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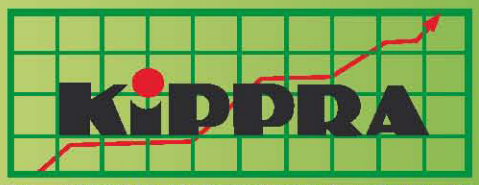

The KENYA INSTITUTE for PUBLIC POLICY RESEARCH and ANALYSIS

Factors Influencing Service Firms' Investment in Research and Development in Kenya

Peris Wachira and Juneweenex Mbuthia

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THE KENYA INSTITUTE FOR PUBLIC POLICY RESEARCH AND ANALYSIS (KIPPRA)

YOUNG PROFESSIONALS (YPs) TRAINING PROGRAMME

Factors Influencing Services Firms' Investment in Research and Development in Kenya

Peris Wachira
Juneweenex Mbuthia

Kenya Institute for Public Policy
Research and Analysis

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Abstract

Research and development (R&D) refers to creative works done to increase knowledge and make new applications using the acquired knowledge. R&D is a vital input to innovation, which plays a critical role in a firm's competitiveness and productivity. R&D investment in Kenya, like most African countries, is below the Africa Union target of 1 per cent of GDP. While half of the services sector is envisioned to deliver 10 per cent annual growth in the Kenya Vision 2030 and create employment, the sector has been performing below its potential in the last decade, which could be attributed to low R&D investment by service firms. Only 15.75 per cent of service firms invest in R&D, of which 45 per cent are small firms, 43 per cent are medium-sized firms and 12 per cent are large firms. The study employed a double hurdle model to analyze the factors that influence service firms' investment in R&D in Kenya. Specifically, the study sought to determine the factors that influence service firm's decision and intensity to invest in R&D in Kenya. The study used 546 observations from the World Bank Enterprise Survey 2018. The study found that participation in international markets, firm size, family ownership, informal competition, previous innovation, skilled human resource on innovation, innovation facility (hubs), taxation and political stability were the key factors that influenced service firm's decision to invest in R&D. Firm sub-sector, firm age, skilled human resource, skilled human resource on R&D and informal competition influenced firm investment in R&D intensity. To foster firm's investment in R&D, the government could consider: public funding to recommended level of 2 per cent of GDP; introducing R&D grants and subsidies to encourage service firms to undertake R&D; rolling out R&D investment campaigns at the county levels, and rolling out sensitization and capacity building programmes on R&D at firm level. To ensure fair competition between formal and informal firms, the National Treasury could consider lowering tax rate for R & D investing firms.

Abbreviations and Acronyms

AU	Africa Union
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on Research and Development
IPP	Intellectual Property Product
KeNIA	Kenya National Innovation Agency
KIRDI	Kenya Industrial Research and Development Institute
KNBS	Kenya National Bureau of Statistics
LRM	Linear Regression Model
MAC	Marginal Adjustment Cost
MTP	Medium-Term Plan
NACOSTI	National Commission for Science, Technology, and Innovation
NRF	National Research Fund
OECD	Organisation for Economic Co-operation and Development
R&D	Research and Development
SDGs	Sustainable Development Goals
SNA	Systems of National Account
S&P	Standard and Poor
ST&I	Science Technology and Innovation
TVET	Technical Vocational Education and Training
UNESCO	United Nations Educational, Scientific and Cultural Organization
WIPO	World Intellectual Property Organization

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1. Introduction

R&D refers to creative works done to increase knowledge and make new applications using the acquired knowledge. R&D is a vital input to firms' innovation. At a firm level, R&D plays a critical role in a firms' competitiveness by enhancing innovation and the ability to exploit new knowledge and productivity (Yatuda, 2015). Firms also invest in R&D because it helps firm managers to predict facts about future phenomena before experimentation and observation. Investment in R&D helps to predict results of trying alternatives, which leads to invention and innovation, thus creating new products and processes (Trott, 2001). Focused research increases knowledge of the relevant field of operation, thus helping in finding a satisfactory path that reduces the number of tried alternatives, which in the long-run lowers the cost of invention and innovation.

R&D is a key driver of the country's economic growth and development. New growth theory and endogenous theory underscore the role of R&D on economic growth through innovation and knowledge accumulation (Romer, 2012). Additionally, R&D is the catalyst to the achievement of critical worldwide development plans, such as the Sustainable Development Goals (SDGs), Africa Agenda 2063, East Africa Agenda 2050, and the Kenya Vision 2030 by intensifying innovations that create a competitive edge for a country. Schumpeter (1950) explains the importance of innovation through technological changes in a capitalist market economy. This is because R&D investment helps firms in shaping technological developments, creating innovation, and sustaining these developments, which consequently increases their market shares in the economy. Besides, a study by John and Sargent (2018), among other studies, illustrates the key role that R&D plays in job creation, public health, energy, agriculture, transportation and security, and poverty alleviation.

