan, Egyptian, and Nigerian firms reported the highest debt to sales ratio, Kenyan, Tunisian, and Ghanaian firms have the lowest debt to sales ratio. Ghanaian firms reported the highest debt to assets ratio of 3.9 followed by firms in Kenya and Zambia.

On average, firms in Kenya and Zambia reported a debt to assets ratio of 1.1622 and 1.3139 respectively. The higher the debt to assets ratio, recorded by the firm, the higher the financial risk. Since the firm paid the interest payment on the debt irrespective of business profitability, too much debt might compromise the entire operation of the firm. These figures, thus, indicated that firms in Ghana, Kenya, and Zambia are more leveraged compared with other African countries, that might hinder their business operation. Research and development investment is also one of the most critical activities that might be influenced by the high debt ratio of firms in these countries. The lower the debt to assets ratio of 0.435, 0.4561, and 0.5 respectively have been reported by firms in Tanzania, Egypt, and South Africa. Accordingly, firms in Tanzania, Egypt, and South Africa recorded an average debt to assets ratio of 0.435, 0.4561 and 0.5009 respectively. From a pure risk perspective, the investors consider the lower debt to assets ratio as a better debt ratio and accordingly, firms in these countries are less leveraged or have a low level of debt financing. On average, African firms reported the debt to assets ratio of 0.7235 during the last ten years.

Table 3 also presented the mean values of control variables. Nigerian, South African and Egyptian firms are found to be the largest as measured by the total assets. The average total assets of Nigerian firms is 5.8692. While firms in South Africa reported the average total assets of 5.814, Egyptian firms reported the average total assets of 5.1596 over the last ten years. We also found that firms in Kenya, Tanzania, and Zambia are found to be the smallest in size. The mean value of the total assets of firms in Kenya, Tanzania, and Zambia is found to be 0.4902, 0. 4242, and 0.4276 respectively. Recently, the firm size- research and development linkage received significant attention. However, the direction of the association is mixed. While some empirical studies (Zhang, 2008) found large firms have better research and development activities, others (Kim, 2000, Akcigity, 2009) found small and medium-sized firms are more active in R&D activities. Hence, the purpose of this study is to investigate the effect of size on research and development of firms in Africa. African firms reported the average total assets of 4.0258.

Firms in Uganda and Tanzania reported the highest enterprise value of 6.7 and 6.13 respectively. Firms in Ghana, Tunisia, and Egypt, contrarily, recorded the lowest enterprise value. The mean value of enterprise value reported by Ghanaian, Tunisian, and Egyptian firms are 4.7351, 4.2612, and 4.7451 respectively. These figures show while Ugandan and Tanzanian firms have a better market value, Ghanaian, Tunisian, and Egyptian firms have less market value.

The highest market capitalization of 5.1, 5.05, and 4.8, on average, are reported by firms in Uganda, Tanzania, and South Africa. The average market cap of African firms over the last ten years is 3.86. From this, we understand that there exists a heterogeneous nature of the market value of the firms' stock in Africa over the last ten years. This heterogeneous nature of the market value of the stock is supposed to have an immense impact on the firms' engagement in research and development in the continent in general and in the countries in particular.

African firms reported the most heterogeneous characterized cost of employees. While Tanzanian firms recorded the highest average cost of employees of is 11,045,330, Ghanaian firms recorded the lowest average cost of employees is 3,513.5. Furthermore, while Ugandan and Nigerian firms recorded an average cost of employees of 6,448, 946 and -1,036,077 US dollars, Egyptian and Tunisian firms have an average cost of employees of -13,665.39and -16,150.1 US dollars respectively. These figures show while Tanzanian, Ugandan, and Nigerian firms have a better compensation for their employees, Ghanaian, Egyptian, and Tunisian firms

have paid less for their employees. This heterogeneity of employees' benefits across countries might have its influence on the firms' engagement in research and development.

We found that Tanzanian firms are more profitable, followed by Ugandan and Kenyan firms. An average return on assets (ROA) of 7.7615, 7.5302, and 5.4852 reported by Tanzanian firms, Ugandan and Kenyan firms over the last ten years. On the other hand, firms in South Africa, Nigeria, and Egypt found to be less profitable with an average ROA of 0.04131, 0.05534, and 0.0611 respectively. This study found that South African, Nigerian and Egyptian firms are the largest and the less profitable firms compared with other African firms. On average, firms in Africa reported the ROA of 1.6266 during the study period. South African, Moroccan, and Tanzanian firms recorded the highest return on equity (ROE) of 1.745, 0.93, and 0.83 respectively. This figure indicated that firms' management in these countries found to be more effective in deploying shareholders' capital to maximize profit. We, to the contrary, found that firms in Nigeria, Ghana, and Zambia reported the lowest ROE, which accounted for 0.3844, 0.1612, and 0.4075 respectively. African firms recorded an average ROE of 0.824 over the last ten years. Nigerian, Zambian, and Ghanaian firms reported the highest return on sales (ROS) of 1.26, 1.196, and 1.19 respectively. These figures show that firms in these countries run their business more efficiently than firms in other African countries. Tunisian, Egyptian, and Kenyan firms report the lowest ROS of 0.6, 0.66, and 0.76 respectively. In comparison, firms in Tunisia, Egypt, and Kenya found to be less efficient in running their business and generating profit from their revenue. African firms reported an average ROS of 0.8857 during the study period.

South African, Nigerian and Egyptian firms are found to be high growth firms in Africa with an average growth rate of 2.24, 0.89, and 1.1. Conversely, Tunisian, Kenyan, Moroccan, and Ghanaian firms are less growth in Africa. Firms in Tunisia are found to be the least growing firms in Africa with an average firm growth rate of 0.0378. Kenyan, Moroccan, and Ghanaian firms reported an average firm growth rate of 0.0615, 0.0659, and 0.0687 respectively. These figures show that there exists a heterogeneous nature of firm's growth in Africa that might have an influence on the research and development activities of firms in the continent in general and in the countries in particular. Ugandan, Tunisian, and Tanzanian firms reported the highest average employment growth rate of 3.8709, 1.06, and 0.92 respectively. Nigerian and Egyptian firms recorded a negative employment growth rate of -0.679 and -0.18 respectively. These negative growth rates reported by Nigerian and Egyptian firms indicated that firms in these countries might tend to reduce employment. The adverse employment growth might be because the firms in these countries tend to be more technology intensive than labor intensive or they are shrinking rather than growing. Over the last ten years, firms in Africa recorded an average employment growth rate of 0.2148, which is close to 21.5%. On average, firms in Africa reported the enterprise value of 5.13.

The continent reported an average bank deposit to GDP% (banking sector development) of 52.18 over the last ten years. However, the banking development has a heterogeneous nature across African countries. Morocco, Egypt, and South Africa reported the highest average bank deposit to GDP% of 82.8, 64.6, and 59.9 over the last ten years. Contrarily, Uganda, Tanzania, and Zambia reported the lowest average bank deposit to GDP% of 14.33, 18.09, and 18.16 respectively. This heterogeneity in the banking sector development might have influenced the R&D investment of firms differently. Like the bank deposit to GDP%, Morocco, Egypt, and South Africa found to have the well-developed stock market development compared to other countries. In Morocco, the average stock market capitalization to GDP% is found to be the highest which accounted for 64. The second highest average stock market capitalization to GDP% is 40, reported by Egypt. The third highest average stock market capitalization to GDP% is 32.5 which is of South Africa. Like banking sector development, the stock market development has been found to be the lowest in Uganda. Uganda reported an average stock market capitalization to GDP% of 3.9. Stock market development in Ghana and Zambia is also left behind other African countries. Ghana and Zambia reported an average stock market capitalization to GDP% of 7.8 and 13.37 respectively. This heterogeneous nature of the development of the stock market might have an influence on the firms' research and development activities and their slack resource accumulation in the continent in general and in the countries in particular. Table 3 country level descriptive statistics

