

Financial Access, Research & Development, and Innovation in Kenya

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Declaration

I hereby declare that this project is my own work and has never been previously submitted for examination or awarding of any academic credentials in any institution.

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This research project has been submitted for examination with my approval as the university supervisor.



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Dedication

To my late mother, Ms. Janet Ciomithea Matheta, who always counseled patience and persistence in the pursuit of my endeavors.

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List of Abbreviations

WBES – World Bank Enterprise Survey

ES – Enterprise Survey

R&D – Research and Development

DEA – Data Envelope Analysis

GDP – Gross Domestic Product

ICT – Information Communication Technology

IT – Information Technology

OECD – Organization for Economic Co-operation and Development

Abstract

Engagement in R&D activities is directly linked to sustained growth of firms. The resource intensive nature of the R&D process requires enterprises to have adequate financial capabilities to finance such activities. Availability of finance is core to investing in R&D and innovation especially considering uncertainty in the prediction of a project's output, and the length of the R&D and or innovation project from its inception to the introduction of the resulting product into the market. Inadequate access to finance therefore hinders research, innovation and subsequently the potential of the enterprise to expand. This study utilized panel data from the WBES 2013-2018 to explore the relation between financial access, R&D, and innovation for firms in Kenya. Using a panel logit model, we found a positive and significant relation between R&D activities undertaken by firms and access to loan financing and international markets. The relation between R&D activities and majority local ownership of firms was determined to be negative and statistically significant. Access to overdrafts and internal finance were found to relate positively with firm R&D though this effect was not statistically significant. The study also explored how access to finance relates with innovation. We found positive but statistically insignificant relationship between innovation and usage of loans, overdrafts, internal finance, access to international markets and majority local ownership of firms. The study advocates for policy interventions to encourage Kenyan firms to participate in innovation and R&D programs.

Chapter 1: Introduction

1.1 Background

Research & Development (R&D) and innovation activities are essential drivers of economic growth and subsequently, development. Policies in the global north have always reflected the importance of R&D to their continued success in the world markets and similarly, the global south is increasingly placing R&D and innovation agenda at the forefront of its policies. Efthyvoulou and Vahter (2016) assert that nations aiming to strengthen their innovation potential have to align their scientific and technological innovation strategies with availability of capital to ensure the actualization of the desired products or processes. Finance and R&D are therefore intertwined.

However, with the underdeveloped financial markets in the global South, the financing of R&D proves a challenge especially for enterprises devoid of adequate internal capital or retained earnings. R&D and innovation activities are resource intensive and risky considering that there exists no guarantee that the product or process being researched will materialize (Metric & Yasuda, 2021). Additionally, enterprises turning to the capital markets for finance usually have to grapple with the challenge of information asymmetries as innovators are reluctant to share sensitive information especially considering the various appropriability concerns inherent in the global south whereby informal economy is quite robust. Additionally, considering that R&D and innovation activities are not viable collateral, accessing financing especially in the underdeveloped financial markets of the developing countries becomes a significant challenge.

There is direct linkage between investments in innovation activities and sustained growth of firms. However, such investment depends on an enterprise's ability to access finance, a critical element in product R&D process (Tolliver et al., 2021). The sensitivity of innovation investment

projects to financial constraints is mainly due to uncertainty especially in the prediction of the project's output, and the length of the innovation project from its inception to the introduction of the resulting product into the market. Inadequate access to finance therefore hinders research, innovation and subsequently the potential of the enterprise to expand.

Globalization has enhanced the ability of firms to access foreign markets and though there is willingness to innovate and expand, access to finance becomes one of the major constraints to such growth (Metric & Yasuda, 2021). The financing gap is more pronounced in the global south than in the developed world due to the latter's advancement in financial markets with institutions that have developed time-tested risk-coping strategies for lending to enterprises. Inaccessibility of finance due to underdeveloped financial markets is essentially a challenge for the global south especially in Africa. Available survey data indicates accessibility of finance as being an ever-present constraint for firms especially in the developing world. Dinh et al (2012) examined data from a 2006 to 2010 World Bank Enterprise Survey (WBES) regarding the biggest constraints on firms in the developing world. The sample spanned across 98 countries with over 39,000 enterprises, who ranked financial access among the top 3 obstacles to firm operations.

African R&D, for instance in the health sector lags behind that of other regions across the world. Though this continent has a considerable professional base within this sector, there are various factors inhibiting successful undertaking of critical R&D across the continent. Simpkin et al. (2019) opines that among these factors, inadequate funding is the most prominent obstacle. This author notes that that health R&D in Africa is also affected by insufficient infrastructure, and a failure to invest in the biotechnology sector hence leaving the health organizations under-resourced. Another notable limiting factor is the lack of collaboration between the African academic ecosystems within the continent and the diaspora. The failure to leverage on the

connections of the diaspora with their motherland prevents the African health sector from benefiting from the immense resources that can be mobilized through the diaspora. Regarding funding, Simpkin et al. (2019) writes that the channeling of resources towards R&D requires the financiers to do so sustainably unlike some instances whereby research is halted due to inadequate resources. These authors also stress on the need for African governments to collaborate with players from the other sectors, for instance the private sector to ensure resources, both private and public are availed for R&D.

This paper explores the relationship between financial access, innovation and R&D for enterprises in Kenya. The paper will utilize WBES data for period 2013 and 2018 in exploring this subject. The interaction of finance, R&D and innovation will be analyzed from an objective approach to eliminate idiosyncratic differences among respondent firms hence ensuring the robustness of the results.

This research will add to the existing works in two ways. First is that its focus on enterprise-level data for Kenyan firms will offer critical insight on the accessibility of finance by these firms and how it affects R&D and innovation. Such insight will therefore inform the designing of the relevant policies and their subsequent implementation, hence enhance financial access and thereby drive innovation for businesses in Kenya. Additionally, this approach will provide a deeper understanding of financial access and its effects on innovation activities. The second contribution is that it will add to the current limited body of research on this topic especially regarding countries in sub-saharan Africa.

1.2 Statement of the Problem

Much of the existing literature explores how finance affects R&D and Innovation from a subjective approach that is prone to bias especially on an individual's perception of the business environment or their firm's performance. Underinvestment in R&D is also quite evident in Africa with Madden (2020) noting that a paltry 1330 patents were registered from Africa in 2017 in comparison to Asia that saw 592,508 registrations in the same year. Madden (2020) further revealed that most of the African patents were actually registered by non-Africans, with R&D financing being a major constraint. Additionally, there is limited literature on the subject topic with respect to Kenya. There is therefore a knowledge gap on the relationship between financial access, innovation and R&D with respect to the Kenyan economy. This research thus aims to address this gap.

1.3 Objectives of the Study

Our general objective is exploring how R&D and innovation relates to various forms of finance in Kenya. Specifically, the research will:

- i. Examine the relationship between internal finance, R&D and innovation
- ii. Examine the relationship between loans, R&D and innovation
- iii. Examine the relationship between overdrafts, R&D and innovation
- iv. Suggest the appropriate policy interventions

1.4 Significance of the Study

This paper examines the relationship between financial access and innovation in Kenya at a time when sub-Saharan Africa is gaining prominence as an emerging market. In exploring this

matter, the paper analyses financial access from an objective perspective whereby we consider an enterprise's ability to obtain financing either from external players or through the mobilization of internal capital. This study intends to explain the relationship between financial access, innovation and R&D in Kenya. We will examine this accessibility alongside firm characteristics for instance whether, they are foreign owned or locally owned, and whether they are exporting or non-exporting firms. Eventually, we will propose policy interventions towards improving R&D in Kenya.

1.5 Organization of the Paper

The organization of this paper is as follows: The second chapter contains the literature review. The methodology is in chapter three and entails the theoretical framework, econometric specification, data source, variables and their definition and measurement, and other econometric issues. In chapter four, descriptive statistics and empirical results are presented. Chapter five contains the summary and conclusion of the findings, the subsequent policy implications and areas requiring further research.

Chapter 2: Literature Review

2.1 Introduction

This chapter contains theoretical review of the value maximization theory and the resource-based theory of the firm. Additionally, empirical literature regarding the subject of finance, innovation and R&D is also explored. An overview of both sections is presented in the third part of the chapter.

2.2 Theoretical Review

2.2.1 Value Maximization Theory (Shareholder Wealth Maximization Theory)

This theory proposes that firms should consider and implement decisions that result in the maximization of their share value, which subsequently maximizes shareholder's wealth. The value maximization theory considers the share value as indicative of the effectiveness and efficiency of a firm (Khan & Hussanie, 2018). This model is a departure from the traditional profit maximization theory whose main assumption was that the primary concern of firm leaders was the maximization of short-run profits. The value maximization model recognizes that firms regularly forego short-run profits in their investment decisions to maximize long-run profits. Based on such sacrifices, firms therefore invest heavily on R&D, and capital equipment to ensure profitability in the long-run. The value maximization model incorporates time in its analysis of managerial decisions whereby the current value is obtained by discounting the present value of the estimated future cash flows. Besides the consideration of the time dimension, this model also accounts for risk and uncertainty by ensuring that high risk ventures are discounted at higher rates in comparison to low risk ventures (Denis, 2019). The value maximization model therefore eliminates two primary shortcomings of the profit maximization model through its recognition of the time-value aspect and its recognition of the risks and uncertainties facing a firm in the long-run.