Recognizing the role R&D plays in a country's economy, especially at the firm level, different measures have been put in place to promote R&D investment as part of the development plan. These efforts include prioritizing the transformation agenda of the Kenya Industrial Research and Development Institute (KIRDI) under the Medium-Term Plan (MTP) III and promotion of incentives and innovations through implementation of the Industrial Property Act of 2001 and the Trademark Act, Cap 506.

Additionally, acknowledging the emphasis on R&D investment as a component of ST&I in the Kenya Vision 2030, the Government of Kenya has established various institutional, regulatory, and policy frameworks to support R&D (Table A1 at the Annex), for instance, the establishment of the National Commission for the Science, Technology and Innovation (NACOSTI), Kenya National Innovation Agency (KeNIA), and the establishment of the National Research Fund (NRF) through implementation of the Science Technology and Innovation Act (2013). The three institutions support R&D by awarding research contracts, grants, and scholarships to fill the R&D finance and skills gap; creat and strengthen collaborations among researchers and stakeholders by disseminating knowledge and exploiting research; accredit research institutes and grant licenses to undertake research; and nominate advisory research committees which, among

other things, are responsible for prioritizing the research projects. Besides, the University Act (2014)and TVET Act (2014) have created a link between academic research and the private sector actor research.

Despite the government and private sector efforts to promote R&D investment, R&D investment in Kenya, like in most African countries, has remained below the Africa Union target of 1 per cent of Gross Domestic Product. For instance, Kenya has been investing an average of 0.79 per cent of GDP on R&D, which is below the country's target of 2 per cent, and the Africa Union target of 1 per cent. Further, the share of researchers per million people has also remained low in Kenya at an average of 221 researchers per million people, against benchmark countries such as Denmark, Korea, and Sweden who have 8,066, 7,980, and 7,536 researchers per million people, respectively. This implies that Kenya's share of researchers per million people is 86 times lower than that of Denmark's (UNESCO, 2020). In addition, the growth rate of R&D expenditure in Kenya, which according to the System of National Accounts (SNA 2008) is recorded as a component of Intellectual Property Product (IPP) under gross fixed capital formation, has been declining since 2015 from 22.2 per cent to 6.4 per cent in 2018 and 7.0 per cent (KNBS 2020)[1]. This implies a possibility of a declining trend in the value of R&D assets in the country.

R&D investment in the economy is undertaken by either government, higher education, business enterprises, and private non-profit (OECD, 2015). R&D investment in business enterprises is critical for the country's innovativeness, as they are major drivers of innovation (OECD, 2016). Highly ranked innovative countries globally, such as the Republic of Korea which rank position 10 has 80.29 per cent of GERD contributed by business enterprises and 76.64 per cent of R&D financed by business enterprises. Unlike Kenya's aspirators[2] (South Africa, Malaysia, and the Republic of Korea) where business enterprises are key contributors to Gross Domestic Expenditure (GERD) and financers of R&D investment, R&D investment in Kenya is low, and its GERD is majorly contributed by the government and higher education. For instance, business enterprises in Kenya contribute 8.66 per cent to GERD compared to 38.22 per cent in Malaysia, 40.95 per cent in South Africa, and 80.29 per cent in Korea. In addition, international sources of financing contribute to over 42 per cent of R&D investment compared to an average of 4.34 per cent for aspirator countries (see Table 1). As Kenya seeks to accelerate economic development and be at par with its aspirators in Science, Technology, and Innovation (ST&I), low R&D investment among the business enterprises in Kenya key area of policy concern.

1 R&D is the major component of IPP in Kenya.

2 Identified in the Kenya Vision 2030.

Table 1: R&D investment in Kenya and selected aspirator countries

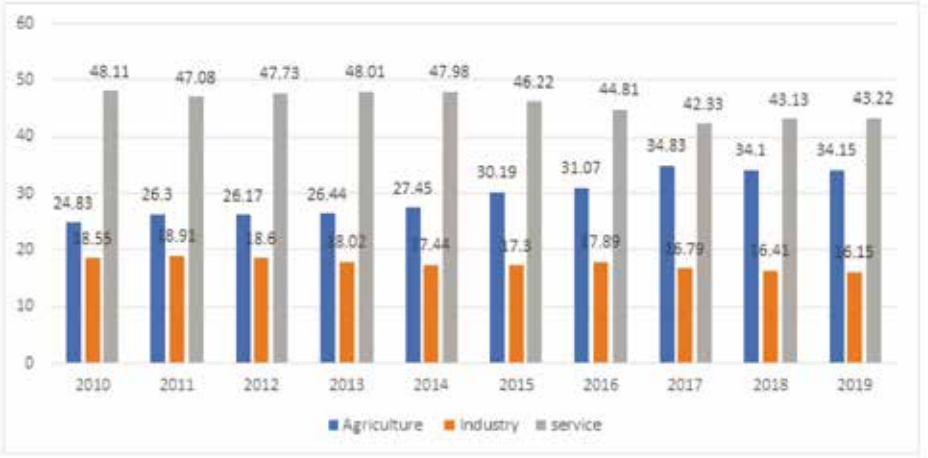
Countries [3]	**Kenya**		**Malaysia**		**South Africa**		**Republic of Korea**	
Global Innovation Rank	86		33		60		10	
Institution	GERD	Source of Funding	GERD	Source of Funding	GERD	Source of Funding	GERD	Source of Funding
Business Enterprise	8.66	4.34	43.92	38.22	40.95	41.49	80.29	76.64
Government	40.64	25.96	13.41	27.92	22.31	46.69	10.07	20.53
Higher Education	39.05	19.03	42.57	25.86	33.60	0.18	8.22	0.58
Private non-profit	11.65	3.53	-	5.48	3.14	1.47	1.41	0.31
Abroad	-	47.14	-	2.52	-	10.17	-	1.94