	South Africa	Nigeria	Egypt	Morocco	Kenya	Tunisia	Ghana	Zambia	Tanzania	Uganda	All
Variables	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
rds	.0165 (.1229)	-.0000167 (.00018)	.0134 (.0988)	-0.00035 (0.0053)	-.00002 (.00024)	-0.00038 (0.0012)	-.0032 (.0179)	0.0212 (0.1652)	-.0001 (.0004)	-.000021 (.0001)	.0085 (.0857)
sgaes	-.3122 (1.9257)	-.25572 (.2475)	-.15402 (2.0547)	-0.1788 (0.1858)	-.2687 (.4971)	-0.24607 (0.2384)	-.6161 (4.6915)	-0.2707 (0.1473)	-.2746 (.1892)	-.2386 (.0801)	-.2437 (1.7321)
cacl	2.4214 (7.6153)	1.294 (.9485)	2.3332 (4.5439)	38.1972 (546.9758)	1.9499 (2.2740)	6.5141 (28.6237)	1.8172 (1.7526)	1.9955 (1.9473)	1.9135 (1.0066)	.5048 (.245)	5.1244 (152.131)
wksales	.14087 (.3021)	.2270 (.3367)	.4685 (1.2504)	0.4127 (0.4187)	.1399 (.1605)	0.3486 (0.5298)	.1407 (.2266)	0.1933 (0.5752)	.1543 (.1122)	.3087 (.2252)	.2927 (.7734)
debt equity	2.5324 (15.9483)	2.9521 (38.2229)	1.224 (6.3477)	0.3455 (0.7498)	.0453 (.1376)	0.4018 (1.8856)	.0709 (.1598)	0.3664 (2.4717)	.0363 (.0422)	.1454 (.2344)	1.4712 (16.624)
debt sales	1.1099 (2.4591)	2.952116 (38.223)	3.9000 (55.0928)	2.1971 (28.7605)	-.2276 (56.8900)	-0.7562 (26.5975)	.5008 (24.2751)	1.0423 (1.3823)	1.9337 (10.7353)	8.3414 (35.998)	2.1677 (40.059)
debt assets	.5009 (.4418)	.57309 (.22257)	.4561 (.2791)	0.80118 (0.6591)	1.1622 (7.9367)	0.7833 (0.8038)	3.9016 (39.3554)	1.3139 (2.6726)	.435 (.3677)	.7949 (.6893)	.7235 (7.5227)
size	5.814 (1.7666)	5.8692 (1.3006)	5.1596 (1.3037)	0.5040 (0.1943)	.4902 (.2585)	0.5271 (0.4846)	1.1510 (4.0723)	0.4276 (0.2332)	.4242 (.2209)	.5219 (.3033)	4.0258 (2.7148)
roa	.04131 (.62401)	.05534 (.09974)	.0611 (.0967)	5.2918 (0.7094)	5.4852 (1.6639)	4.5177 (1.2600)	4.1483 (1.315)	4.8231 (1.8721)	7.7615 (.6363)	7.5302 (.6001)	1.6266 (2.5612)
roe	1.7454 (37.2323)	.3844 (.4018)	.49511 (.3468)	0.9325 (3.7347)	.540951 (.8617)	0.6949 (1.7769)	.1612 (2.3051)	0.4075 (0.2385)	.8316 (1.3025)	.6163 (.2894)	.824 (18.3079)
ros	1.0416 (1.0009)	1.2616 (2.1222)	.6606 (.62393)	0.7769 (0.4137)	.7663 (.9453)	0.6178 (0.536)	1.1902 (1.2445)	1.1969 (1.1653)	.8444 (.5462)	1.0975 (.7668)	.8857 (1.1113)
firmgrowth	2.2420 (58.7782)	.8997 (3.9529)	1.1046 (17.1516)	0.0659 (0.0655)	.0615 (.1101)	0.0378 (0.0927)	.0687 (.5357)	0.1252 (0.1463)	.1986 (.1568)	.0657 (.0727)	1.0376 (30.4546)
employee	.36792 (15.1998)	-.6793 (.4735)	-.1822 (.3931)	0.7359 (2.9645)	.8475 (1.4361)	1.0674 (2.1373)	.5797 (5.7887)	0.8039 (4.1733)	.9277 (1.554)	3.8709 (25.1683)	.2148 (8.0023)
enterprise	5.7224 (1.9205)	5.2474 (2.1848)	4.7451 (1.7697)	5.1931 (1.0765)	5.0145 (2.1660)	4.2612 (1.6562)	4.7351 (1.0087)	5.4042 (1.049)	6.1397 (3.4469)	6.7139 (2.6245)	5.1348 (1.9378)
market	4.8339 (2.5626)	2.6175 (2.9819)	3.1789 (2.5893)	4.7439 (1.7234)	4.4726 (2.5323)	3.6424 (2.1485)	4.3042 (1.9342)	3.7436 (2.4278)	5.0544 (3.9123)	5.104 (2.9566)	3.8607 (2.7055)
coe	-907,699.8 (26703.17)	-1,036,077 (43702.21)	-13,665.39 (3082.075)	-50,171 (970.517)	-628,187.8 (18956.05)	-16,150.1 (513.9932)	-3,513.5 (59.3364)	-33,914.8 (762.691)	-11,045,330 (158120.1)	-6,448,946 (96487.69)	-675,324.8 (34934.92)
bdpgdp	59.955 (2.0511)	20.7278 (5.7613)	64.6678 (7.1336)	82.8733 (4.2413)	37.9544 (2.8611)	51 (3.9751)	20.9144 (2.2032)	18.1657 (1.1126)	18.0911 (.6507)	14.3344 (1.6193)	52.1888 (20.0455)
stmktcgdp	32.5033 (10.7914)	17.7522 (9.7301)	40.1022 (24.7003)	64.0322 (14.0484)	30.6783 (5.0168)	18.5542 (3.471)	7.8388 (.8259)	13.3753 (0.8606)	3.9211 (.2788)	20.768 (5.8269)	32.8584 (20.8439)

NB: standard deviation in parenthesis, rds is R&D expense/sales, sgaes is selling and general administrative expense/sales, cacl is current assets/current liability, wksales is working capital/sales , debt equity is debt/equity, debt sales is debt/sales, debt assets is debt/assets, size, logarithm of total assets, roa is ROA, roe is ROE, ros is ROS, firmgrowth is firm growth, employee is employee growth, enterprise is enterprise value, market is market capitalization, coe is cost of employees, bdpgdp is banking sector development and stmktcgdp is stock market development

6.2 Industry-level descriptive statistics

Table 4 presents the industry level descriptive statistics. We included 12 industry categories using dummies. Firms engaged in media & entertainment found to be relatively more innovative.

Firms engaged in media and entertainment reported the highest average research and development to sales ratio of 0.034 (3.4 %). Firms involved in IT and telecom recorded the second highest research and development to sales ratio (0.021). Firms engaged in agriculture, construction, energy, food and beverage, trade and investment, and transport reported the same research and development to sales ratio during the study period (i.e., 0.01 or 1%). We found that firms engaged in manufacturing found to be the least innovative firms in Africa. These firms reported average research and development to sales ratio of -0.0002 over the last ten years. Firms engaged in Hotel and tourism, Service, and Healthcare recorded average research and development to sales of 0.007, 0.006, and -0.002 respectively. The manufacturing firms recorded the lowest research and development to sales of -0.0002 (0.02 %). Contrarily, Media and Entertainment firms reported the highest research and development to sales ratio of 0.034 (3.4n %) over the last ten years. This figure indicated that there exists a disparity in research and development intensity across industries in Africa.

We found firms engaged in energy, healthcare, hotel and tourism, trade and investment, and transport reported the same selling and general administrative expense to sales ratio (-0.3 or 30%) over the last ten years. Again, firms engaged in agriculture, construction, IT and Telecom, manufacturing, media, and entertainment and services reported similar selling and general administrative expense to sales ratio (-0.2 or 20%) in the same period. Firms engaged in Food and Beverage, however, reported a minimum (considering absolute value) selling and general administrative expense to sales ratio (-0.17 or 17%).

The highest current ratios, 13.41, 11.09, and 7.28, are reported by firms engaged in Transport, construction, and Service respectively. Whereas, the lowest, 1.63, 1.69, and 2.08, are recorded by IT and telecom, Media & entertainment, and agricultural firms respectively. Construction firms reported a higher working capital to sales ratio (0.44) followed by healthcare with average working capital to sales ratio of 0.35. Transport firms with 0.34, service firms with 0.33, and manufacturing firms with average working capital to sales of 0.31. While firms engaged in food and beverage, Trade & investment, and Media & entertainment reported an average working capital to sales ratio of 0.26, 0.25, and 0.24 respectively, firms engaged in agriculture, energy, Hotel and tourism, and IT and telecom reported an average working capital to sales ratio of 0.2.

Manufacturing firms reported the highest average debt to equity ratio of 2.69. The trade and investment, service and the construction firms also recorded the second highest debt to equity ratio of 1.76 and 1.74, and 1.69

respectively. Hotel and tourism and media and entertainment firms reported the third highest debt to equity ratio of 1.56. We also found a heterogeneous debt to sales ratio across industries in Africa with the highest average debt to sales ratio of 13.96, reported by healthcare firms, and with the lowest average debt to sales ratio of -0.14, reported by energy firms. This figure depicted that while healthcare firms are highly leveraged, energy firms have more sales. We also found that trade and investment and transport firms are highly indebted. These firms reported an average debt to assets ratio of 1.45 and 1.3 respectively. Contrarily, agricultural firms are found to be least indebted with an average debt to sales ratio of 0.48 over the last ten years.