According to the value maximization model, the firm's value is dependent on pricing decisions, product sales and the firm's costs (Freeman et al., 2021). The pricing and sales decisions are dependent on the firm's marketing strategy – which requires innovation – and its demand function. The production technology undertaken by the firm significantly influences the nature of the costs incurred both variable and fixed costs. For instance, application of capital intensive technology translates to higher fixed costs hence the need for continued research by firms in pursuit of more efficient technology. Production cost is thus determined by the firm's technology and the input prices. This theory also recognizes the role of the financial market in determining firm profitability in that this markets determines the interest rates hence directly impacting the borrowing costs of the firm.

The firm's primary goal of shareholder wealth maximization is constrained by various factors including level of technology, inputs, competition, financial and legal constraints. These constraints thus restrict the potential opportunities available to the firm and in effect impede the wealth maximization goal (Khan & Hussanie, 2018). The constraining factors thus necessitate R&D and innovative activities to ensure better technology, and improved innovative approaches of dealing with competitors to gain a bigger market share. To combat the financial constraints, this model recognizes two primary approaches of raising financial resources, which include share issue and debt finance. This model thus recognizes that shareholder wealth maximization requires better technology – hence the need for R&D and innovation – both of which are impacted by the financial constraint.

2.2.2 Resource-based Theory of the Firm

This model argues that a firm's ownership of strategic resources facilitates its development of competitive advantage over other firms. Such competitive advantages enable the firm to realize

increased profits over time. This theory was propounded by Wernerfelt (1984) who defined strategic resource as a rare and valuable asset that is non-substitutable and difficult to imitate. This model recognizes the degree of value in a particular resource as being dependent on a firm's ability to create opportunities using the subject resource in addition to warding off threats. The difficulty to imitate aspect ensures that the resource is not easily duplicated by competitors and such difficulty could be due to legal protections like patents and trademarks. The non-substitutability aspect arises whereby competitors are unable to use alternative means to obtain the benefits provided by that particular resource.

A resource with the four qualities as outlined in this model ensures sustained competitive advantage. However, Barney (2018) notes that even in the absence of one or two of these qualities, the resource will still provide a measure of competitive advantage, albeit in the short-run. For instance, a rare and valuable resource that is easily imitated will most likely provide a short-term edge before competitors replicate it.

The resource-based theory recognizes the essence of innovation and R&D and activities in ensuring that a firm obtains a strategic resource. As elaborated for businesses by Wernerfelt (1984), firms need to grow their technology capabilities to protect and grow their positions in the market. This theory further distinguishes resources into two groups namely tangible and intangible resources, with the former having a higher likelihood of meeting the strategic resource criteria of being rare, of high value, non-substitutable and difficult or expensive to imitate. The model also underscores the essence of dynamic capability – skills and knowhow –, which continually generates other skills and know-how.

The presence of strategic resources within a firm is dependent on the extent of research activities that a firm undertakes in search of new capabilities and resources. Wernerfelt (1984)

identifies the presence of technology groups and cross-divisional strategic organizations in firms as being indicative of essence of techno-focus in firm strategy.

2.2.3 The Innovation Theory of profit

Joseph A. Schumpeter was the proponent of this theory. He posited that entrepreneurs can introduce successful innovations hence earning economic profits (Mehmood et al., 2019). According to Schumpeter, the primary function of entrepreneurs in any industry is to innovate and introduce the resulting inventions into the market upon which they earn profits. Schumpeter defined innovation as any policy undertaken by entrepreneurs for facilitating cost reduction or even ensuring increased demand of products by the market. He thus devised two categories of innovation namely cost reduction activities and demand creation activities. Cost reduction activities could for instance be new techniques of production that improve efficiency hence reducing wastage. Schumpeter also believed that new innovative methods and machinery could also reduce costs hence resulting in increased profits for the entrepreneur (Mehmood et al., 2019). Industry reorganization is also one of the cost reduction activities that Schumpeter emphasized in this theory. In terms of increasing demand, Schumpeter identified various activities including availing new quality goods into the market, sourcing raw materials in new environments, discovering new markets or introduction of new product designs. This theory thus stresses that achievement of increased profits for entrepreneurs is possible through demand creation or cost reduction both of which require R&D and innovation.

Schumpeter argued that due to imitation of innovations by competitors, innovative entrepreneurs earn profits for a limited time (Dalton & Logan, 2020). This theory posits that an innovator initially enjoys a monopoly position courtesy of their invention hence earning significant profits, which begin to diminish due to imitation by competitors. This imitation happens due to

either absence of legislative mechanisms to protect innovations or poor enforcement of patent laws which exposes innovators to infringement of their rights. Schumpeter stressed that patenting was critical in protecting entrepreneurs from copyright infringement. The theory further posits that due to rising factor prices, production cost also subsequently rises. The adoption of an innovation by imitators also increases resulting in profit reduction for the innovators due to the increasing unit cost and the reducing unit revenue.

In formulating this theory, Schumpeter proposed that innovation promotes the evolution of the markets through creative destruction. The process of creating destruction happens when long-standing arrangements are disrupted by new inventions which frees resources for new deployments hence promoting market efficiency (Dalton & Logan, 2020). For instance, introduction of new machinery operating independently could result in layoffs, with this labor being freed for deployment into other sectors hence increasing productivity.

Schumpeter argued that technological change usually occurs in three stages namely invention of a particular technology, innovation and eventually diffusion into the markets. The invention stage comprises of idea conception, innovation involves channeling resources towards the implementation of the new invention whereas the diffusion stage involves the adoption of the new innovation and its subsequent imitation by competitors (Mehmood et al., 2019). Schumpeter's view of innovation was limited to the economic aspects. However, other economists such as Friedrich Hayek argued that innovation also occurs at the social and political spheres.

The innovation theory that though the presence of capital is necessary for innovation, it also needs to be stable and mobile. Potential innovators require capital mobility as it ensures the convertibility of different types of wealth into credit form (Mehmood et al., 2019). Mobility includes transferable documents for immovable property for instance title deeds, which can be

availed as collateral to potential investors. Capital stability emanates from a functional justice system which ensures lawful resolution of any disputes including the application of patent law.

Various criticisms have been mounted against the innovation theory of profit. For instance, this theory fails to factor in the uncertainty that is inherent in the markets. Uncertainty has significant influence in determining the success of innovations and in effect the profits derived by entrepreneurs from such innovations. Opponents of this theory argue that even without innovation, firms can be profitable if the entrepreneurs can reduce uncertainty through predictive mechanisms (Dalton & Logan, 2020). As such, these opponents argue that prediction of the demand and supply conditions is of greater essence than innovation since profitability can be present even in the absence of innovation. Another criticism of this theory is that Schumpeter stressed on innovation as the only source of profits and ignored other factors from which entrepreneurs can derive profits. An example of such is monopoly power, which is also a source of profits for firms in some industries. Entry barriers could also ensure long term profits for existing players even in the absence of innovation and the same applies to ownership of strategic resources (Mehmood et al., 2019). Schumpeter also claimed that risk is entirely borne by credit providers and not entrepreneurs, which is not accurate. The entrepreneur bears the risk since financiers require security for their money, which necessitates entrepreneurs to offer collateral for credit. Schumpeter also argued that an entrepreneur's role is limited to introducing innovations, a claim that contradicts the reality of the modern entrepreneur. Entrepreneurs play various roles including efficiently organizing business, coordinating production factors, and as such, their role is not limited to only innovation.

2.3 Empirical review

Available literature indicates a strong correlation between availability of financing and a firm's ability to conduct R&D projects. Himmelberg and Petersen (1994) studied how R&D is impacted by internal finance. They utilized panel data comprising of observations from 179 enterprises operating in high-tech industries in America. Their study revealed a statistically significant connection between internal finance and investment in R&D. Himmelberg & Petersen (1994) concluded that due to imperfections in capital markets, the acquisition of technology by small firms through R&D is mainly determined by internal financing. This study however has scope limitations as it did not take into perspective firms resource constrained firms especially in developing countries and their need for external finance for their research and innovation activities.

Bond et al. (2005) explored the issue of innovation investment in both Britain and Germany. Their study tested the impact of cashflow on investment in R&D and fixed capital by using micro panel data from the subject countries for the period 1985 to 1994. Their research revealed different trends for both countries with reference to cashflow. Bond et al. (2005) employed simple econometric models of R&D, and in the case of for German businesses, cash flow was not informative on either investment or R&D spending. However, regarding the British firms, identical specifications revealed cashflow as being informative on investment and not on R&D spending levels. Their study also revealed that for British firms, the level of cashflows was indicative of an enterprise's engagement in R&D. Overall, Bond et al. (2005) concluded that financial constraints affected R&D decisions especially for British firms and that enterprises engaging in R&D tended to be those with less binding financial constraints. The major shortcoming of Bond et al.'s (2005) study is that they excluded foreign firms – significant players in R&D – hence their sample was not representative of the firm population in both countries

The 1990s experienced an R&D boom especially in the United States followed by a subsequent decline post 2000. Brown, Fazzari and Petersen (2009) examined whether this 90s boom and subsequent decline in R&D was caused by finance supply shifts. In their Paper, Brown et al. (2009) estimated R&D models through the application of the generalized method of moments (GMM) on firm-level data of 1,347 listed technology firms. An analysis of the indicators of access to external and internal equity revealed statistically significant results for young enterprises. Brown et al. (2009) noted that American firms tended to finance R&D through stock issues and cashflows. The estimated models revealed a pattern whereby unavailability of external equity and funding affected young firms whereas for the more established firms, financing of R&D was through their retained earnings hence less dependence on the financial markets for such operations. Overall, this study stressed on the connection between finance, R&D and economic growth due to increased productivity. These authors observed that considering the R&D boom was primarily attributable to the young firms, the findings are in tandem with shifts in financial supply.