Source of Data: UNESCO Institute of Statistics and WIPO

Kenya's economy can be broadly categorized into three sectors: agriculture, industry, and services sectors. To achieve the Kenya Vision 2030 of attaining an annual growth rate of 10 per cent, there are 8 sub-sectors under the economic pillar to envision the target. Out of the 8-sub sectors, half of them belong to the services sector. These are tourism, wholesale and retail, trade, and financial services. The other sub-sectors include agriculture and livestock, manufacturing, business process offshoring, and IT-enabled services. In addition, the services sector is increasingly important in terms of direct contribution to Gross Domestic Product (GDP), exports, and employment. The share of services increases as incomes increase. In 2019, the share of agriculture in Kenya's GDP was 35.15 per cent, and the industry contributed approximately 16.18 per cent and the services sector contributed about 42.19 per cent (Figure 1).

3 R&D expenditure (% GDP) Kenya 0.79% in 2010; Malaysia (1%) in 2018; South Africa(0.8%) in 2017 and Republic of Korea (4.5%) in 2018.

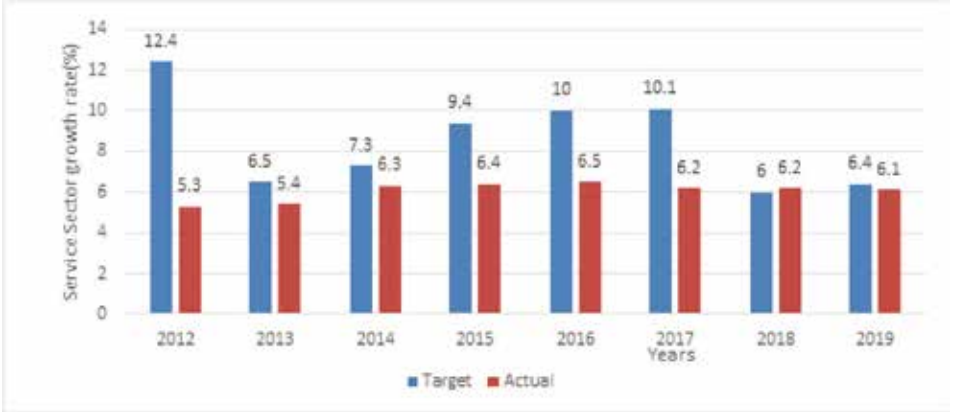
Figure 1: Percentage contribution to GDP by sector, 2010-2019



Source of data: KNBS (Various), Economic Surveys

Despite the services sector contributing the largest share to GDP, it has been recording lower sectoral actual growth rates compared to the sectoral growth targets. The sector recorded growth rates of 5.4 per cent in 2013, 6.3 per cent in 2014, 6.4 per cent in 2015, 6.5 per cent in 2016, and 6.2 per cent in 2017, all of which were lower than MTP II (2013-2017) projections as shown in Figure 2. This shows that the sector has potential for growth that will contribute to employment and support other sectors to attain a 10 per cent annual growth rate targeted in the Kenya Vision 2030.

Figure 2: Targeted and actual services sector growth rates, 2012-2019



Source of Data: KNBS (Various), Economic Surveys, and MTP III

1.1 Motivation of the Study

The services sector is critical in the achievement of the Kenya Vision 2030, as it is a major contributor to economic growth and employment creation. Half of the sectors envisioned to deliver 10 per cent annual growth in the Kenya Vision 2030 belong to the services sector. These sectors include tourism, wholesale and retail trade, and financial services. Since 2011, the sector has contributed an average of 44.7 per cent to Kenya's real GDP and employs an average of 166,530 people per year (KNBS, 2020). However, irrespective of the larger contributions to GDP, the sector has been unable to attain its annual growth target over the last decade, which implies that it has been performing below its potential. The failure by the sector to attain its growth targets is an issue of policy concern among policy makers, academia, and development partners.