We found that IT and telecom firms are relatively largest with an average firm size of 4.71 followed by hotels and tourism firms with an average firm size of 4.61. Conversely, Food and Beverage and construction firms are found to be relatively smaller with an average firm size of 3.38 and 3.58 respectively. Trade and investment, IT and telecom, hotel and tourism, and energy firms reported an average market capitalization of 4.06, 4.08, 4.03, and 4.18 respectively. Healthcare firms recorded the lowest market capitalization of 3.43. Manufacturing firms exhibited the minimum enterprise value. However, firms involved in other industries reported almost the same (closer to 5) average enterprise value in Africa (see Table 4).

Construction firms, food and beverage, and energy firms are found to be more profitable with an average ROA of 2.15, 2.06 and 2.0 respectively. Compared to others, however, IT and telecom and hotel and tourism firms are found to be less profitable with an average ROA of 0.69 and 1.21 respectively. Transportation firms reported the highest ROE (average ROE = 4.56), indicating transportation firms are far better in generating profit with the money their shareholders have invested. Manufacturing firms reported an average ROE of 0.65, the second highest ROE, followed by the transportation firms (see table 4). Agricultural firms exhibited the lowest average ROE of 0.41. Service firms also reported an average ROE of 0.42 over the last ten years. These figures revealed the fact that agricultural and service firms do not efficiently generate profit using the money that has invested by their shareholders. Firms engaged in trade and investment, hotel and tourism, and agriculture found to have a better operational performance with an average ROS of 1.18, 1.12 and 1.0 respectively. However, transport, health care, food and beverage, and energy firms found to have a relatively the lowest operational performance. Transportation, food and beverage, health care, and energy firms exhibited an average ROS of 0.77, 0.73, and 0.76 respectively during the study period.

Firm growth exhibited a heterogeneous nature across industries in Africa. Food and beverage and construction firms are found to be the least growth firms with an average growth rate of 0.014 and 0.39 respectively. IT and telecom firms have recorded a negative firm growth rate of-0.74 that indicates there exists a business contraction in this industry in Africa. Conversely, healthcare, trade and investment, and media and entertainment firms recorded the highest firm growth rate of 5.53, 3.59, and 2.61 respectively. Expansion and a contraction of employment growth have exhibited in agriculture and media and entertainment with an average growth rate of 1.29 and -0.005 respectively. On average, media and entertainment and food and beverage firms incurred, the highest, cost of employees. These firms reported an average cost of employees of -1,250,602 and -1,200,704 US dollars during the study period. Compared to others, however, trade and investment and manufacturing firms incurred the minimum cost of capital (an average cost of employees of -253,468.7 and -256,044 respectively). In general, this industry level descriptive statistics, like the country level descriptive statistics, exhibited various characteristics of variables across industries that for sure has an implication plus influences on the association between research and development intensity and slack resources in Africa.

Table 4 Industry level descriptive statistics

	South Africa	Nigeria	Egypt	Morocco	Kenya	Tunisia	Ghana	Zambia	Tanzania	Uganda	All
Variables	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
rds	.0165 (.1229)	-.0000167 (.00018)	.0134 (.0988)	-0.00035 (0.0053)	-.00002 (.00024)	-0.00038 (0.0012)	-.0032 (.0179)	0.0212 (0.1652)	-.0001 (.0004)	-.000021 (.0001)	.0085 (.0857)
sgaes	-.3122 (1.9257)	-.25572 (.2475)	-.15402 (2.0547)	-0.1788 (0.1858)	-.2687 (.4971)	-0.24607 (0.2384)	-.6161 (4.6915)	-0.2707 (0.1473)	-.2746 (.1892)	-.2386 (.0801)	-.2437 (1.7321)
cacl	2.4214 (7.6153)	1.294 (.9485)	2.3332 (4.5439)	38.1972 (546.9758)	1.9499 (2.2740)	6.5141 (28.6237)	1.8172 (1.7526)	1.9955 (1.9473)	1.9135 (1.0066)	.5048 (.245)	5.1244 (152.131)
wksales	.14087 (.3021)	.2270 (.3367)	.4685 (1.2504)	0.4127 (0.4187)	.1399 (.1605)	0.3486 (0.5298)	.1407 (.2266)	0.1933 (0.5752)	.1543 (.1122)	.3087 (.2252)	.2927 (.7734)
debt equity	2.5324 (15.9483)	2.9521 (38.2229)	1.224 (6.3477)	0.3455 (0.7498)	.0453 (.1376)	0.4018 (1.8856)	.0709 (.1598)	0.3664 (2.4717)	.0363 (.0422)	.1454 (.2344)	1.4712 (16.624)
debt sales	1.1099 (2.4591)	2.952116 (38.223)	3.9000 (55.0928)	2.1971 (28.7605)	-.2276 (56.8900)	-0.7562 (26.5975)	.5008 (24.2751)	1.0423 (1.3823)	1.9337 (10.7353)	8.3414 (35.998)	2.1677 (40.059)
debt assets	.5009 (.4418)	.57309 (.22257)	.4561 (.2791)	0.80118 (0.6591)	1.1622 (7.9367)	0.7833 (0.8038)	3.9016 (39.3554)	1.3139 (2.6726)	.435 (.3677)	.7949 (.6893)	.7235 (7.5227)
size	5.814 (1.7666)	5.8692 (1.3006)	5.1596 (1.3037)	0.5040 (0.1943)	.4902 (.2585)	0.5271 (0.4846)	1.1510 (4.0723)	0.4276 (0.2332)	.4242 (.2209)	.5219 (.3033)	4.0258 (2.7148)
roa	.04131 (.62401)	.05534 (.09974)	.0611 (.0967)	5.2918 (0.7094)	5.4852 (1.6639)	4.5177 (1.2600)	4.1483 (1.315)	4.8231 (1.8721)	7.7615 (.6363)	7.5302 (.6001)	1.6266 (2.5612)
roe	1.7454 (37.2323)	.3844 (.4018)	.49511 (.3468)	0.9325 (3.7347)	.540951 (.8617)	0.6949 (1.7769)	.1612 (2.3051)	0.4075 (0.2385)	.8316 (1.3025)	.6163 (.2894)	.824 (18.3079)
ros	1.0416 (1.0009)	1.2616 (2.1222)	.6606 (.62393)	0.7769 (0.4137)	.7663 (.9453)	0.6178 (0.536)	1.1902 (1.2445)	1.1969 (1.1653)	.8444 (.5462)	1.0975 (.7668)	.8857 (1.1113)
firmgrowth	2.2420 (58.7782)	.8997 (3.9529)	1.1046 (17.1516)	0.0659 (0.0655)	.0615 (.1101)	0.0378 (0.0927)	.0687 (.5357)	0.1252 (0.1463)	.1986 (.1568)	.0657 (.0727)	1.0376 (30.4546)
employee	.36792 (15.1998)	-.6793 (.4735)	-.1822 (.3931)	0.7359 (2.9645)	.8475 (1.4361)	1.0674 (2.1373)	.5797 (5.7887)	0.8039 (4.1733)	.9277 (1.554)	3.8709 (25.1683)	.2148 (8.0023)
enterprise	5.7224 (1.9205)	5.2474 (2.1848)	4.7451 (1.7697)	5.1931 (1.0765)	5.0145 (2.1660)	4.2612 (1.6562)	4.7351 (1.0087)	5.4042 (1.049)	6.1397 (3.4469)	6.7139 (2.6245)	5.1348 (1.9378)
market	4.8339 (2.5626)	2.6175 (2.9819)	3.1789 (2.5893)	4.7439 (1.7234)	4.4726 (2.5323)	3.6424 (2.1485)	4.3042 (1.9342)	3.7436 (2.4278)	5.0544 (3.9123)	5.104 (2.9566)	3.8607 (2.7055)
coe	-907,699.8 (26703.17)	-1,036,077 (43702.21)	-13,665.39 (3082.075)	-50,171 (970.517)	-628,187.8 (18956.05)	-16,150.1 (513.9932)	-3,513.5 (59.3364)	-33,914.8 (762.691)	-11,045,330 (158120.1)	-6,448,946 (96487.69)	-675,324.8 (34934.92)
bdpgdp	59.955 (2.0511)	20.7278 (5.7613)	64.6678 (7.1336)	82.8733 (4.2413)	37.9544 (2.8611)	51 (3.9751)	20.9144 (2.2032)	18.1657 (1.1126)	18.0911 (.6507)	14.3344 (1.6193)	52.1888 (20.0455)
stmktcgdp	32.5033 (10.7914)	17.7522 (9.7301)	40.1022 (24.7003)	64.0322 (14.0484)	30.6783 (5.0168)	18.5542 (3.471)	7.8388 (.8259)	13.3753 (0.8606)	3.9211 (.2788)	20.768 (5.8269)	32.8584 (20.8439)

NB: standard deviation in parenthesis, rds is R&D expense/sales, sgaes is selling and general administrative expense/sales, cacl is current assets/current liability, wksales is working capital/sales , debt equity is debt/equity, debt sales is debt/sales, debt assets is debt/assets, size, logarithm of total assets, roa is ROA, roe is ROE, ros is ROS, firmgrowth is firm growth, employee is employee growth, enterprise is enterprise value, market is market capitalization, coe is cost of employees, bdpgdp is banking sector development and stmktcgdp is stock market development

7.Correlation matrix

The pairwise Pearson's correlation was employed to evaluate the association of explanatory variables used in this study. There is no standard effect size of the correlation coefficient in the extant econometric literature. However, Cohen (1988) provides the widely used guideline for the effect size of the correlation for the behavioral sciences. According to Cohen (1988), an absolute value of the correlation ranging from 0.1 to 0.3 is a small association. Cohen also stated that while the correlation coefficient ranges from 0.3 to 0.5 are medium, the absolute correlation coefficient greater than 0.5 are the large correlation. Furthermore, Evans (1996) suggested for the absolute value of correlation (r) from 0.00-0.19 "very weak", 0.20-0.39 "weak", 0.40-0.59 "moderate", 0.60-0.79 "strong", and 0.80-1.0 "very strong". The correlation analysis result of our study seems to be in favor of the guideline suggested by Evans. Therefore, we tend to follow Evans' guideline to interpret the correlation result of our study.