Hewitt-Dundas (2006) adopted a more holistic approach to studying constraints to innovation by examining both capability and resource constraints in large and small plants. This author noted that for innovating initiatives in firms to succeed, there is need to understand aspects constraining the innovation activity and their corresponding impacts on large and small firms. Hewitt-Dundas (2006) utilized longitudinal data from a study on enterprises and innovation in Ireland to demonstrate the evolutionary nature of the innovation process. This author argued that innovative activities by enterprises are reflective of their heterogeneity and that resource and knowledge accumulation by innovative firms ensures attainment of dynamic increasing returns. Hewitt-Dundas (2006) further explained that the presence or absence of inherited resources has a significant impact on resource accumulation and subsequently the innovation process regardless

of the firm size. However, small plants face greater difficulty in overcoming organizational and financial constraints to innovation in comparison to big plants due to the latter's ability to tap into either external financing or retained earnings to finance the innovation process.

Efthyvoulou and Vahter (2016) investigated the impact of financial deficiencies – inadequate internal and external finance – on a firm's innovativeness. A unique aspect of their study is that they adopted a sectoral approach in their analysis to further understand the subject of study. The study utilized sample data from enterprises in 11 Western European countries. Their analysis revealed that innovative enterprises experiencing financial constraints are less likely to be ranked among the most successful innovators by 15-20%. Efthyvoulou and Vahter (2016) attributed this decreased likelihood to the assertion that firms tend to finance innovation projects through either the issuance of equity or from their retained earnings. If these financing sources fail to materialize, then they present a binding constraint to the innovation process. The study also revealed a sectoral difference on how enterprises react to financial constraints. Firms in service industries proved to be less sensitive to funding constraints in comparison to those in production industries. Presence of exporting activities also proved to be an added advantage as exporting firms tended to have greater resilience to financial constraints in their innovation process compared to non-exporting firms. Efthyvoulou and Vahter (2016) further noted that the intersectoral differences in the effects of financial constraints are due to variations in the intensity and combination of inputs in the innovation process. The service sector inputs are less financially draining and tend to require inter-departmental or inter-company synergies like better cooperation with suppliers and clients unlike those for non-service firms, which often require new products, hence more financially demanding. Exporting firms have access to international markets hence their ability to access external credit as compared to non-exporting enterprises.

Idea generation and implementation is essential for economic growth. Chiu et al. (2017) used an endogenous growth model to study this assertion. In their model, innovation induces an increase in productivity and technology transfer ensures that firms with comparative advantage, such as financial access get to implement ideas. However, Chiu et al. (2017) noted that even in the midst of this exchange, there are various frictions or obstacles relating to searching, bargaining and organizational commitment. These authors asserted that innovation is enhanced by a functional idea market due to the transfer of ideas to those better placed to implement them and the ability of such a market to incentivize the innovation process. However, availability of credit significantly affects the innovation process and or the actualization of the end product of innovation. Chiu et al. (2017) thus recognized that credit friction is a major hinderance to innovation hence the need for financial intermediation to smoothen the process of R&D and the eventual actualization of the innovated product.

The primary productive forces in the modern world are technology and science. Li et al. (2019) notes that in China, technological and scientific development are intertwined with finance. They further write that there was an increase of 333.41% (300.31 to 1301.6 billion yuan) in R&D expenditure between 2006 and 2014, which translated to a 440.25% (223,860 to 1,209,402 patents) increase in patent applications. Having recognized the significance of finance in the R&D process, Li et al. (2019) proceeded to explore differences in financial efficiency versus innovation between Chinese non-coastal and coastal regions. Their study utilized the Data Envelopment Analysis (DEA) model in analyzing financial input technological and scientific output for 20 non-coastal and coastal administrative regions in China between 2006 and 2013. This study revealed an increasing trend of efficiency of finance supporting innovation especially for coastal regions, which further underpines the essence of finance in the innovation process.

Business cycles affect availability of funding and subsequently impact R&D and innovation activities. Mannasoo and Merikull (2014) explored the effect of credit frictions and demand fluctuations on the odds of an enterprise undertaking R&D. Their study utilized data mainly from the World Bank and some from the European Bank for Research and Development. Microdata on new entrants into the European Union for instance from eastern Europe indicated the presence of an underdeveloped venture capital environment and subsequently low levels of R&D in the business sector. Mannasoo and Merikull (2014) asserted that credit constraints negatively affect the undertaking of R&D especially for eastern European firms. These authors further explored the relation between business cycles and low levels of R&D in these countries. Their analysis revealed that enterprises in the CSEE region had a tendency to conduct more R&D activities during low demand cycles as opposed to peak demand. This finding corroborated the opportunity-cost theory, indicating that recessions spur businesses into focusing on measures to enhance productivity hence the tendency to invest in innovative research during recession. However, the actualization of such R&D expenditure requires the presence of a developed financial market to provide the necessary funding or availability of internal funds like retained earnings.

Access to finance also varies depending on whether a firm is either a R&D innovator or a non-R&D innovator. Leitner and Stehrer (2016) defined the former as those who conduct formal R&D and the latter as those firms that carry out innovations without undergoing a formal R&D process. Their analysis focused on both types of innovators in the Latin American market and their experiences during the financial crisis. Findings revealed that credit constraints reduced the propensity of R&D innovators to undertake any formal research process. However, non-R&D innovators were not affected by such constraints due to the low resource intensiveness of their

innovation processes. Additionally, this study also revealed that large firms have higher likelihood of conducting R&D in comparison to smaller firms because of the availability of internal funds.

Unlike majority of the literature that has concentrated on linking financial access and innovation, Gorodnichenko and Schnitzer (2013) adopted a different approach by exploring the inability of underdeveloped countries to bridge the problem of financial constraints and thereby spur innovation. Their research utilized Business Environment Enterprise Performance Surveys (BEEPS) from Commonwealth countries and classified firms as either domestic or foreign owned. Gorodnichenko and Schnitzer (2013) concluded that for domestic firms in developing countries, access to external finance is expensive hence their inability to invest in the technology frontier like their foreign owned counterparts. Unlike Leitner and Stehrer (2016), Gorodnichenko and Schnitzer's (2013) methodology did not differentiate between R&D and non-R&D innovators hence did not provide for differences in financial intensiveness of innovation among firms. Gorodnichenko & Schnitzer (2013) thus concluded that failure of developing countries to smoothen financial frictions hampered investment in innovation and R&D.

In their study to explore entrepreneurship and innovation behavior in Ghana, Robson et al. (2008) studied innovation activity among 496 entrepreneurs. Their analysis revealed a preference for incremental innovation as opposed to novel innovation. Robson et al. (2008) opined that this behavior is reflective of problems in attaining external finance which makes entrepreneurs in resource-poor environments to adopt incremental innovation, which is less risky compared to novel innovation or R&D.

A vast portion of R&D in Africa occurs in the health sector. Simpkin et al. (2019) examined the level of health R&D in Africa, its limiting factors and potential areas of progress. Their study revealed that despite Africa comprising of 15% of global population, its proportion of

global R&D investment was 1.1% in 2016. Additionally, their analysis revealed a disproportionate expenditure on R&D in Africa with Egypt, South Africa and Nigeria responsible for 65.7% of the continent's total R&D expenditure. Simpkin et al. (2019) further revealed heavy dependency on foreign aid to finance African health R&D, though they also noted increasing contribution to this research by African governments. Private sector investment in health R&D in sub-Saharan Africa is constrained by various factors including corruption and political instability and limited pharmaceutical manufacturing capacity. Simpkin et al. (2019) thus opined that the limited health R&D investment in Africa could be improved through incentivizing investments, and the structuring of collaborative financing mechanisms between public and private sector players.

Ahmad et al. (2019) examined the propensity of African firms to innovate based on the resource endowment level of their respective home countries. Their study analyzed WBES data using mixed effect modelling. This research explored the hypothesis that firms operating in resource endowed environments have low innovation propensity than those in less endowed environments. The study results revealed that firm-level innovation was negatively impacted by high resource endowment only in countries with poor technological and institutional capabilities. Ahmad et al. (2019) concluded that enhancement of firm-level innovative activities for instance through adequate financing and provision of effective institutional environments is vital in combating the resource curse presently evident in resource-rich sub-Saharan countries.

Remittances are critical capital inflows for economies in the global south. Taylor and Grimes (2019) examined the interaction between financial access, innovation and international remittances. Their study acknowledged various factors limiting remittances including trans-border payment risks and costs. Such limitations necessitate the need for innovative approaches to enhance the repatriation of incomes from one country to another. Taylor and Grimes (2019) also

noted that considering that remittances constitute a critical element of engagement between the underdeveloped countries and the developed ones, there is the potential of such financial movements to create new avenues for vulnerability to shocks and also new opportunities. This study revealed increased financial innovation especially regarding products that encourage faster and less intrusive transfer of remittances to the recipient countries. The authors further recognize the critical role played by innovation in creating efficient remittance infrastructure in Asia and Africa. The creation of better avenues for remitting funds in the developing world enhances access to finance and conversely, availability of finance is critical to the development of efficient infrastructure for remittance. Taylor and Grimes (2019) thus conclude by noting the interdependence between financial access, innovation and international remittances.