Despite efforts by the Government of Kenya to support R&D investments through the establishment of various institutions, development of policies and legal frameworks, the country's R&D investment has remained below the AU target of 1 per cent of GDP and the Kenya Vision 2030 target of 2 per cent of GDP. Currently, Kenya invests around 0.79 per cent of GDP in R&D. In addition, business enterprises' contribution to GERD in Kenya, which is critical for a country's innovativeness, has remained low at 8.66 per cent. At firm level, only 15.75 per cent of the services sector firms invest in R&D. As a result, discussions on R&D investment have raised a lot of policy makers' attention, especially now that Kenya seeks to become a globally competitive and prosperous country by 2030. The question is what influences the firm's decision and intensity to invest in R&D.

While literature on R&D is vast, literature concerning the services sector is limited, as most of the studies focus on the manufacturing sector (Cirera, 2014). This paper, therefore, seeks to close the gap by: (1) focusing on the services sector firms in Kenya which, despite several studies on R&D, focus on the manufacturing sector (Fishman and Rob, 1999; García-Quevedo, Pellegrino and Vivarelli, 2014; Lai, Lin and Lin, 2015; Park, Shin and Kim, 2010; Shibia, 2021; and Yasuda, 2005). Also, despite the contribution to GDP and employment creation of the services sector, little is known about services-sector investment in R&D, and the extent to the investment. Compared to manufacturing, R&D in services is not yet fully integrated into academic and policy literature (Menor, 2000). Therefore, a broad overview of the current insights in a firm's decision to invest in R&D in the services sector firms is necessary; (2) The study considers additional variables specifically, firms' age, firms' main market, source of firms financing, and emphasis on firms' size. For instance, the paper questions how a firm's size influences the decision to invest in R&D, and if it does, to what extent?; (3) Unlike other studies that have utilized the Tobit and Probit model, this study utilizes the double-hurdle model as presented by Cragg, J.G. (1971) and guided by García, B. (2013).

Specifically, the study sought to analyze the factors that influence the service firms decision to invest in R&D in Kenya, and consequently establish the factors that affect the extent of the service firm's investment in R&D in Kenya.

The rest of the paper is organized as follows: section 2 highlights the literature that exists concerning R &D; section 3 explains the data and methodology used to answer the study objectives; section 4 discusses the results while conclusions and policy implications are discussed in section 5. The study limitations and area for further research are stated in the last section 6.

2. Literature Review

This section presents theories and empirical literature related to R&D investment.

2.1 Theoretical Literature

This section reviews the theoretical understanding of the interaction between R&D investment and firm behaviour. This includes R&D investment expected to generate a stream of feature benefits; uncertain outcomes; and market failures associated with non-rivalry of outputs from R&D, and information asymmetry between the firm and potential financiers (Bloch, 2005; Hall, 2008 and OECD, 2015). The implications of these features vary with firm characteristics and how firms operate.

The economics of R&D dates back to the time of Nelson (1959), who argued that firms spend on R&D because they expect a given flow of benefits over time, which they would not have attained if they chose not to invest in R&D. The firm managers in this case expect market research to create marginal social value in excess of that collectable on the free market. However, spending on research and development means we forgo other investments on other activities that can generate future benefits. This implies that investment in R&D has a social cost associated to it. Firms therefore need to allocate resources to R&D at that point where they maximize social profit after taking care of social costs.

Neoclassical- Accelerator Theory of firm investment explains how firms maximize their profit from a given investment (Jorgenson, 1963; Jorgenson and Siebert, 1968). This is based on the fact that R&D investment results from differences in desired capital stock and the actual capital stock. The neoclassical-accelerator theory postulates that a profit maximizing firm would undertake R&D investment up to the point where expected marginal benefits equate the marginal cost (Li and Hall, 2020). The cost of capital and marginal returns in turn depends on firm-specific, sectoral, and business environment factors. For instance, some of the channels through which these factors impact on cost of capital are related to adjustment costs, information gaps between the firm and providers of finance, and uncertainty of realizing returns on investments. This theory of firm investment serves as the foundation for other theories that explain firm characteristics and their interaction with cost of capital or expected marginal returns on capital investments.

Market structure (or industrial organization) theory can be explained by Schumpeterian hypothesis, that perspectives important characteristics of the firms' structure such as the firm size (Schumpeter, 1942). The hypothesis states that larger firms in concentrated markets have higher incentives to invest in R&D. This may be explained by the larger resource base and lower risks of adverse impacts for undertaking activities with uncertain outcomes. In reference to 'creative destruction', a term he coined, Schumpeter argued that innovation, as an outcome of R&D, is a source of market power in that firms compete to gain

larger market share. The Schumpeterian hypothesis can be tested by looking at knowledge investment activities that increase with an increase in market concentration and increase more than proportionately with firm size (Schumpeter, 1942). In addition, there is an emerging issue in literature to consider the role of competition on the behaviour of firms. Early economic view was that formal firms and informal firms are segregated and operate in a dual economy (Lewis, 1954).