Accordingly, we found the small and positive association between current ratio and selling and administrative to sales ratio. The correlation coefficient of these variables is 0.0001 and shows that an increase in the current ratio will lead to an increase in the selling and administrative to sales ratio. There exists a small and negative association between working capital to sale ratio and selling and general administrative to sales ratio. The correlation coefficient is -0.032, indicating a decrease in the current ratio will lead to an increase in selling and general administrative to sales ratio or vice versa. The association among these variables is also statistically significant with the p-value of 0.002. We also found a small negative association between the debt to equity ratio and selling and general administrative expense to sales ratio. The ratio of debt to sales and debt to assets have a moderate negative association with the selling and general administrative expense to sales ratio. We also found a small positive association between firm size and selling and administrative expense to sales ratio with a coefficient of 0.0012 indicating that an increase firm size is dependent on selling and general administrative expense and vice versa. The selling and general administrative/sales ratio has a small positive association with market capitalization, firm's growth, employment growth, enterprise value and cost of employees (employees' compensation in our study). The association of selling and general administrative expense to sales ratio with firm's growth and employee growth is statistically significant with r=0.0731, p =0.0000 and r=0.0418, p=0.001 respectively. We also found a positive and significant association between selling and general administrative

expense to sales ratio and the banking sector and the stock market development. The correlation coefficient between selling and general administrative expense to sales ratio and the banking sector development is 0.0337 with the p-value of 0.0004. The association between the current ratio and the working capital to sales, debt to equity, and debt to sales, ROE, ROS, firm size, market capitalization, firm growth, and enterprise value is found to be small and negative. The association between the current ratio and firm size is statistically significant with r=0.0292 and p= 0.01. However, its association with the variables described above is not statistically significant. To the contrary, the current ratio is found to have a weak and positive association with the ROA, the cost of employees, the banking and the stock market development. The association of current ratio with the banking and the stock market development is statistically significant with the correlation coefficient (r) of 0.0282 and p-value of 0.0101 and r of 0.0331 and p-value of 0.0027 respectively. These association indicated the fact that a development of the stock and the banking sector development will lead to the increment in the accumulation of a firm's current assets. We found a very weak association between debt to equity ratio and working capital to sales. There exists a negative correlation between debt to equity and working capital to sales with r=-0.0045 indicating an increase in the ratio of debt to sales ratio will lead to a decrease in the ratio of working capital to sales and vice versa. The correlation coefficient between the debt to sales and working capital to sales ratios is 0.065 with a p-value of 0.0000. This figure shows that there is the same direction in the movement of the debt to sales and the working capital to sales ratios. The correlation between the ratio of debt to assets and the ratio of working capital to sales is very weak and negative with r=-0.0012, indicating that a decrease in the ratio of debt to assets will lead to an increase in the ratio of working capital to sales. The association between the working capital to sales ratio and ROA, ROE, and ROS is negative. The correlation between working capital to sales and ROA is -0.0426 with the p-value of 0.0001. While the correlation of working capital to sales with ROE is -0.0056 with a p-value of 0.6094, its correlation with ROS is -0.0359 with p-value = 0.0005. These figures indicated the fact that the boost in firms' performance will decline its working capital. The association between firm size and working capital to sales ratio is positive (r=0.0302, p=0.0127). While the correlation between employment growth and enterprise value is negative, the relationship between the firm's growth, the working capital to sales ratio and the cost of employees, the banking sector, and the stock market development is positive. This correlation indicated the fact that as employment growth and enterprise value increases, working capital decreases and as firm's growth, the cost of employees, the banking sector, and the stock market development increases, the firm's working capital increases. The ratio of debt to equity positively correlates with the ratio of debt to sales with r=0.31, p= 0.0000 and the ratio of debt to assets with r= 0.0013and p=0.8864. Similarly, the relationship between debt to equity and firm size, ROE, ROS, firm growth and the stock market development is positive. Contrarily, we found a negative association between the debt to equity and the ROA, market cap, employee growth, enterprise value, the cost of employees, and banking sector development. A very weak and negative correlation between the ratio of debt to sales and debt to assets has happened (r=-0.0015, p=0.8911). Likewise, there exists a very weak negative association between debt to sales and ROA, ROE and ROS with r=-0.0138, p=0.0996, -0.0007, p=0.9506, and -0.0201, p= 0.0392 respectively. This negative association tells us as the financial and operational performance of firms increased, the debt to sales decreases and vice versa. On the contrary, a very weak and positive association between debt to sales and firm size, market capitalization, firm's growth, enterprise value, cost of employees, and the stock market development has existed. The association between the ratio of debt to assets and firm size, market capitalization, firm's growth, employee growth, and enterprise value is negative. We also found the negative association of debt to assets with the banking sector and the stock market development with the correlation coefficient and p-value of -0.0324 & 0.0034 and -0.0208 & 0.0598 respectively. This association shows that the development of financial sector decreases the debt to assets ratio. A unique association between debt to assets and ROE has happened. We found a nonlinear association between the ratio of debt to assets and ROA with r=0 and p= 0.9968. As we can see from here, the p-value is higher, indicating that there exists a non-linear association between these two variables (the higher p-value shows that the correlation coefficient is not different from 0 and a 0 correlation coefficient indicated there is no linear relationship between the variables). We found a strong and a negative association between firm size and ROA with r=0.7906 and p=0.0000, indicating that as the firm's profitability increased, the firm size decreases. We computed ROA as net income divided by total assets. As a result, empirical investigation of Kartikasari and Merianti (2016) evidenced that the less a total asset held by a firm, the higher ROA it generates, taking net income constant. This fact is what evidenced in this study too. Likewise, there exists a negative correlation between firm size and market cap, employee growth, the cost of employees, and stock market development. However, the correlations between firm size, ROE and ROA are positive with r=0.0086, p=0.4401 and r= 0.0548, p=0.0000. Hence, an increase in the ROE and ROS will lead to an increase in the firm size. Similarly, we found a positive association between firm size and firm growth (r=0.0267, p=0.0104), the enterprise value (r=0.1474, p= 0.0000) and banking sector development (r=0.061, p=0.0000). This figure indicated that the firm's growth, enterprise value, and the banking sector development have a positive contribution to firm size and vice versa. The correlation between ROA and market cap (r=0.1401, p= 0.0000), employee growth (r=0.0513, p=0.0000),

and enterprise value (r=0.0524, p=0.0000) is found to be positive, indicating the fact that an increase in market capitalization, employee growth, and the enterprise value leads to an increase in the firms return on assets. Whereas the ROA's association with ROE, ROS, firm's growth, the cost of employees, the development of banking and stock market is negative. ROE is also negatively associated with ROS (r=-0.0159, p=0.1394), firm's growth (r=-0.001, p=0.9247), and stock market development (r=-0.0019, p=0.8625). However, it is positively correlated with market capitalization (r=0.0279, p=0.0101), employee growth (r=0.0003, p=0.9767), the enterprise value (r=0.0087, p=0.4347), cost of employees (r=0.0021, p= 0.8233), and banking sector development (r=0.0141, p=0.1932). The ROS is found to have a positive association with a market cap with the correlation coefficient of 0.012 and p-value of 0.2677, firm growth (r=0.0326, p= 0.0021), enterprise value (r=0.0269, p=0.0044), and cost of employees (r=0.0038, p=0.9419). On the other hand, it is negatively associated with employee growth (r=-0.004, p= 0.8580), banking sector development (r=-0.1251, p=0.0000), and the stock market development (r=-0.072, p= 0.0000). This relationship revealed that while an increase in market capitalization, the firm's growth, enterprise value, and cost of employee leads to an increase in operational performance, an increase in employee growth, the banking sector, and the stock development will lead to a decline in firm's operational performance. A very weak and negative association has happened between market cap and the cost of the employee (r=-0.0741, p=0.0000), indicating the fact that as the cost of employees moves up, market cap will decline. Contrarily, there exists a positive association between market cap and the firm's growth, employee growth, the enterprise value, the banking sector, and the stock market development. There exists a positive correlation between the firm's growth, the banking sector, and the stock market development with the r (p-value) of 0.0079 (0.4444) and 0.0153 (0.1665). This relationship implies the fact that the boost in the financial sector development will enhance the firm's growth and vice versa. However, we found a negative correlation between the firm and employee growth and the cost of employees with the correlation coefficient of -0.0009 (p= 0.9191) and -0.0006 (0.9989) respectively. As a result, an increase in the cost and growth of employee will lead to a decline in the firm's growth. The employee growth is weakly and negatively correlated with cost of employees and positively correlated with enterprise value, the banking sector, and the stock market development. We found a negative association between enterprise value and cost of employees, the banking sector and the stock market development. The cost of employees is positively correlated with the banking sector and the stock market development, indicating the financial market development will increase the cost of employees. Finally, we found a strong positive association between the banking sector and the stock market development with r=0.6719, p=0.0000.