Xu et al. (2019) explored the nexus between innovation, productivity and financial access. Their analysis of WBES data for 32 African countries revealed that innovation positively relates with productivity and that developed financial markets mediate this interaction. This study noted that in the presence of well-developed finance sector, there is significantly higher probability of investment in quality R&D projects compared to instances whereby the financial sector is underdeveloped. Agents of developed financial systems are adept at analyzing and choosing projects that promise the maximum underlying productivity and are capable of channeling adequate financial resources to such projects hence ensuring success, which further enhances productivity. Xu et al. (2019) noted that for financially developed economies, innovation and productivity are intertwined. This finding informed one of their conclusions that financial intermediation is a critical stimulating factor for innovation, which in turn enhances productivity. As such, firms operating in a developed financial environment have a higher tendency to maximize their R&D and innovation undertakings compared to their counterparts in countries with under-developed

financial systems. Xu et al. (2019) further note that developed financial institutions facilitate R&D and innovation financing, which in turn boosts efficiency through application of new production processes or equipment. This study proposes that African countries with less financial investment in R&D can still benefit through imitating current innovations, which will subsequently accelerate productivity. This view however ignores the copyright issues that are likely to arise out of such replication of innovations from other well-endowed countries.

Yawe and Prabhu (2015) examined the relationship that exists between financial inclusion, and innovation. Their study showed that financial inclusion is driven primarily by innovation especially by firms in the financial sector. Their findings revealed that to improve financial inclusion in an economy, it is critical to bypass the traditional banking systems hence the essence of undertaking R&D and innovation activities. The study pinpoints mobile money services, a product that has revolutionized financial access especially in previously underserved markets. Yawe and Prabhu (2015) argue that its success underlines the essence of innovation in promoting financial inclusion especially in the current environment whereby traditional banking is under threat through management actions like closure of less profitable branches to cut costs and enhance efficiency. This study proposes establishment of research partnerships between players in the financial and technology sectors to mobilize resources for R&D and innovation undertakings hence promoting financial inclusion through implementation of the resultant innovative products.

O'Connell et al. (2022) explores how financial leverage interrelates with investment in R&D. Their study of firms in the United Kingdom and the European Union established that a current increase in financial leverage negatively impacts one-period-ahead investment in R&D. However, the success of the subject R&D undertaking reverses this negative relationship. O'Connell et al. (2022) attributes this reversal to the reduction in risks arising from the R&D

investment since success has already been achieved. These authors further note that successful R&D and innovation undertakings unlock further financing for the innovators due to the confidence generated by their previous innovations. Innovation success is thus essential as it impacts a firm's ability to mobilize resources for future innovation undertakings. A unique approach by O'Connell et al. (2022) was their recognition of the connection between prior R&D and innovation success and current period financing by lending institutions and also their insistence of investment financing via intangible assets.

Public funding through subsidies is essential in promoting R&D and innovation activities by firms. Czarnitzki et al. (2007) examined the connection between subsidies offered by the government, R&D collaborations and performance for Finnish and German enterprises. These authors analyzed firm level R&D activity through econometric matching. Their analysis revealed a general tendency for collaboration – both private and public – to elicit positive results in R&D undertakings. Their study further revealed that for German firms, the subsidizing of individual research did not affect R&D undertaking. However, increasing collaboration incentives resulted in potential improvements in innovation performance. Additionally, Czarnitzki et al. (2007) noted that Finnish firms significantly depend on government subsidies for R&D financing. Absence of subsidies resulted in less patenting activity by Finnish firms, which further underlines the critical role of subsidies in providing financial resources for R&D and innovation. Czarnitzki et al. (2007) thus recommend that enhancing collaborations between players in the private sector with their counterparts in the public sector is key to promoting firm R&D, which results in increased productivity hence benefiting the country through increased growth.

Internal funding contributes significantly in determining a firm's potential to engage in R&D and innovation activities. Bogliacino, and Pianta (2013) examine the connection between a

firm profits, and the R&D activities it undertakes. They explore three dynamic relationships namely successful R&D efforts, high profits arising from exploiting R&D undertakings and the tendency of firms to reinvest such profits into additional R&D and innovation ventures. Bogliacino, and Pianta (2013) study exposes the complex interaction among R&D, firm profits, and the propensity to reinvest into research. The resultant model exhibits a positive link between successful R&D undertakings by European firms, increased profits due to the patented technologies arising from such R&D activities and the tendency for firms who have previously conducted successful R&D to reinvest part of their profits into additional R&D hence further enhancing their competitiveness. These findings thus stress on the critical role of internal funding for instance through retained earnings in financing firm R&D and innovation.

Exports provide firms with access to international markets hence enhancing their ability to mobilize funds both locally and internationally. Sandu and Ciocanel (2014) examine the relation between firm R&D activities and technology exports by European firms. These authors note that economic recovery in countries like Romania has revived high-tech exports. Sandu and Ciocanel (2014) opine that R&D expenditure, and quality human resource has enhanced high technology exports especially among countries in the European Union. Their economic analysis revealed a causal relationship between the intensity of R&D expenditure incurred and the extent of high-tech exports by European firms. These authors further note that unlike developing countries whereby public expenditure is the major source of R&D spending, the influence of private expenditure is the most significant source of R&D expenditure for high-tech exports by firms in Europe. In conclusion, Sandu and Ciocanel (2014) stress on the need to correlate firm R&D policies with a country's export policy to ensure maximum benefits for the firm. They further note that exporting firms have a higher likelihood of mobilizing external finance – due to their presence in multiple

markets – and are thus capable of financing R&D and innovation undertakings in comparison to the non-exporting firms.

The majority of the literature reviewed has mainly tackled the nexus between Finance, R&D and innovation. Lederman and Maloney (2013) employed a unique approach by first examining the connection between R&D investment, and the magnitude of development in a particular country. Through their analysis of global panel data that contained different variables relating to innovation, they examined investment in R&D across different stages of a country's development process. Their study revealed that R&D investments increases with the development process of a country, least developed countries have significantly less investment in R&D, whereas the developed countries registered the highest investments in R&D undertakings. However, Lederman and Maloney (2013) also noted a unique trend whereby some of the countries examined seemed to undergo extraordinary take offs with regards to R&D investment when compared with the median tendency. These authors noted that in comparison to other regions, Latin America investment in R&D underperformed when viewed against expectations based on their active labor force and GDP. However, unlike Latin America, other regions such as East Asia over performed.

Lederman and Maloney (2013) further examined R&D returns relative to a country's GDP and their analysis revealed that they fell with level of development. The R&D rate of returns for United States and other countries in the OECD were lower compared to those from the developing countries. Lederman and Maloney (2013) observed that regardless of the lower returns of R&D relative to GDP in developed countries, there was continued investment in R&D in the global north. They attributed this pattern to various factors including financial depth of the developed world, which ensures ease of funding R&D undertakings. Additionally, government participation in R&D through channeling of public resources and institutional quality were also among the

factors explaining the propensity of the western world to invest in R&D, and innovation despite lower returns of R&D investments relative to the GDP of these countries.

Zhu and Huang (2017) explored how R&D investment impacts a firm's finances in the Chinese information technology sector. Their analysis testing how R&D intensity correlates with a firm's financial performance, which they lagged by one year. Preliminary analysis by Zhu and Huang (2017) revealed that R&D intensity of the IT firms examined correlated significantly with financial performance. These authors thus argue that considering finance is necessary for R&D undertakings and given their findings that engaging in R&D activities reinforces financial performance, finance and R&D are thus interdependent. Zhu and Huang (2017) further opine that despite the significant role of R&D in ensuring continued competitiveness of firms, there are numerous obstacles that face the R&D process. Some of the obstacles singled out in this study include irreversibility of R&D investments, and the probability of failure both of which could contribute to R&D avoidance by firm managers. This study thus emphasizes on the need for examining the interaction between firm financial performance, and R&D expenditure as the resultant knowledge is useful in informing management decision on undertaking R&D and also the setting of budgets for the same.

The cash flow cycle is a critical element that affects a firm's finances. Availability or lack of secure cash flows impacts management decisions including those dealing with whether the subject firm should undertake R&D or refrain from it. Kim and Zhu (2018) explored the how R&D intensity relates with an organization's dependence on few customers. These authors aimed to reveal whether depending financially on a very narrow customer base affected the channeling of financial resources towards R&D engagements by the supplier firm. The authors further investigated whether any negative effects on R&D financing arising from supplier dependence on

few customers could be mitigated through leveraging social capital of the enterprise. Through their analysis, they revealed that the dependence on a narrow customer base by a supplier firm affects its ability to channel resources towards R&D and innovation activities. However, Kim and Zhu (2018) further established that this negative effect of customer dependence by suppliers on R&D intensity is can be mitigated through the leveraging of external information. These authors therefore stress on the essence of firms maintaining active collaborations with their counterparts in the supplier networks especially if they are dependent on few major customers. Kim and Zhu (2018) thus introduced supplier connectedness, a unique aspect of analyzing R&D intensity and its relation to firm finances. They argue that financial deficiencies and risks associated with narrow customer base negatively impact the availability of resources for undertaking R&D activities and that this effect can be avoided by forging strong connections among peer firms hence facilitating sharing of information.