Agency theory explains the interaction of R&D investment and family businesses. This is guided by the firm's innovative behaviour and risk preferences that are dependent on its ownership and governance structure. Therefore, family-owned firms are expected to take fewer risks because of the fusion of ownership and management that results in a situation where owners and managers have much of their wealth invested in the firm. They thus bear the full financial burden of failed investments (Gedajlovic, 2004). Risky strategic decisions, such as committing resources to R&D, tend to be avoided because of concerns about the family's financial wealth (Schulze et al., 2002). Accordingly, Naldi et al. (2007) found support for their conceptual idea that family firms are less likely to take risks than non-family firms.

Resource-based theory of the firm propounded by Wernerfelt (1984) strives to explain the available firm's resources pitched towards gaining sustainable competitive advantage over other firms in similar sector. The idea is that competitive advantage can only be achieved by the effective and efficient employment of all resources available to a firm (Mahoney, 2001). The resources can be classified as tangible, intangible, and personnel-based. Tangible resources refer to physical assets such as financial resources, land, facilities, equipment, machinery, and buildings. Intangible resources refers to identifiable long-term assets of a company with no physical existence, such as patented technology, computer software, and knowledge, and technical know-how (Grant, 1991). However, looking at the inimitable features of a resource, Peteraf (1993) urges that if a firm's resources can easily be imitated by competitors, then sustainable competitive advantage would be difficult to be achieved. Therefore, the theory emphasizes the crucial role of a firm's resources in the achievement of greater performance and competitive advantage over other firms or competitors in the industry (Miller and Shamsie, 1996).

Life cycle hypothesis 'learning by doing' theoretical literature by Spence (1981) argues that, over time, as firms age increases, they learn to be more effective and efficient in doing their business through practice and interactions with customers and other firms. Consequently, occurrence of learning spillovers from one firm to another may affect competition among firms (Ghemawat and Spence, 1985). Whereas Spence (1981) sights spillovers as a phenomena that affects all firms equally, work on absorptive capacity notes that firm's may invest in R&D to enhance their ability to absorb external knowledge (Cohen and Levinthal, 1990). However, if there are different types of spillovers, then it is possible that firms vary in their pursuit of these different spillovers. For instance, the 'learning by exporting' theory argues that participation in international markets exposes firms to advanced knowledge from other countries (Grossman, 1991). Therefore, firms' participation in the export market have the advantage of exposure to stiff

competition and international consumer preference that creates incentives for the firms to be innovative by increasing R&D investment to remain competitive (Love and Ganotakis, 2013).

In summary, theoretical literature on determinants of firm's investment on R&D is shown to vary from the firm's characteristics such as age, size, competition, resources, ownership and learning from participation in the export markets. Various literature categorizes the factors that influence a firm's decision/ intensity to invest in R&D into three: tangible factors such as firm size, level of debt; intangible factors such as human resources, commercial resources and organizational resources; and strategic factors such as diversification and internalization (Del Canto and Gonzalez,1999; Galende and de la Fuente, 2003; Costa et al., 2014) while others such as Alessandri and Pattit (2014) classify the drivers into organizational slack, distance to bankruptcy and level of attainment.

2.2 Empirical Literature

2.2.1 R&D as investment

R&D investment is not an ordinary investment due to its distinct characteristics. First, the payback time for funds invested in R&D is marked by uncertainty, regarding both the level of return and the duration of the payback period. In practice, 50 per cent or more of R&D spending is the wages and salaries of highly educated scientists and engineers. Their efforts create an intangible asset, the firm's knowledge base, from which profits in future years will be generated. This knowledge is embedded in the human capital of the firm's employees and is therefore lost if they leave or are fired. Further the intangible nature of R&D investment means that R&D projects cannot be collateralized (Hall et al., 1986; Lach and Schankerman, 1988).

Second, problems of asymmetric information and moral hazard may arise if the investor has difficulty in distinguishing the good projects from the bad, or indeed if the firm is wary of disclosing detailed information about its R&D projects. Information asymmetry can be expected to be especially severe in the case of high-tech firms (Guiso, 1998). Moral hazard problems may be amplified by the inherent uncertainty of R&D projects.

Third, the possibility of technological spillovers and imitation by rivals may discourage investment in R&D. This is because R&D relies on knowledge to create an output of new or improved product and process, and this knowledge is non-rival. It implies that use by one firm does not impede its use by another. To the extent that knowledge cannot be kept secret, the returns to investment in knowledge cannot be appropriated by the firm undertaking the investment, and therefore such firms will be reluctant to invest, leading to under-provision of R&D investment in the economy (Schumpeter, 1942). For all these reasons, and perhaps more besides, investment in R&D may be below the level that would be socially optimum. The concern that there may be under-investment in R&D by business

firms has materialized in the form of a tremendous policy interest regarding the dynamics and determinants of R&D expenditure and questions relating to how R&D can be stimulated.