Generally, we found a strong correlation between firm size and return on assets and the banking sector and the stock market development. The correlation coefficients between explanatory variables are under Evan's category of 'very weak' correlation. The correlation analysis, moreover, is used to detect the multicollinearity problem. A strong correlation (r=0.8) among the explanatory variables shows the existence of a multicollinearity problem in the model. However, the association among many of the variables used in this study is very weak; reasonably small and we can conclude that our model is free from multicollinearity.

Table 5 correlation matrices

	sgaes	cacl	wksales	debteq~y	debtsa~s	debtas~s	size	roa	roe	ros	market~n	firmgr~h	employ~h	logent~e	cost~100	bdpgdp	stmktcgdp
sgaes	1																
cacl	0.0001	1															
wksales	-0.0322*	-0.0077	1														
debtequity	-0.0102	-0.0023	-0.0045	1													
debtsales	-0.3703*	-0.0008	0.0654*	0.3094*	1												
debtassets	-0.4878*	-0.0008	-0.0012	0.0013	-0.0015	1											
size	0.0012	-0.0292*	0.0302*	0.057*	0.0183	-0.0148	1										
roa	-0.0001	0.0287*	-0.0426*	-0.0493*	-0.0138	0.0317*	-0.7906*	1									
roe	-0.0009	-0.0007	-0.0056	0.0011	-0.0007	0	0.0086	-0.0052	1								
ros	-0.006	-0.0013	-0.0359*	0.0047	-0.0201*	0.0092	0.0548*	-0.0377*	-0.0159	1							
marketcapi~n	0.002	-0.0053	-0.0325*	-0.0125	0.0012	-0.0018	-0.0902*	0.1401*	0.0279*	0.012	1						
firmgrowth	0.0731*	-0.0006	0.0018	0.0028	0.0367*	-0.0022	0.0267*	-0.0186	-0.001	0.0326*	0.0035	1					
employeegr~h	0.0418*	0.0013	-0.0058	-0.0051	-0.0001	-0.0886*	-0.036*	0.0513*	0.0003	-0.004	0.023	-0.0009	1				
logenterpr~e	0.0056	-0.0053	-0.0382	-0.0392*	0.0054	-0.0072	0.1474*	0.0524*	0.0087	0.0269*	0.0817*	0.0111	0.0168*	1			
costofem~100	0.0042	0.0042	0.0336*	-0.0045	0.0008	0.0025	-0.0578*	0.1372*	0.0021	0.0038	-0.0741*	-0.0006	-0.0153	-0.2336*	1		
bdpgdp	0.0337*	0.0282*	0.0853*	-0.0081	-0.0003	-0.0324*	0.061*	-0.1436*	0.0141	-0.1251*	0.0808*	0.0079	0.0117	-0.0355*	0.1677*	1	
stmktcgdp	0.039*	0.0331*	0.039*	0.0068	0.0001	-0.0208	-0.0287*	-0.009	-0.0019	-0.072*	0.043*	0.0153	0.0139	-0.0579*	0.1174*	0.6719*	1

NB: standard deviation in parenthesis, rds is R&D expense/sales, sgaes is selling and general administrative expense/sales, cacl is current assets/current liability, wksales is working capital/sales , debt equity is debt/equity, debt sales is debt/sales, debt assets is debt/assets, size, logarithm of total assets, roa is ROA, roe is ROE, ros is ROS, firmgrowth is firm growth, employee is employee growth, enterprise is enterprise value, market is market capitalization, coe is cost of employees, bdpgdp is banking sector development and stmktcgdp is stock market development

8. Multicollinearity

Multicollinearity problem in the model will cause (1) the variation in coefficient estimates based on the inclusion and the exclusion of other predictors in the model, that is coefficients become very sensitive to small changes in the model and (2) it lessens the accuracy of the estimated coefficients (weakens the statistical power of the model); the p-value might not be trusted to identify predictors that are statistically significant and then, it is hard to draw a useful conclusion (Belsley et al., 2005, Greene, 2003). We can multicollinearity in different ways. For instance, (1) the non-significant t-tests for coefficients while the overall f-test is significant, (2) a strong correlation of two or more predictors (r=.95) and small sample size (N=100) can be a sign of multicollinearity existence in the model. The most common and frequently used way of detecting multicollinearity is the correlation analysis. According to Farrar and Glauber (1967), an admittedly arbitrary rule of thumb is established to constrain simple association between predictors to be smaller than, say, r = 0.8 or 0.9. That is, a higher correlation (r=0.95) of predictors shows the existence of multicollinearity problem in the model. Looking at only the correlation's coefficients among predictors, however, has limitation. It is possible that the pairwise correlation is small, and yet a linear dependence exists among three or more variables, for example, if x4= 2x2+3x3+error, say. That is why many empirical studies often rely on the Variance Inflation Factor (VIF) help detecting multicollinearity. VIF quantifies how much the variances of estimated coefficients are inflated. Accurately how large a VIF has to be before it causes issues is a subject of debate. What is known is that the more the VIF value increases, the less reliable the regression results are going to be. However, the general rule of thumb is that VIF which is higher than four warrants further investigations, while VIF greater than ten indicates the presence of serious multicollinearity problem (O'brien, 2007). However, O'brien (2007) recently argued that it is possible to draw a useful conclusion even with VIFs exceeding the rule of thumb of four and ten because in some given situation it might not be possible to change factors influencing the VIF; like small sample size. However, sometimes a high VIF is not an issue. For instance, we may get a high VIF if we include the product of a predictor itself (x and x2). Likewise, we used the products of selling and general administrative expense to sales ratio (SAGAE/Sales2), current ratio (CA/CL2) and working capital to sales ratio (wk/sales2) as the purpose of this study is to investigate the curve-linear relationship between research and development intensity and slack resources. Therefore, we expect the strong correlation between selling and general administrative expense to sales ratio and SAGAE/Sales2, current ratio and CA/CL2, and working capital to sales ratio and wk/sales2. Accordingly, we excluded (SAGAE/Sales2), wk/sales2, (CA/CL2 from the model when we employed VIF. Both the correlation (see Table 3) and VIF (see Table 4) show multicollinearity is not an issue. We found the highest correlation coefficient between firm size and ROA (r=0.79) and banking sector development and the stock market development (r=0.67). These correlation coefficients are below the rule of thumb of 0.95, indicating that multicollinearity is not a problem. Also, the VIFs are reasonably small. The largest VIF is 3.19 and 3.12 (see Table 4) which is somewhat below the rule of thumb of four and ten, in turn, revealed no multicollinearity existed in this study. Hence, we are confident enough to conclude that our model is

free from multicollinearity and we can retain all the predictors in our model. Furthermore, we are pretty sure to proceed to other required investigations.