R&D and innovation investment is also impacted by other factors such as the institutional environment of a particular country. Alam et al. (2019) examined how the operating environment in developing economies affected the channeling of resources towards R&D and innovation undertakings. They utilized panel data analysis of 664 firms sampled from developing countries and applied the Generalized Method of Moments in their analysis. Alam et al. (2019) notes that the results revealed strong correlation between institutional quality and the financing of R&D. Among the most notable institutional elements emphasized in their study as influencing R&D investment positively include the effectiveness of government, a reputable financial sector that is well regulated, and regularity quality. These authors also noted that political instability, corruption and an unpredictable justice system were obstacles to R&D financing in emerging markets. Unstable environments provide minimal protection of intellectual property and patent rights, and

leave firms exposed to a robust informal sector that is likely to produce counterfeits hence preventing patent owners from fully benefiting from their inventions. Alam et al. (2019) stresses on the essence of these findings especially to investors making decisions on where to channel their R&D investment. Countries hoping to attract external R&D financing ought to ensure the stability of their institutional environment. This improves the competitiveness of their operating environment and ensures that innovations are protected from potential intellectual property theft and counterfeiting. Ahmad et al. (2019) concludes that though finance is critical in undertaking of R&D and innovational activities, institutional environment is essential in attracting these resources in a particular country.

Fombang and Adjasi (2018) explored how finance influences firm innovation in five African countries namely Morocco, Kenya, Cameroon, Nigeria and South Africa. In their analysis of WBES data, they built an innovation index based on outcome and once they controlled for endogeneity, the results revealed that availability of finance promotes innovation. Fombang and Adjasi (2018) further stressed on the essence of implementing financial sector development measures for ease of access of credit. These authors also proposed tax breaks targeting financial intermediaries providing credit for purposes of R&D and innovation.

Challenges associated with Innovation and R&D vary greatly depending on various factors including resource endowment. Hyvarien et al. (2020) conducted a case study covering East Africa's water service sector with a view to understand how the uncertain nature of resource-constrained environments affects the innovation process. This study focused on water innovation process in Kenya and identified that uncertainty management and the subsequent development of resource-constrained innovations required the adoption of three principles namely versatility in R&D approaches, cultivating internal trust and the development of partnerships to unlock

complementary resources. Hyvarien et al.'s (2020) study showcases the complexity of innovating in financially constrained environments. These authors concluded that uncertainties arising from innovating in resource-constrained environments can potentially be managed through the adoption of context-specific strategies in project implementation and leveraging on partnerships.

Molla et al. (2020) explored the factors determining innovation by African firms. These authors obtained data from the WBES survey in 28 countries in Africa covering 9988 firms. In addition to examining the impact of resource availability on firm innovation, Molla et al. (2020) also explored how other firm characteristics such as openness affect its ability to innovate. Their subgroup analysis and baseline estimation revealed that the size of respondent firm, export intensity, workforce training and access to credit are critical determinants in the propensity to innovate by a firm. A unique aspect of this study was the subgroup analysis which revealed critical insights on how firm characteristics influence innovation behavior of enterprises in Africa. For instance, Molla et al. (2020) observed that informal market competition had insignificant effect on innovation by large firms in comparison to small firms. Additionally, their study further revealed that despite the greater investment in R&D by large firms, the small firms tend to exhibit better efficiencies in R&D expenditure. A critical strength of the study by Molla et al. (2020) was their consideration of the heterogeneities and endogeneity of enterprises when examining their innovation behavior.

Financing constraints can limit a firm's engagement in R&D, and innovation activities. Carrasco (2022) explored the effects of these constraints on SMEs innovation in Africa. This study utilized WBES data and upon controlling for the respective firm characteristics, the findings revealed that inaccessibility of bank credit inhibited innovation for Tanzanian firms. However, for Ugandan and Kenyan firms, Carrasco notes that there was no evidence of credit constraints

impacting firm innovation. Carrasco (2022) explains that there is need for improvement of public policies to promote R&D engagements in these countries. The lack of evidence on the effect of financing constraints on R&D and innovation in Kenya and Uganda is indicative of either a reluctance by SMEs in these countries to undertake R&D and innovation activities or a presence of other factors that impede R&D and innovation at a greater than financial constraints (Carrasco, 2022). This author stresses that considering the immense poverty and the low industrialization levels in sub-Saharan Africa, understanding the factors inhibiting R&D and innovation is of essence in turning the fortunes of the region.

R&D and innovation is an essential tool for combating food insecurity across the world. Climate change is rendering entire communities as food insecure hence the need to research on climate resilient solutions to the food problem. Fuglie (2016) examined the role that the global private sector is playing in promoting agricultural R&D. This study revealed that private spending geared towards promoting agricultural R&D has been on the rise globally. By excluding R&D spending incurred by food industries, Fuglie (2016) reports that the 25-year period spanning from 1990 to 2014 saw an increase of 10.5 billion dollars in agricultural R&D across the globe. This author notes that in 2003, there was an acceleration of private investment in agricultural R&D, most of which occurred in the global north. However, Fuglie (2016) observes that despite the majority of the agricultural R&D expenditure being conducted in the developed countries, the resultant technologies have been instrumental in promoting food security in the developing world. Fuglie (2016) proposes that there is need for policy makers in the global south to encourage agricultural R&D through the creation financing mechanisms that incorporate both public and private players. The pooling of resources will encourage R&D and innovation activities hence helping solve the food crisis that is currently worsening due to climate change.

Ejemeyovwi et al. (2021) examined innovation, adoption of ICT and financial development across Africa. Their research revealed that financial development across different countries in Africa occurred in varying patterns. Adoption of the digital economy, which is relatively young in African compared to other regions is greatly dependent on cash flows and availability of credit. In their study, Ejemeyovwi et al. (2021) categorized a country's adoption of ICT and innovation as either low or high. These authors then proceeded to investigate the interaction of financial development, innovation and ICT. Through a Bayesian Vector Auto-regressive analysis, Ejemoyovwi et al. (2021) determined that the ICT innovation relates positively with financial development in the countries under study. These authors further noted a higher propensity for innovations in countries with vibrant financial market as opposed to those with underdeveloped financial environment. They conclude that economic agents should leverage on the positive interaction between innovation and finance to ensure improved competitiveness especially at the global stage.

A different approach was adopted by Ansong et al. (2011) who examined the relation between savings and financial innovation in Ghana. Their research utilized two proxies of financial innovation namely M2/M1 and the perception index. Through analysis, these authors determined that in the short-run, savings relate negatively with financial innovation. However, across the long-run, the two variables exhibited a positive relationship. Ansong et al. (2011) opined that a possible explanation for this relationship especially in the short run was that the current innovative products in Ghana's financial markets mainly encouraged expenditure and withdrawals from financial institutions. As such, among the recommendations was that institutions in the financial industry ought to consider funding the development of innovative products geared towards saving rather than the current trend that favors products that promote withdrawals. Ansong et al. (2011) further

notes that R&D and innovation products that encourage saving are critical especially in developing countries whereby the saving rate is relatively low hence affecting the investment rate in the economy.

Adenle et al. (2017) examined agribusiness innovation and various factors driving it including financial access. They noted that competitive agribusiness requires technological innovation, hence necessitating R&D and innovation activities. These authors conducted a case study in which they contrasted the agricultural value chain in two developing countries namely Nigeria and Thailand. The Nigerian agricultural value chain is less developed in comparison with that of Thailand though both countries are still developing. This study revealed that increased competitiveness is a critical element in achieving sustained agribusiness growth. Adenle et al. (2017) stressed on the essence of financial access, infrastructure and R&D in strengthening the agricultural sector. These authors noted that rural agro-processing in Nigeria was minimal compared to Thailand hence limiting the contribution of agriculture to the GDP of the Nigerian economy. Adenle et al. (2017) write that agri-business in Asia has mainly developed due to concerted efforts of both private sector establishments and the government entities especially on matters regarding the undertaking of R&D and innovation activities. The synergies created by sustained public and private investment in agribusiness research in Thailand have thus enabled the country's agricultural value chain to progress significantly compared to Nigeria whereby less public and private resources are being channeled towards agribusiness innovation. Adenle et al. (2017) singled out the cassava production in both countries and noted that whereas Nigeria is the world leading cassava producer, Thailand is the world leader in cassava exports. The study notes that the disparity between production and export is primarily because of under-investment in the value-chain in Nigeria, which also means less resources are channeled towards R&D and

innovation. Thailand cassava value-chain is however better fused hence the significant export of this crop to the world markets. Adenle et al. (2017) concludes by noting that financial access drives innovation, which further enhances the development of agricultural value chains.