2.2.2 Research and development in the services sector

The services sector consists of a wide set of industries including retail trade, telecommunication, transportation, renting of machinery, finance, insurance, real estate, hotels, and restaurants. This diversity has been highlighted by Miles (2006), who claims that some services are more like manufacturing in the sense that they are technology-intensive or work with materials. Still, despite the heterogeneity across services-sector industries, there are some fundamental differences between manufacturing and services.

First, services can typically not be stored and are therefore often produced and consumed simultaneously in the same geographical location; that is, there is both a physical and a spatial dimension. In plain English, many services are intangible and cannot be transported or exported, such as manufactured goods, nor can they be stored (Miles, 2006). This means that the decision to invest in R&D is highly influenced by competition from close neighbours.

Second, as compared with the manufacturing sector, knowledge generated in the services sector is less connected to physical innovations. Therefore, education, training, and similar pro-innovative such as R&D activities should be more important in the services sector, just as in the manufacturing sector.

Third, parallel to the manufacturing sector where much of the R&D consists of products, innovation in the services sector is not only about the identification of new services. Innovations in the services sector also consists of fragmentation of existing processes and services into modules. This fragmentation allows services-sector firms to focus on specific services such as the creation of Internet web pages, rather than IT services in general, as noted by Miles (2006).

Despite the heterogeneity of the services sector, it is clear that the nature of the services-sector innovation differs from that of the manufacturing sector, and that the firm's decision to invest in R&D may therefore be different for firms in the services sector. But we also expect the decision to invest and extend to differ across different services sub-sectors. In addition, given that the services sector to a relatively large extent relies on technologies that depend on knowledge capital that is accelerated by R&D rather than physical capital, it is of prior interest to investigate the factors that influence the firms' decision to invest on research and development and to what extent.

2.2.3 Drivers of R&D investments

Firm characteristics also play a role in firms' associated value towards investing in R&D. Firm size and availability of resources for investment are key factors that influence firms' R&D investment decisions. For instance, large firms are full of new

product ideas, which are scarce among small firms. This may explain why large firms hesitate to invest in R&D (Trott, 2001; Bloch, 2005; Becker and Pain, 2008). There exists opposing arguments that suggest that efficiency in R&D investment diminishes with larger firm size because of loss of managerial control (Cohen and Levin, 1989). While smaller firms tend to demonstrate a lower probability of undertaking R&D, they tend to have higher R&D intensity (Baumann and Kritikos, 2016). This is explained by the fact that smaller firms may face entry barriers to undertake R&D, but once they overcome such constraints, they tend to outperform larger firms. Additionally, firms undertaking R&D investments for the first time tend to have larger financial outlays than existing and repeat R&D firms (Peters et al., 2017), suggesting that smaller firms that undertake R&D may face higher costs.

Family ownership is undesirable to R&D intensity. A study on Canadian firms found that established families controlling business groups are reluctant to undertake R&D investments (Morck et al., 2000). Similarly, in the context of listed Taiwanese firms, Chen and Hsu (2009) assert that family ownership negatively affects R&D intensity, and its better when there is a greater number of independent directors on the board. Further, `in an analysis on European firms, Munari et al. (2010) argued that higher family shareholding is negatively associated with R&D investments because of the risk aversion of controlling families and their need for stability and cash flow protection. Block (2012), using panel data from S&P 500 firms, finds that while family ownership is negatively associated with R&D intensity level, sole founder firms show higher levels.

Availability of internal financial resources positively influences firms' R&D investment decisions (Cohen, 1995). While these findings may corroborate the view that financial resources above those required for current operations are needed to support R&D investment, there are contrasting findings that decline in profitability creates incentives for firms to invest in R&D to remain competitive and viable (Hundley, Jacobson and Park, 1996). Firms may prefer to utilize internal finances for R&D as opposed to borrowing for several reasons, such as the tendency to cover its technological plans from external parties for concerns over leaking such information to competitors and information asymmetry between the firm and the lenders that tend to increase costs of external finance (Myers and Majluf, 1984; Hall and Lerner, 2010; Jung and Kwak, 2018).

Firm size was found to be the main driver of a firms' decision to invest. The findings of a study by Galende and de la Fuente (2003) on 152 innovative Spanish firms using binomial logistic model supports the Schumpeter hypothesis (1942) on the size of firms being the critical determinant for a firm's engagement in R&D. The study found that large firms were more likely to invest in R&D due to economies of scale, lower risk of uncertainty, greater markets and better appropriation possibilities. In addition, study findings support the results by Costa (2014) on R&D drivers and obstacles to innovation in the energy industry, which found that firm size was a key determinant of a firm's decision to invest in R&D but not the intensity. However, these findings contradict the findings by Fishman and Rob (1999), which found that smaller firms were more likely to invest in R&D due to their flexibility and specialization nature.