Table 6 tests of multicollinearity

Variable	VIF	1/VIF
roa	3.19	0.313
size	3.12	0.321
bdpgdp	1.98	0.506
stmktcgdp	1.86	0.537
sgaes	1.66	0.603
debtassets	1.41	0.711
debtsales	1.39	0.718
costofem	1.16	0.865
logenterpr~e	1.15	0.870
debtequity	1.14	0.879
marketcapi~n	1.05	0.957
ros	1.03	0.975
wksales	1.02	0.983
firmgrowth	1.02	0.984
employeegr~h	1.01	0.988
cacl	1.00	0.998
roe	1.00	0.998
Mean VIF	1.48	

NB: standard deviation in parenthesis, rds is R&D expense/sales, sgaes is selling and general administrative expense/sales, cacl is current assets/current liability, wksales is working capital/sales , debt equity is debt/equity, debt sales is debt/sales, debt assets is debt/assets, size, logarithm of total assets, roa is ROA, roe is ROE, ros is ROS, firmgrowth is firm growth, employee is employee growth, enterprise is enterprise value, market is market capitalization, coe is cost of employees, bdpgdp is banking sector development and stmktcgdp is stock market development

9.Result

9.1Overall regression result: hypothesis testing

We run a regression analysis taking all countries together to investigate the association between R&D intensity and slack resources. We presented these overall regression results in the last column of Table 7. The first hypothesis of this study proposed the inverted U-shape between available slack and innovation intensity of firms in Africa. However, our study does not confirm this hypothesis. This study has exhibited the U-shape relationship between available slack and innovation intensity. Both the current and the working capital to sales ratios have a negative influence on the innovation intensity of firms in Africa. However, the current ratio and the working capital to sales ratio beyond a certain level have a positive association with innovation intensity of African firms. Our study has exhibited an inverted U-shape relationship between recoverable slack and innovation intensity. That is this study confirmed the second hypothesis. The recoverable slack has a negative influence on the innovation intensity of firms. However, the recoverable slack beyond a certain level tends to have a positive impact on the innovation intensity of firms. The main effect of the potential slack is found to be positive, indicating that potential slack components hurt the R&D investment of firms. Notably, the ratio of debt to assets has exhibited a statistically significant and negative impact on the innovative intensity of firms. This result shows that the third hypothesis, potential slack has a positive relationship with innovation intensity, is not confirmed.

Our overall regression result also has presented the relationship between control variables and innovation intensity. Firm size, as measured by the logarithm of total assets, has a negative and significant association with innovation intensity. Market capitalization (significant with p-value = 0.05) and enterprise value have a positive association with innovation intensity of firms in Africa. While the ROA and ROE have a negative association, ROS have a positive association on with the innovation intensity in Africa. The overall regression result exhibited a negative and a positive correlation between firm growth and employment growth with the innovation intensity of African firms. We found an inverse relationship between the cost of employees and innovation intensity in Africa. The overall regression exhibited a positive, but not statistically significant association between the banking sector development and innovation intensity in Africa. We finally found a negative but not strong association between the stock market development and the innovation intensity in Africa.

Table 7: OLS regression taking all countries (overall regression)

	rds
sgaes	.0009192**
	(.0003407)
sgaes2	-9.12e-06
	(6.54e-06)
cacl	-.0003109*
	(.0000676)
cacl2	3.69e-08*
	(8.03e-09)
wksales	-.0067238*
	(.0012125)
wksales2	.0004165*
	(.0000828)
debtequity	3.69e-06
	(.0000246)
debtsales	.0000232
	(.0000157)
debtassets	.0002773*
	(.0000749)
size	-.0262718*
	(.003384)
roa	-.0062714**
	(.0021482)
roe	-.0000225**
	(9.24e-06)
ros	.0004171
	(.0007779)
market	.0008144**
	(.0003706)
firmgrowth	-6.30e-06
	(7.83e-06)
employee	.0000248**
	(.0000117)
enterprise	.0060268*
	(.0006942)
cost	-1.25e-08
	(2.64e-08)
bdpgdp	.0004012
	(.0002513)
stmktcgdp	-.0000233
	(0000998)
_cons	.0410546**
	(.0183737)
Industry fixed effects	Yes
Country fixed effects	Yes

NB: Robust standard error in parenthesis, *is significant at 1% level, **is significant at 5 % level, *** is significant at 10 % level, *rds is R&D expense/sales, sgaes is selling and general administrative expense/sales,* sagaes2 is *selling and general administrative expense/sales square, cacl is current assets/current liability,* $cacl^2$ *is current assets/current liabilities square, wksales is working capital/sales ,* $wksales^2$ *is working capital/sales square, debt equity is debt/equity, debt sales is debt/sales, debt assets is debt/assets, size, logarithm of total assets, roa is ROA, roe is ROE, ros is ROS, firmgrowth is firm growth, employee is employee growth, enterprise is enterprise value, market is market capitalization, coe is cost of employees, bdpgdp is banking sector development and stmktcgdp is stock market development*

9.2 Industry-level regression result

Table 8 presents the industry level regression results. The purpose of this regression is to investigate whether there exists a difference in the relationship between slack resources and research and development intensity

across industries in Africa. We controlled the country fixed effect believing the heterogeneous nature of states might have a strong influence on the association of the slack resources and innovation intensity. Our fourth hypothesis is confirmed in this study because we found different slack components affect the innovation intensity of firms differently across industries. That is, our study confirmed both a linear and a curve-linear relationship between slack resources and innovation intensity across industries in Africa (see Table 8).

Both linear and non-linear relationship between the recoverable slack and innovation intensity have existed across industries. For instance, this study confirms a positive correlation between recoverable slack and innovation intensity in agricultural, energy, hotel and tourism, media and entertainment, service, and transportation industries. We also found a negative linear relationship between recoverable slack and research and development intensity in IT and Telecom and manufacturing firms. That is, no matter how much the recoverable slack the firm has, such slack resources adversely impact the innovation intensity of these industries. While an inverted U-shape relationship between recoverable slack and innovation intensity has confirmed in the construction industry, a U-shape relationship between these two variables has existed in food and beverage, healthcare, and trade and investment industries.

We found a curve-linear relationship between available slack and innovation insanity in all industries, and the curve linearity has a different nature. We found an inverted U-shape relationship between current ratio and innovation intensity of firms in agriculture, construction, energy, food and beverage, hotel and tourism, IT and telecom, media and entertainment, service, trade and investment, and transport industries. To the contrary, a U-shape relationship between current ratio and innovation intensity has confirmed in the healthcare and manufacturing industries. Both curve linear and linear relationship between working capital to sales and innovation intensity has existed. We found an inverted U-shape relationship between working capital ratio and innovation intensity in construction, energy, healthcare, media and entertainment, trade and investment, and transport, IT and telecom, manufacturing, and service industries. We also found a U-shape relationship between innovation intensity and working capital ratio in IT and telecom, manufacturing and service industries. A negative association between innovation intensity and the working capital ratio (both wksales and $wksales^2$) has exhibited in agriculture, food and beverage, and hotel and tourism industries.

Potential slacks are found to have a mixed linear relationship with innovation intensity of firms across industries. The debt-equity ratio of firms in agriculture, construction, energy, hotel and tourism, and manufacturing industries has a positive associated with innovation intensity. Debt to equity is also negatively associated with the innovation intensity of firms in food and beverage, healthcare, IT and telecom, media and entertainment, services, trade and investment, and transport industries. The ratio of debt to sales has a negative associated with the research and development intensity of agriculture, construction, and energy industries. Conversely, it has a positive association with innovation intensity of food and beverage, healthcare, hotel and tourism, IT and telecom, manufacturing, media and entertainment, trade and investment, and transport industries in Africa. A negative association between the ratio of debt to sales and the innovation intensity of agriculture, energy, healthcare, hotel and tourism, IT and telecom, media and entertainment, services, and transport industries has confirmed. The positive association between these two variables has also exhibited in construction, food and beverage, manufacturing, and trade and investment industries.

We controlled the firm-level and the country-level variables in employing the industry-level regression, and we found the relationship of the firm-level and the country-level variables with the innovation intensity is different across industries (see Table 8).