Arisa and Muthinji (2020) explored how financing decisions by firms in Kenya relate with R&D and innovation activities undertaken by those firms. They further refined their analysis to investigate whether usage of a particular type of finance source is more likely to result in firms engaging in R&D activities. Their analysis of WBES data for year 2019 revealed that access to debt finance, whether from banking institutions or the non-banking ones increased the propensity of Kenyan firms to venture into R&D and innovation programs. Consequently, Arisa and Muthinji (2020) note that for firms using internally generated funds, the likelihood of undertaking R&D was minimal. Their study revealed that constrained access to external finance limited firm's spending options hence causing firm managers to avoid channeling resources towards R&D. Arisa and Muthinji (2020) opine that non-investment in R&D for firms without access to external funding could potentially be due to the unpredictable nature of R&D investments and also their resource intensiveness. Their analysis of the 2019 WBES data also revealed that size and profitability were critical factors determining an enterprise's investment in R&D and innovation undertakings. They determined that the likelihood of a large and profitable enterprise undertaking R&D was significantly higher in comparison to that of a small firm that is also underperforming. Arisa and Muthinji (2020) also noted that firms primarily using capital borrowed from family and friends were wary of engaging in R&D activities unlike those with access to funds from the government. The latter group showed a higher propensity to undertake R&D and innovation activities. Among the reasons fronted by Arisa and Muthinji (2020) in explaining this observation was that financing from relatives is characterized by short repayment terms hence making the borrower to be at high

risk of defaulting on such payments. Additionally, this source of finance is often inadequate hence limiting the probability of firm managers to engage in R&D with all its uncertainties. Alternatively, the authors note that government funding is characterized by attractive concessions to the firms and longer repayment terms hence making it better suited for financing R&D and innovation.

Khan et al. (2021) took a unique approach in examining the finance-innovation nexus by classifying innovation into either technological or non-technological. Their study utilized WBES survey data from 21 countries including Kenya, and their analysis revealed that financial frictions impeded the introduction of technological innovations by firms, while also affecting non-technological innovation. Unlike other studies examined above, Khan et al. (2021) introduced the aspect of innovation radicalness and finance and concluded that the two are negatively correlated. Their analysis showed that inadequate financing had a greater effect on incremental innovation in comparison to radical innovation. Overall, Khan et al.'s (2021) study findings are in consensus with the rest of the literature reviewed above in that financial friction is an impediment to innovation and R&D.

Despite the above reviewed literature providing critical insight on the connection between finance and R&D, the subject studies and the tests implemented therein have mainly covered respondents in developed countries. There is thus an inadequacy of studies on impact of access to finance on innovation activities and R&D at the micro-level for Sub-Saharan African countries.

2.4 Overview of Literature Review

The value maximization model and the resource-based theory reviewed under theoretical literature emphasizes the critical role of technology in driving growth. The value maximization model recognizes that shareholder wealth maximization is constrained by various factors including

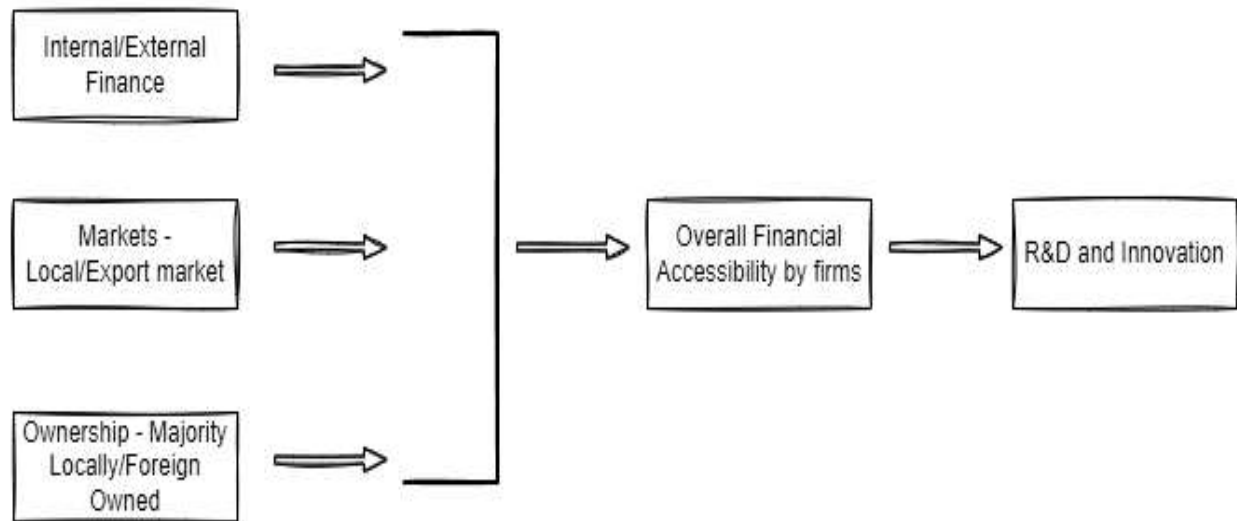
level of technology thus necessitating R&D and innovative activities to ensure better technology, and improved innovative approaches of dealing with competitors to gain a bigger market share. The resource-based model complements the value maximization theory by recognizing the essence of innovation and R&D activities in ensuring that a firm obtains a strategic resource.

The theoretical literature reviewed shows a long-going interest in exploring the linkage of finance, innovation endeavors and R&D. This interest is mainly because innovation activities enhance the competitiveness of not only the firm but entire economies and therefore spurs growth. However, that notwithstanding, there is consensus that R&D is also a difficult area to finance especially considering the uncertainties surrounding the product or technology being researched, the information imbalance between lenders and innovators and the inability of R&D to serve as collateral for credit. Himmelberg and Petersen (1994) explored the prospect of financing R&D using internal finance, an option that is mostly the preserve of established businesses and not start-ups or firms operating in resource poor environments. Bond et al. (2005) in the UK and Germany exploring the effect of cash flows on R&D conducted a variant of this research. Their study however revealed cash flow as not informative on R&D spending in both countries. Bond et al.'s (2005) sample was however not representative of the entire population due to their exclusion of foreign owned firms from their study.

The literature reviewed has explored this topic from various angles including how finance supply shifts affect R&D (Brown et al. 2009), examination of capability and resource constraints on innovation (Hewitt-Dundas, 2006), and the connection between finance, technology and scientific developments (Li et al., 2019) among others. Majority of the firm-level research on finance and R&D and innovation relates to studies mostly from the US, Europe, China and Latin America. The aspect of finance, innovation and R&D at the firm-level has been under-explored in

sub-Saharan Africa despite the increasing prominence of this region as an emerging market. This paper seeks to explore this gap in the Kenyan context.

2.5 Conceptual Framework



Chapter 3: Methodology

3.0 Introduction

Included in this chapter is the econometric specification, definition and measurement of variables, and econometric issues.

3.1 Econometric Specification

This research seeks to explore the relationship between finance, R&D and Innovation activities by firms in Kenya. Access to finance will be explored through several variables capturing the firms financing needs. The variables include Internal finance, which will capture a firm's usage of internal funds to finance working capital needs, loans and overdraft, which examines the respondent firm's access to these external financing facilities.

Various firm characteristics will be captured in the econometric model including ownership (whether majority is foreign or locally owned), and access to international markets (whether exporting or non-exporting). By including firm characteristics, we provide for any differences in objective conditions experienced by different firms in the country. A panel data model will be used in analysis with R&D and innovation being the dependent variables. Panel data is advantageous over time series and even cross sectional data in various ways. Gujarati and Porter (2009) note that among these advantages is the ability of panel estimation to accommodate subject-specific variables and thereby account for heterogeneity. Gujarati and Porter (2009) further write that since it integrates cross sectional and time series observations, panel data has the ability to accommodate more information, with greater efficiency and more variability than is possible in cross sectional or even pure time series data. The adoption of panel data model will also ensure the minimization of estimation biases that could potentially arise if groups are aggregated into time series.

Additionally, a panel data model will enable the modelling of both individual and common behaviours of the respondents.

The resultant panel data models examining the relationship between financial access, R&D, and innovation are as follows:

$$R\&D_{it} = \beta_0 + \beta_1 IF_{it} + \beta_2 Ln_{it} + \beta_3 OD_{it} + \beta_4 Own_{it} + \beta_5 Mkt_{it} + \mu_i + \alpha_i + \varepsilon_{it} \dots \dots \dots 1$$

$$Inn_{it} = \beta_0 + \beta_1 IF_{it} + \beta_2 Ln_{it} + \beta_3 OD_{it} + \beta_4 Own_{it} + \beta_5 Mkt_{it} + \mu_i + \alpha_i + \varepsilon_{it} \dots \dots \dots 2$$

Whereby *R&D* denotes variable R&D, *Inn* represents Innovation, *IF* is internal finance, *Ln* is loans, *OD* is overdraft financing, *Own* is whether majority foreign owned firms or majority locally owned firms, *Mkt* is whether firm is exporting or non-exporting. ε_{it} is the error term, μ_i is the time fixed effect and α_i is the firm fixed effect. For a summary of the above variables, see section 3.2 below

3.2 Variable Definition and Measurement

Table 1. Definition and Measurement of Variables

Variables	Measurement
Dependent Variables	
R&D	Dummy variable. 1 = R&D was undertaken, 0 = Otherwise
Innovation	Dummy variable. 1 = Innovation was undertaken, 0 = Otherwise
Independent Variables	
Internal Finance	Dummy variable. 1 = Firm primarily uses internal finance, 0 = Otherwise
Loans	Dummy variable. 1 = Firm has access to loan financing, 0 = Otherwise
Overdraft	Dummy variable. 1 = Firm has access to overdraft financing, 0 = Otherwise
Control Variables	

Ownership Dummy variable. 1 = Majority locally owned, 0 = Majority foreign owned

Market Dummy Variable. 1 = Exporting Firm, 0 = Non-exporting firm

3.3 Data Source

This study will explore secondary data from the 2013 and 2018 WBES conducted on firms in Kenya. The WBES are conducted on representative firms sampled from the non-agricultural private sector. They cover all geographical regions and are conducted on large, medium and small companies with the resultant data being critical in the creation of indicators of investment and business environment in the respective countries. The enterprise surveys (ES) examine various factors that impact the operating environments for enterprises in the country of study (Morris, 2017). As such, the elements explored in these surveys could either be constraining factors for firms or enabling factors both of which are critical in influencing the prosperity of a firm. The core questionnaire utilized in these surveys and the uniformity of methodology enhances comparability across the period under survey.