Firms that engage in international markets through export are in favour of innovation to maintain their competitive edge, hence a high possibility of engaging in R&D investments. Additionally, their participation in international markets increases the firm's need for technological inputs, therefore motivating firms to invest more in R&D (Del Canto and Gonzalez, 1999).

A study on the factors affecting a firm's R&D investment decisions in Taiwan, Japan, and Korea using logistic regression by Lai et al. (2015) found cross-country mixed results. For instance, financial autonomy and company size had a positive influence on R&D investment in Taiwan and Korea but not in Japan. Additionally, while the level of profitability supported the decision to invest in R&D in Taiwan, the case was different in Japan and Korea where profitability did not support the decision to invest. Similarly, human resources were found to be a significant determinant in R&D investment in Japan and Korea but not in Taiwan. Only goodwill and patent factor were found to have a positive influence on the decision to invest in R&D in all three countries.

While several studies have been carried out globally to determine the theoretical and empirical factors that influence a firm's decision to invest in R&D, only a few have concentrated on Kenya's economy (Shibia, 2021). Therefore, due to cross-country and sector variations in economic behaviour and policies, these results cannot be used to generalize the case for Kenya and the case of service firms. This study is, therefore, a continuation of Shibia's work by focusing on service firms. Secondly, the study seeks to close the gap by employing the double hurdle model to analyze the factors that influence services firms' decision and intensity to invest in R&D in Kenya. This study utilizes the two-part extensions proposed by Cragg (1971), that is an extension of standard Tobit (1958) model. This was informed by the main limitation of the standard Tobit model as it only allows both processes to be subjected to the same variables for which also only one coefficient is reported. Therefore, the effect of a certain variable cannot have a different sign in the outcome equation, which is not always the case. This is explained by the fact that standard Tobit model only accounts for unobserved zeros; an example firms that do not invest on R&D are a 0 and firms that do invest on R&D but at a certain period it cannot invest are a 0 as well, while the two-part models assume only true zeros. Therefore, Cragg (1971) double hurdle model originated to correct the limitation where 2 hurdles, first it captures a positive amount for example if a firm invests on R&D or not, then second it captures favourable circumstances must arise for the positive desire to be carried out; i.e. a firm that does investment and has sufficient resources to invest.

3. Methodology and Data Sources

This section highlights the data and methodology used to answer the study objectives.

3.1 Theoretical Framework

The study is underpinned on two theories of research and development investment: Schumpeter (1942) theory and the Neo-classical accelerator theory of investment. According to Schumpeter, R&D investment decision depends on firm size. In that, large firms find R&D investment less risky compared to small firms (Kenneth, 1952). This is because based on the financial position of the firms, large firms have a low incidence of risk failure due to the possibility of diversifying the R&D projects. In addition, large firms have the advantage of enjoying economies of scale, market power (Arrow, 1962) and are highly endowed with a diversified human resource base compared to small firms, which makes it easier to invest in R&D.

Therefore, Schumpeter's theory on R&D investment can be summarized as follows:

$$R\&D=f(firm\ Size)\ldots\ldots \qquad 3.1$$

Where R&D is the decision to invest in research and development.

The behavioural agency theory views investment in R&D as a firm way of creating a competitive edge in the market by strengthening their product and/or processes or by providing an entry into the new market (Cyert and March, 1963). The behavioural theory is based on the analogy of the accelerator theory of investment that a profit-maximizing firm undertakes the R&D investment at a point that Marginal Benefits (MB) equal Marginal Cost.

$$MB=MC\ldots. \qquad 3.2$$

In the case of R &D investment, the marginal benefit is the marginal product of R&D investment while MC relates to the user's cost of capital which includes the marginal adjustment cost and the opportunity cost of other investments (interest foregone, and depreciation or appreciation rates)

Therefore, a profit-maximizing firm would be faced by;

$$MP_{(R\&D)}= r + \delta + MAC\ldots. \qquad 3.3$$

Where $MP_{(R\&D)}$ is a marginal product for R&D investment, r and δ is the opportunity cost foregone by interest rate and appreciation/depreciation rate respectively, while MAC is the marginal cost of adjustment. According to this theory, a firm's decision and intensity to invest in R&D transitions from the level of user's cost of capital and marginal product for R&D investment. For instance, if the business environment leads to an increase in users cost of capital, then the $MP_{(R\&D)}$ needs to be higher for the firm R&D to remain profitable. Depreciation or appreciation

cost relates to cost that might be incurred due to imitation and competition, since there is the possibility of spillovers in R&D especially when the firm does not have patent rights. MAC relates to the cost of acquiring human resources and equipment, and finances available for investment.