Table 8 Industry level regression result

rds	agriculture	Construction	Energy	Food & b.	Health care	Hotel and T.	IT & Tel.	Manufacturing	Media & Ent.	Service	Trade & inv.	Transport
sgaes	.2260145* (.0770729)	-.0001421 (.0001951)	.0181895 (.0165717)	.022281* (.0073422)	.0078844** (.0041282)	.014248* (.0052992)	-.1002086** (.038929)	-.0001549 (.0002264)	.0086159 (.0355567)	.0319867* (.0100868)	.0032827* (.0016088)	.0092064 (.006984)
sagaes2	.1903788* (.0687036)	8.03e-07 (.0000114)	.0003526 (.0003403)	-.0151181** (.0063774)	-.0001099 (.0001734)	.0007399* (.0002449)	-.1176977** (.0534617)	-.0000648 (.0001205)	.0024578 (.0156572)	.0122133** (.004961)	-.0000574** (.0000268)	.0002218 (.0002644)
cacl	-.0034807 (.0039693)	-.0000878** (.0000448)	-.0005502*** (.0002959)	-.0034578** (.0016968)	.0005866 (.0007158)	-.001839* (.0005948)	-.044341* (.0151654)	5.08e-06*** (3.01e-06)	-.0408921* (.0143927)	-.0052703*** (.0029277)	-.0023651** (.0011901)	-.0033621 (.004086)
$cacl^2$	.0000704 (.0001291)	1.06e-08** (5.33e-09)	1.54e-06 (1.04e-06)	.0000515*** (.0000286)	-.0000492 (.0000493)	.0000105* (3.87e-06)	.0043867** (.001735)	-1.92e-08 (2.24e-08)	.0041107** (.0016345)	6.25e-07*** (3.47e-07)	.0000169*** (8.65e-06)	3.99e-07 (4.85e-07)
wksales	-.004778 (.0035578)	-.0033119** (.0015828)	-.0369518* (.0125019)	-.0018977 (.0029677)	-.0116189 (.0109405)	-.0011946 (.0027988)	.0215594 (.0251967)	.0000238 (.0000506)	-.072461** (.0395384)	.0070283** (.0029285)	-.0125111** (.0050894)	-.0027658 (.004555)
$wksales^2$	-.0002696 (000805)	.0002351** (.0001009)	.012826** (.0063766)	-.001322 (.0008854)	.0170401 (.0145844)	-.0017931 (.0014136)	-.0019389 (.0090002)	-2.97e-06 (3.33e-06)	.0432475 (.027466)	-.0008112** (.0003738)	.0006359** (.0002487)	.0006956 (.0007429)
debtequity	.0001248 (.0000875)	.0000461 (.000037)	.0008717 (.0007021)	-.0000922** (.0000462)	-.0002447 (.000967)	.001871** (.0007285)	-.0000434 (.0027153)	1.24e-06** (4.95e-07)	-.000358*** (.0002086)	-.0000755*** (.0000396)	-.0001164*** (.0000693)	-.0009449 (.0005768)
debtsales	-.0001579 (.0001027)	-.0000139 (.0000288)	-.0000232 (.000019)	6.46e-06 (.0000276)	.0004879 (.0003801)	.0003909* (.0001455)	.0001561 (.002704)	.0000117* (3.07e-06)	.0008685 (.0005561)	.000059** (.0000298)	.0000894 (.00007)	1.85e-06 (.000031)
debtassets	-.0916833* (.0319581)	.0001931 (.0008217)	-.0000318 (.0015762)	.0082482* (.0028318)	-.0019025 (.0018509)	-.0314658* (.009752)	-.0779243** (.0338602)	.0000181 (.0000551)	-.0154845 (.0152522)	-.0049135** (.0022215)	.000366*** (.0002154)	-.0004458 (.0013289)
size	-.0540425* (.0170123)	-.0254741* (.009545)	-.0291024** (.0130876)	-.0371003* (.0102629)	-.0038225*** (.0021133)	-.0315584* (.0061452)	-.0308519* (.0055619)	3.45e-06 (.000029)	-.0586555* (.0064547)	-.0283898* (.0077394)	-.0156009** (.0079497)	-.0112024* (.0056623)
roa	.0099444** (.0042064)	.0050615* (.0021119)	-.0067784** (.0030261)	-.0040418** (.0017662)	.0005465 (.0007169)	-.0243225* (.0067915)	.0134827 (.0102959)	-7.95e-06 (.0000175)	-.0098708*** (.0053256)	-.0043995 (.0029635)	.0007906 (.0029024)	-.0090628 (.0055582)
roe	-.0090567 (.0145039)	.0038992 (.0025392)	.0017389 (.0021575)	.0024079 (.0020156)	.0012488 (.0029584)	-.0033388 (.0034877)	-.0229373 (.0205986)	1.25e-06 (2.48e-06)	.0166072*** (.0092141)	.0002094 (.0003739)	-.0108884 (.0075515)	-.0000318* (.0000107)
ros	-.0015008 (.0018924)	-.0008335 (.0021612)	.0125796** (.0053591)	-.0057376*** (.0029417)	.0014313 (.0009253)	.0001241 (.0013149)	.0078601 (.0097913)	-5.41e-06 (.0000146)	-.0028155 (.0036968)	.0032334 (.0015996)	-.0017476 (.0016091)	-.0028449 (.0044278)
marketcapitalization	-.0022912 (.0014776)	.0014857* (.0005548)	.0041281 (.002524)	.0018593 (.0011507)	-.0003514 (.0004898)	.0022539* (.000657)	.000381 (.0018579)	5.19e-07 (5.87e-06)	.0029403 (.0018827)	-.0003219 (.0007723)	-.002613** (.0011824)	.0005899 (.0019796)
firmgrowth	-.000746 (.0005493)	-.000052 (.0000818)	-1.66e-06 (.0001291)	-.0000634** (.0000253)	-.0004166 (.0003184)	-.0000291 (.000165)	.0001334* (.0000508)	2.32e-07 (3.66e-07)	.0000369** (.0000142)	.0001358* (.0000488)	-5.62e-06 (4.35e-06)	-.0010524*** (.0005944)
employeegrowth	.0000467 (.0000308)	.0009576*** (.0005059)	6.62e-06 (.0001093)	.00388 (.0004401)	.0002615 (.0002741)	.0003245 (.0037643)	-.0076286 (.0076046)	-.0000606 (.0000435)	-.0002695 (.0015652)	.0016092 (.0012089)	-.0020939*** (.0011459)	-.0023378 (.0037007)
logenterprisevalue	.0091271* (.0027777)	.0045978** (.0019048)	.0061922*** (.003383)	.0087969* (.0026069)	.0003909 (.0006943)	.0056847* (.0016857)	.00864* (.0025838)	5.16e-06 (7.68e-06)	.0183456* (.003174)	.0056536** (.0022079)	.0049567* (.0016468)	.0043417*** (.0023789)
coe100	-6.33e-07** (2.86e-07)	2.75e-07** (1.28e-07)	-1.65e-07 (1.43e-07)	5.81e-08* (2.24e-08)	-1.18e-07*** (6.36e-08)	-4.00e-07* (1.35e-07)	4.98e-08 (2.44e-07)	1.69e-09 (2.74e-09)	-4.71e-07* (1.37e-07)	-1.60e-07* (5.62e-08)	1.70e-06* (6.49e-07)	1.91e-07** (8.13e-08)
bdpgdp	.0016783 (.0020385)	.0001126 (.0008043)	.0006281 (.0007765)	-.0004334 (.0004696)	.0001194 (.0001127)	.0007545*** (.0004105)	-.0004877 (.00079)	4.93e-06 (5.00e-06)	.0005998 (.0008552)	-.0000202 (.000388)	.0015935 (.0016512)	.0001824 (.0009985)
stmktcgdp	-.0006386 (.0007225)	-.0001349 (.000281)	.0001468 (.0003096)	.0004426 (.0003495)	.000014 (.0000278)	-.0002769** (.0001381)	.0000467 (.000241)	-1.04e-06 (1.77e-06)	.0006567 (.0004303)	.0002311 (.0002296)	-.0005257 (.0005812)	-.0001951 (.0003674)
_cons	.0506461 (.0356794)	-.0410859* (.0133669)	.2967183* (.0379539)	-.006264 (.0146382)	-.0062789 (.0059064)	.1645268* (.0386055)	.2416155* (.0936523)	-.000073 (.0001031)	-.0786216 (0504509)	.0351136*** (.0193265)	-.01063 (.0258581)	.3584011* (.0442742)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

NB: Robust standard error in parenthesis, *is significant at 1% level, **is significant at 5 % level, *** is significant at 10 % level, *rds is R&D expense/sales, sgaes is selling and general administrative expense/sales,* sagaes2 is *selling and general administrative expense/sales square, cacl is current assets/current liability,* $cacl^2$ *is current assets/current liabilities square, wksales is working capital/sales ,* $wksales^2$ *is working capital/sales square, debt equity is debt/equity, debt sales is debt/sales, debt assets is debt/assets, size, logarithm of total assets, roa is ROA, roe is ROE, ros is ROS, firmgrowth is firm growth, employee is employee growth, enterprise is enterprise value, market is market capitalization, coe is cost of employees, bdpgdp is banking sector development and stmktcgdp is stock market development*

10.Discussion

Previous studies have been focused on innovation because it creates competitive advantage through organizational adaptation and product development. Studies also focus on slack resources because it buffers firms from a shortage of funds and foster innovation. Previous studies also investigated the wastefulness and inefficiency of slack resources held by an organization (Nohria and Gulati, 1996). However, studies involving organizational slack have limited to the slack's impact on organizational outcomes such as risk-taking, organizational behavior, performance, and innovation. The first study on the relationship between slack and firm's innovation has carried out by Nohria and Gulati (1996). However, this study was not able to examine the impact of multidimensional slack resources on organizational outcomes, though they call future researches for doing so. Based on their call, Cheng and Kesner (1997) and Geiger and Cashen (2002) investigated the multidimensional impacts of slack on innovation. Unfortunately, no study to date has examined the relationship between the slack components and the innovation of firms in different industries (hereinafter heterogeneous nature of industries).

The current study has investigated the impact of different slack components on innovation taking the heterogeneous nature of industries into consideration. Specifically based on data from a sample of 923 firms in 10 African countries and 12 industries, results show that different types of financial slack impact innovation intensity of firms differently across industries. These different relationships between slack resources and innovation come from the heterogeneous nature of industries. Our study yields the following key results.