Stratified random sampling was applied in selecting the Kenyan sample in both years 2013 and 2018. The sample frame for panel firms in the 2018 survey consisted of 740 firms that had participated in the 2013 WBES (The World Bank, 2020). From this sample frame, a total of 233 firms were interviewed in Kenya in both years 2013 and 2018 and these form the dataset from which we will conduct our empirical analysis.

Chapter 4: Results and Discussions

4.0 Introduction

This chapter outlays the study findings. It begins with descriptive statistics, followed by diagnostic test, logit regression and marginal effects, and a discussion of the findings.

4.1 Descriptive Statistics

Tables 2 & 3 below shows the descriptive statistics alongside a correlation matrix of the variables of interest. Considering that our analysis comprises of two dependent variables (R&D and Innovation), *Table 2* contains R&D alongside the explanatory variables (internal finance, loans, overdraft, market and ownership) and *Table 3* contains dependent variable Innovation alongside the same explanatory variables. Some of the control variables (Foreign-owned and Non-Exporting) were omitted from the study due to the multicollinearity issue.

In tables *Tables 2 & 3*, the statistical properties of the variables have been outlined and they comprise of the maximum and minimum values, the mean value and also the standard deviation of the variables. The maximum and minimum values indicate the highest and lowest value of the observations of a given variable respectively. Since the variables are in dummy form, the maximum corresponds to the value of one and the minimum corresponds to the value of zero for each of the variables. The mean indicates the average value for the respective variables whereas the standard deviation is indicative of the dispersal of the observations from their respective mean values.

The correlation coefficient is an indicator of the direction of the relationship existing between one variable and another and also its strength. A value of +1 or -1 is indicative of complete correlation whereas a value of zero indicates the absence of correlation between the subject variables.

Table 1: Descriptive Statistics and Correlation Matrix for R&D

Variable	Mean	Std.Dev	Min	Max	1	2	3	4	5	6
1 R &D	0.26	0.44	0.00	1.00	1.00					
2 Overdraft	0.40	0.49	0.00	1.00	0.13	1.00				
3 Loan	0.40	0.49	0.00	1.00	0.16	0.33	1.00			
4 Internal Finance	0.17	0.37	0.00	1.00	0.01	-0.06	0.00	1.00		
5 Market	0.38	0.49	0.00	1.00	0.22	0.14	0.11	-0.10	1.00	
6 Ownership	0.90	0.30	0.00	1.00	-0.11	-0.02	-0.02	-0.04	-0.12	1.00

From the correlation matrix, it is evident that all the predictors correlate positively with R&D. For instance, the correlation between R&D and overdraft is $r=0.13$, R&D and loan is $r=0.16$ and the relationship between internal finance and R&D is given as $r=0.01$. For the control variables, market has positive correlation with R&D whereas ownership is negatively correlated to R&D.

Table 3: Descriptive Statistics and Correlation Matrix for Innovation

Variable	Mean	Std.Dev	Min	Max	1	2	3	4	5	6
1 Innovation	0.60	0.49	0.00	1.00	1.00					
2 Overdraft	0.40	0.49	0.00	1.00	0.05	1.00				
3 Loan	0.40	0.49	0.00	1.00	0.05	0.33	1.00			
4 Internal Finance	0.17	0.37	0.00	1.00	0.02	-0.06	0.00	1.00		
5 Market	0.38	0.49	0.00	1.00	0.05	0.14	0.11	-0.10	1.00	
6 Ownership	0.90	0.30	0.00	1.00	0.06	-0.01	-0.02	-0.04	-0.12	1.00

Table 3 above outlines the descriptive statistics for dependent variable, innovation alongside the explanatory variables. The correlation coefficient indicates that all the predictors are positively correlated with innovation.

4.2 Empirical Results

The Hausman test is essential in deciding whether to apply the fixed or random effects model. It tests whether there is any correlation between random errors and the regressors (Woodridge, 2015). The null hypothesis being that random errors and the regressors are not in any way correlated hence random effects model should be applied.

After conducting the Hausman test, this study uses the random effects model in estimating both dependent variables R&D (Model 1) and Innovation (Model 2). See Appendix 1 and 2 for the Hausman test results

Table 4: Model 1-R&D

R&D	Logit Coefficients		Marginal Effects	
Internal Finance	0.229.	(0.311)	0.040.	(0.055)
Loan	0.603**	(0.246)	0.105**	(0.043)
Overdraft	0.331.	(0.248)	0.057.	(0.043)
Market	0.963***	(0.244)	0.174***	(0.044)
Ownership	-0.623*	(0.357)	-0.115	(0.070)
_cons	-1.424***	(0.397)		
Wald chi2 (5) =29.86				
Prob.>chi2 = 0.000				
No. of observations = 463				
Notes:				
*** Significant at the 1 percent level				
** Significant at the 5 percent level				
* Significant at the 10 percent level				
. Not significant.				

We carried out a logit model to address the study objectives for Model 1 with R&D being the independent variable. The results are as summarized in *Table 4* above.

The marginal effects reveal the change in probability of a firm in Kenya engaging in R&D given a unit change in one of the independent variables being studied *ceteris paribus*. The independent variables examined include access to internal finance, loans and overdrafts, presence in international markets (whether exporting or non-exporting), and firm ownership (whether majority ownership is local or not).

The findings revealed a positive relationship between access to internal finance and firm R&D in Kenya as seen in the positive coefficient (*coef* = 0.229). The likelihood of a firm with adequate internal capital to engage in R&D activities is 4 percent higher in comparison to that of a firm without adequate internal finance. Although this relationship is not statistically significant, the positive sign of the coefficient and the marginal effects is indicative of the positive relationship between availability of adequate internal finance and R&D activities by firms in Kenya.

Access to business loans – a measure of financial accessibility – was revealed to have a positive relationship with R&D activities conducted by firms in Kenya as evidenced by the positive coefficient (*coef* = 0.603). Firms with access to business loans are 10.5 percent more likely to participate in R&D activities compared to their counterparts without access to this form of financing. This effect is significant at 5 percent level ($p = 0.014 < 0.05$). This finding indicates that access to business loans tends to increase the likelihood of firms undertaking R&D as it enhances the ability of firms to channel resources towards research. This finding is in line with a study by Leitner and Stehrer (2016) which concluded that credit constraints reduced the propensity of R&D innovators to undertake any formal research process.

Access to overdrafts was also found to relate positively with R&D activities conducted by Kenyan firms due to the positive coefficient (*coef* = 0.331). The results indicated that firms with current access to overdraft financing have a 5.7 percent higher likelihood of undertaking R&D

than those without access to this form of financing. This finding implies that availability of overdraft financing increases the chances of a firm implementing formal R&D. It mirrors empirical investigation by Fombang and Adjasi (2018) which determined that availability of finance promotes R&D and innovation.

The variable, markets (whether a firm is exporting or non-exporting) was used in this study as a measure of access to international markets. The positive coefficient ($coef = 0.963$) is indicative of a positive relation between exports and firm R&D. The study revealed that exporting firms have a 17.4 percent higher likelihood of undertaking R&D activities compared to non-exporting firms. This effect is statistically significant at 1 percent level ($p = 0.000 < 0.01$). This result implies that access to international markets widens a firm's options with regards to obtaining finance, which further enhances its ability to engage in R&D. This finding echoes the sentiments of Efthyvoulou and Vahter (2016), who noted that exporting firms have access to international markets hence their ability to obtain international credit as compared to non-exporting enterprises.

The variable, ownership was used to examine the relation between firm ownership (whether majority local or foreign owned) and R&D. The negative coefficient ($coef = -0.623$) revealed the negative relationship between these two variables. The findings showed that majority locally owned firms have a 11.5 percent less likelihood of engaging in R&D activities compared to the majority foreign owned firms. This effect is statistically significant at 10 percent level ($p = 0.082 < 0.10$) This finding reinforces similar results by Gorodnichenko and Shcnitzer (2013) who concluded that for domestic firms in developing countries, access to external finance is expensive hence their inability to invest in R&D like their foreign owned counterparts.

Table 2: Model 2 - Innovation

Innovation	Logit Coefficients		Marginal Effects	
Internal Finance	0.041.	(0.258)	0.010.	(0.061)
loan	0.134.	(0.207)	0.032.	(0.049)
Overdraft	0.148.	(0.208)	0.035.	(0.049)
Export	0.214.	(0.202)	0.051.	(0.047)
Local	0.459.	(0.313)	0.112.	(0.077)
_cons	0.204.	(0.332)		

Wald chi2(5) = 4.600
Prob.>chi2 = 0.466
No. of observations = 463

Notes:
*** Significant at the 1 percent level
** Significant at the 5 percent level
* Significant at the 10 percent level
. Not significant.

Table 5 above summarizes the findings of the logit model with innovation as the independent variable.

From the findings, we infer a positive relationship between internal finance and innovation activities conducted by firms as evidenced by the positive coefficient ($coef = 0.258$). Kenyan firms with access to adequate internal finance for their working capital needs have a 1 percent higher likelihood of engaging in innovation activities compared to their counterparts with inadequate internal finance.

Access to loans relates positively with innovation activities as evidenced by the positive coefficient ($coef = 0.134$). Analysis of the marginal effects revealed that firms with access to business loans have a 3.2 percent higher likelihood of undertaking innovation than those without access to this form of financing. Though this effect is not statistically significant, it reinforces the observations of Fombang and Adjasi (2018) that access to finance promotes R&D and innovation.

Access to overdraft financing also revealed to have a positive relationship with innovation ($coef = 0.148$). Firms with overdrafts were found to have a 3.5 percent higher likelihood of engaging in innovation activities as opposed to those who did not have access to this form of financing. Such finding is indicative of the extent to which availing overdraft facilities to firms may eliminate or reduce constraints to the innovation process hence making them more competitive. The study by Ahmad et al. (2019) provides similar insight and observes that the provision of adequate financing enhances the ability of businesses to innovate.

Access to international markets (exporting) was also found to relate positively with innovation ($coef = 0.214$). Analysis of marginal effects further revealed that exporting firms are 5.1 percent more likely to innovate in comparison to firms without access to the export market. This finding though not statistically significant points to a similar relationship between access to international markets and innovation as revealed by Efthyvoulou and Vahter (2016). They noted that exporting firms' access to international markets enhances their ability to participate in R&D and innovation projects.

Firm ownership (majority local shareholding) was also found to relate positively with innovation as evidenced by the positive coefficient ($coef = 0.459$). A majority locally owned firm has a 11.2 percent higher likelihood of engaging in either product or process innovation compared to majority foreign owned firms. This relationship is unlike that observed between R&D and majority local ownership whereby we established that firms with majority local shareholding are less likely to engage in formal R&D. The implication of this finding is that majority local owned enterprises prefer to innovate – which is less costly – compared to conducting formal R&D, which is preferred by majority foreign owned firms that have a wider access to external finance. This insight mirrors Gorodnichenko and Shcnitzer's (2013) observation that for domestic firms in

developing countries, access to external finance is expensive hence their inability to invest in the technology frontier like their foreign owned counterparts.

Chapter 5: Summary of Findings and Policy Implications

5.1 Summary of Findings and Conclusion

In this study, we sought to examine the relation between financial access and R&D and innovation activities undertaken by firms in Kenya using WBES data for 2013 and 2018. Using a panel data logit model and marginal effects analysis, we conclude that firm R&D & innovation relates positively with access to internal finance, overdrafts, loans, and export markets. The relationship between majority local ownership of firms and R&D is however negative.

The study established that firms using internal funds to primarily finance their working capital requirements had increased likelihood of engaging in R&D activities unlike their counterparts without adequate internal finance. This observation mirrors that of Leitner and Stehrer (2016) whose study revealed that inadequate internal finance coupled with inability to access external funding discourages firms from undertaking innovation and R&D activities. The risky nature of such activities and resource intensiveness forces firm managers to avoid engaging in them due to resource constraints.

The study also determined the existence of a positive relation, which also proved as being statistically significant between access to loans and R&D. Firms with access to this form of financing showed a higher likelihood of undertaking R&D activities compared to those without such financing. Likewise, we determined that access to overdrafts also relates positively with R&D. The findings indicated that firms with active overdraft facilities have a greater likelihood of undertaking R&D activities compared to firms devoid of overdraft financing. The positive relation evident between access to external finance, for instance through loans and overdrafts is similar to the general trend in majority of the literature reviewed. This relation further confirms that access to external financing provides Kenyan firms with the financial flexibility needed to engage in R&D

activities. As Chiu et al. (2017) opines, financial intermediation smoothens credit friction hence facilitating firms to undertake expensive R&D and innovation ventures.

This study ascertained that access to export markets has a positive relation with R&D. This interaction is statistically significant. Exporting firms showed a higher likelihood of engaging in R&D than the non-exporting firms. This finding echoes the sentiments of Efthyvoulou and Vahter (2016), who in their study of ‘The impact of Financial Deficiencies on a Firm’s Innovativeness’ determined that the presence of exporting activities was an added advantage as exporting firms tended to have greater resilience to financial constraints in their R&D and innovation process. Exporting firms are advantaged in terms of mobilizing external capital due to their presence in foreign markets hence their ability to undertake R&D and innovation activities. Given their presence in external markets, exporting firms have a larger exposure to the latest innovations especially by their competitors, which spurs them to undertake R&D and innovation activities to safeguard their market.

We determined that majority local ownership of firms relates negatively and significantly with R&D. Majority locally owned firms were found to have a lesser probability of participating in R&D activities compared to the majority foreign owned firms. The estimated negative coefficient for this variable could be due to financial constraints for local firms hindering their ability to undertake R&D activities.

Regarding financial access and innovation, we conclude that there is an overall positive relationship between a firm’s innovativeness and access to the measures of financial access examined. We established a positive relation between firm innovation, and majority local ownership. This finding is unlike the negative relationship established between R&D and majority local ownership and it points to majority locally owned firms preferring to engage in innovation –

which is less financially demanding – rather than formal R&D. Robson et al. (2019) offers an intriguing explanation that credit constrained firms are most likely to undertake incremental innovation than R&D since the former option is less financially taxing.

The positive relationship established in this study between R&D and innovation and indicators of access to finance such as loans, overdrafts, internal capital and access to export markets is consistent with majority of literature reviewed. Inadequate finance is a constraint to R&D hence the need to improve financing mechanisms as an enabler to the R&D and innovation process.

5.2 Policy Recommendations

Among the most notable findings in this paper is that exporters have a higher likelihood of conducting R&D than non-exporters. We therefore propose that the relevant authorities coordinate in putting up measures to improve the business environment, which in effect will improve the competitiveness of our products internationally hence enabling more Kenyan firms to export. Encouraging exports will result in international exposure and access to wider markets hence increasing the propensity of Kenyan firms to conduct R&D activities.

This study established that majority local owned enterprises have a lower likelihood of conducting R&D compared to their foreign owned counterparts. We propose that the relevant government departments such as The Ministry of Trade and the Kenya Industrial Property Institute should hold periodic expos to sensitize local firm owners and managers on the need to participate in R&D programs.

The government should incentivize R&D and innovation activities especially for majority locally owned firms. Such incentives could be through concessional loans to firms undertaking

R&D in critical sectors for instance agricultural R&D. Increased public funding with longer payment terms will enable firms to undertake R&D activities without the additional pressure posed by the risk of default due to short payment periods.

5.3 Further Areas of Research

This study focused on firms randomly sampled across Kenya in all industries except the agricultural sector. We propose an industry specific study on how financial access relates with R&D and innovation to further inform more defined policies that account for the uniqueness of different sectors of the economy.

We note that majority locally owned firms are less likely to undertake R&D compared to majority foreign owned firms. We propose a study on whether the risk of counterfeiting posed by the informal economy in Kenya is discouraging local firms from undertaking R&D activities.

Further research also needs to be done on the relationship between cheap imports and the willingness of local firms to conduct innovation and R&D activities.

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APPENDICES

Appendix 1: Model Specification using Hausman Test (Model 1-R&D)

	(b) Fe	(B) Re	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E
Internal Finance	-0.139	0.041	-0.180	0.234
Loan	0.011	0.134	-0.123	0.194
Overdraft	0.019	0.148	-0.129	0.191
Export	0.173	0.213	-0.041	0.267
Local	0.884	0.459	0.425	0.385

b = consistent under Ho and Ha; obtained from xtlogit

B = inconsistent under Ha, efficient under Ho; obtained from xtlogit

Test: Ho: difference in coefficients not systematic

$$\begin{aligned} \text{chi2}(5) &= (b-B)[(V_b-V_B)^{-1}](b-B) \\ &= 2.800 \end{aligned}$$

$$\text{Prob}>\text{chi2} = 0.731$$

Appendix 2: Model Specification using Hausman Test (Model 2-Innovation)

	(b) fe	(B) Re	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E
Internal Finance	0.257	0.229	0.029	0.356
Loan	0.305	0.603	-0.298	0.269
Overdraft	0.293	0.331	-0.038	0.268
Export	0.520	0.963	-0.443	0.389
Local	-0.471	-0.623	0.152	0.456

b = consistent under Ho and Ha; obtained from xtlogit
 B = inconsistent under Ha, efficient under Ho; obtained from xtlogit

Test: Ho: difference in coefficients not systematic

$$\begin{aligned} \text{chi2}(5) &= (b-B)'[(V_b-V_B)^{-1}](b-B) \\ &= 4.490 \\ \text{Prob}>\text{chi2} &= 0.481 \end{aligned}$$