First, our study confirmed an inverted U-shaped relationship between available slack and innovation, thereby hypothesis 1 has confirmed. This inverted U-shape relationship between available slack and R&D intensity has supported in IT and telecom, Manufacturing, and service industries. This result supported the behavioral theory of the firm stating slack favorably impacts innovation by easing managerial control, quasi-resolution of conflicts and avoiding uncertainties (Cyert and March, 1963). Once the firm is protected from uncertainties (uncertainty of experimental projects' failure), because of the existence of slack, firms innovative culture is likely to develop (Bourgeois III, 1981, Nohria and Gulati, 1996). However, slack resources beyond a certain level, in the above industries, have a negative impact on innovation. Agency theory argued slack results from principal-agency conflicts. In the real world, agents do not always have incentives to behave in the best interest of the firm. Again, the principal does not always have perfect information to monitor the agent.

Therefore, the agent is inclined to use the excess resources, slack in our case, in the way they can maximize their wealth that impacts the innovative activities of the firms adversely. The inverted U-shape relationship between available slack and innovation intensity, in our study, therefore is because of incentive-asymmetric information structure.

Second, we found a U-shape relationship between available slack and innovation in construction, energy, media and entertainment, trade and investment, and transportation industries. The U-shaped relationship in this study confirms the idea of advocates of slack resources on innovation. From a psychological perspective, innovation is more acceptable with the existence of excess slack because it protects the firms from the risk of failures (Singh, 1986, Cyert and March, 1963). The presence of little slack restricts the range of available alternatives open to managers, so does an organization's flexibility and innovativeness (Miles and Cameron, 1982). Thus, the U-shaped relationship between available slack and innovation in this study supports the advocates of slack resources. The argument by the behavioral theory of the firm (Cyert and March, 1963) is that organizations are viewed as political coalitions consist of individuals or subgroups with different personal goals. Thus, the role of management is to achieve quasi-resolution of conflicts and uncertainty avoidance. The management of the firm, therefore, crucially used slacks for resolving such latent disputes and uncertainty avoidance. Firms in construction, energy, media and entertainment, trade and investment, and transportation industries were able to use available slack in the way it allows innovative projects. Moreover, slack resources enable firms in these industries to more safely experiment with new strategies for introducing new products and entering emerging markets.

Third, we found an inverted U-shape, curve linearity, between recoverable slack and innovation intensity in Africa and healthcare and trade and investment industries. This result indicated the fact that the recoverable slack (already absorbed) supported the firms to be more innovative in healthcare, and trade and investment industries. However, it has also shown by this study that the innovation intensity of firms in healthcare and trade and investment industries are declining with an excess recoverable slack beyond a certain level.

Fourth, a unique, U-shape relationship between recoverable slack and innovation intensity has exhibited in the construction industry. The innovation intensity of the construction industry declines with recoverable slack and then started to rise at some point with the recoverable sack beyond a certain level.

Fifth, we found both a negative and positive association between potential slack and innovation intensity of firms across industries indicating a heterogeneous nature of industries makes a difference in the relationship of potential slack and innovation. The positive correlation between the ratio of debt to sales (an adverse effect of debt to sales on R&D investment) and innovation has exhibited in food and beverage, healthcare, hotel and tourism, IT and telecom, manufacturing, media and entertainment, services and transport industries. This association of potential slack and innovation intensity indicates as the potential slack (debt to sales) increases, innovation declines. The negative relationship (positive effect of the ratio of debt to sales on innovation) between debt to sales and innovation has exhibited in agriculture, construction, and energy industries. This association of potential slack and innovation intensity indicates as potential slack of the firm (debt to sales) increases, innovation intensity increases. The mixed result (positive and negative effects of potential slack on innovation) indicated that because of the heterogeneous nature of industries, the impact of potential slack on the firms' innovation intensity is different across industries. This relationship is a manifestation that a financing strategy (debt financing) of firms has to take the different natures of industries into consideration to reach into clear and particular financial decision. For instance, any action taken to correct the ratio of debt to sales in favoring innovation of firms in food and beverage, healthcare, hotel and tourism, IT and telecom, manufacturing, media and entertainment, services and transport industries, it will adversely influence the innovation of agriculture, construction, and energy industries. This result also showed that the debt financing strategy of firms need to be in line with the innovative activities of the industry in which the firm is operating.

Similarly, this study found a mixed result on the correlation of debt to assets and innovation across industries. The positive association of debt to assets and innovation has exhibited in construction, food and beverage, manufacturing, and trade and investment industries. The positive association of potential slack (debt to assets) and innovation indicates the fact that potential slack has a negative influence on the innovativeness of firms in the above countries and industries. The correlation between debt to assets and innovation is found to be negative in agriculture, energy, healthcare, hotel and tourism, IT and telecom, media and entertainment, service and transport industries. This negative correlation indicates potential slack also has a positive influence on the innovativeness of firms in the above industries.

11.Policy implication and future research direction

Our study found different types of slacks affects innovation intensity of firms differently across industries in Africa. Firstly, our study has confirmed an inverted U-shape and a U-shape relationship between available, recoverable slack and innovation intensity in different industries in Africa. That is, an excess available slack beyond a certain level hurt innovation intensity of some industries and a positive impact on the innovation

intensity of other industries (see the discussion part of this study). With this regard, our study implies that considering the heterogeneous nature of industries is very important to make a managerial decision on the accumulation of slack resources and utilizing it for the enhancement of innovative activities of firms. Secondly, potential slack has a favorable effect on some industries and an adverse impact on some other industries. This result also implies that a debt financing strategy of the firm should be in line with the industry in which it is operating. That is a debt financing strategy of the firm in the agriculture industry might not be effectively enhancing the innovation of the firm engaged in IT and telecom industry because of the heterogeneous nature of these industries. This study finally calls for the future studies. This study is limited to examining whether the relationship between financial slack resources and innovation is different based on the sizes and the age of the firms. Therefore, futures studies should investigate the relationship between slack resources and innovation by taking firm size categories (small, medium and large firms) and firm age (young and mature). Future studies should also investigate the effects of organizational slack resources such as human resources and technology on firm's innovation intensity.

12.Conclusion

This study examined the association of different slack components with the innovation of firms in Africa. We extracted the data from OSIRIS database. Our sample is consists of 923 firms in 10 African countries. The descriptive statistics have done across countries and industries that clearly show the difference in the level of finical slack accumulation and innovation intensity in different African countries and industries. Accordingly, firms in Zambia, South Africa, and Egypt found to be more innovative, and firms in Nigeria, Kenya, and Uganda are less innovative. Again, firms engaged in media & entertainment found to be relatively more innovative and manufacturing firms found to be the least innovative. Regarding the level of financial slack, Ghanaian, South African, Tanzanian, and Kenyan firms reported the highest recoverable slack. Moroccan firms accumulated so much more available slack (current ratio) and Ugandan firms recorded the lowest available slack during the last ten years. Similarly, while Transport, construction, and Service firms accumulated the highest available slack, IT and telecom, Media & entertainment, and agricultural firms recorded the lowest available slack. A potential slack has been found to be higher in Nigeria and South Africa, and the lowest potential slack is recorded by firms in Tanzania, Kenya, and Ghana. Manufacturing firms have much potential slack and food, and beverage firms found to have the lowest potential slack. These figures show that there exists a disparity in the accumulation of financial slack and in the level of innovation across countries and industries. This disparity allows us to employ the industry-level regression so as to reach to a strong policy implication.

An industry-level OLS regression results show different slack resources affect the innovation intensity of firms differently across industries. On the one hand, our study confirmed a behavioral theory, on the other hand, it supported the agency theory. An inverted U-shape relationship between available and recoverable slacks and innovation has exhibited in some industries. Contrarily, the available and the recoverable slack found to have a U-shape relationship with innovation. An inverted U-shape relationship between available slack and R&D intensity has confirmed in IT and telecom, Manufacturing, and service industries. Our study also has exhibited a U-shape relationship between available slack and R&D intensity in construction, energy, media and entertainment, trade and investment, and transportation industries. A curve-linear relationship (inverted U-shape) between recoverable slack and innovation intensity has confirmed in healthcare and trade and investment industries. Conversely, a U-shape relationship between recoverable slack and innovation has exhibited in the construction industry.

A mixed result on the correlation of potential slack and innovation intensity has exhibited in this study. We found both a negative and positive association between potential slack and innovation intensity across industries indicating a heterogeneous nature of industries makes a difference in the relationship of potential slack and innovation intensity. Potential slack positively affects agriculture, construction, and energy firms.

Our study finally offers the following policy implications. First, our study implies that the heterogeneous nature of industries is fundamental to make a managerial decision on the accommodation of slack resources and enhancement of innovative activities of firms. Second, the debt financing strategy of the firm should be in line with the industry in which it is operating.

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