Thus, through the transmission channel:

$$R\&Dinv=f(\text{ R \&D employees,R\&D facilities,finances,business env)} \ldots 3.4$$

Combining both theories

$$R\&D\ invest=f(\text{firm size,R \&D employees,R\&D facilities,finances,business env}\ldots. \quad 3.5$$

Other factors that affect R&D investment include firm's age, the firm's main market, and ownership structure. For instance, young firms are likely to spend less on R&D since their focus is more on profitability and sustainability compared to older firms. Additionally, a firm whose main market is local is less likely to invest in R&D due to low local competition. Similarly, family-owned firms are faced with dual goals, thus ensuring business continuity and meeting family needs. As such, due to the uncertain nature of R&D investment, family-owned firms may invest less.

3.2 Estimation Model

The study seeks to determine the factors that influence service firms' decision to invest in R&D in Kenya. Recognizing that the extent of R&D investment is critical for a firm's innovation and productivity, the study also examines the factors that determine the extent to which services firms invest in R&D. To achieve this, the study utilizes the double-hurdle model as presented by Cragg (1971) and guided by García (2013). The model was previously used by Aristei and Pieroni (2008), Newman, Henchion and Matthews (2003), Ricker-Gilbert, Jayne and Chirwa (2011 and Teklewold, Dadi, Yami and Dana (2006) in a study to examine the decision and intensity of tobacco consumption in Italy, Irish potato consumption, adoption of poultry technology and use of subsidized fertilizer in Malawi. The double hurdle model allows for different methods to examine the R&D investment decision and the extent (Cragg, 1971).

The model is estimated in two stages:

1. The decision to participate where the firm determines whether it will invest in R&D or not, and later determining the factors that influence the decision.
2. The intensity stage, where the firm estimates the optimal level of investment which may be zero given their circumstances. The values of R&D investment include both zeros if a firm does not invest in R&D and non-zero (amount invested) if a firm invests in R&D.

To estimate this, the double-hurdle uses a combination of the Probit and Tobit model for each hurdle. The double-hurdle model is preferred because, unlike other models such as standard Tobin which consider unobserved zero, the model provides the true situation of zero (intensity).

3.2.1 The decision to participate in R&D investment

The first objective of the study is to determine factors that influence service firms' decision to invest in R&D in Kenya. To achieve this, the study employs the first hurdle of the model by utilizing the probit model. The probit model is preferred since the dependent variable involves a binary decision of whether a firm participated in R &D investment. Secondly, unlike the logit model, the probit model assumes normality in the error distribution, which enhances the ability to address the specification problems (Wooldridge, 2002). The model is estimated using the maximum likelihood method, which selects the most probable estimates that maximize the likelihood of a function.

To achieve the objective, function 3.5 was modified to include other variables that affect firms R&D investment decisions based on the empirical literature presented in section 2. Therefore, the econometric equation 3.6 was estimated for the R&D investment decision:

$$\begin{aligned}\text{Prob}(R\ \&\ D\ Decn_i = 1) = {} & \propto_0 + \propto_1 d1 medium\_firm_i + \propto_2 d2 large\_firm_i + \\ & \propto_3 lnsales_i + \propto_4 Inter\_mmkt_i + \propto_5 \ln fage_i + \propto_6 f\_ownershp_i + \propto_7 hres_i + \\ & \propto_8 faci_i + \propto_9 Inf\_competn + \propto_{10} family\ own_i + \propto_{11} tax_i + \propto_{12} politsta_i + \\ & \propto_{13} innov_i + \propto_{14} d1\ transport_{sect_i} + \propto_{15} d2\ Construction\_sect_i + \\ & \propto_{16} d3\ hotel\ rest\_sect_i + \propto_{15} d4\ IT\_sec_i + \varepsilon_i \ldots\end{aligned} \qquad 3.6$$

The dependent variable *R&D Decn*$_i$ refers to service firms' decision to invest in R&D and is related to the previous fiscal year before the year of study. The variable reflects if the firm is reported to have undertaken R&D investment either in-house or contracted by other companies. If the firm had undertaken the R&D investment, the response was coded 1 and 0 otherwise. In addition, the introduction of a new product or process by the firm three years before the study period (innov) was also used. The resource variable used include finance (lnsales), availability of trained employees on R&D(hres$_i$) and incubation labs(faci). The firm-level variable includes employment rated firm size (medium$_{firm}$ and Large$_{firm}$), firm age(ln fage), ownership by foreign(f$_{ownershp}$) firm's main market (Inter$_{mmkt}$), if the firm is family-owned(family own) and firm sub-sector (either transport, construction, hotel and restaurant and IT. The business environment variable includes political status (politsta) and tax rate (tax). The variable description is as presented in Table 2.

3.2.2 R&D investment intensity

The second hurdle utilizes the Tobit model to determine the factors that influence the firm's R&D investment intensity. The dependent variable *R&D ext* is measured by R&D expenditure as a ratio of the current year's annual sales. The double

hurdle model is preferred since the majority of the firms do not invest in R&D, which implies that most of the dependent variable values are zero (censured to the left). Unlike the Linear Regression Model (LRM), which results in biased and inconsistent estimates of the regression coefficients when the variables are concentrated at some point, the Tobit model is applicable even when variables are censured to the left. Additionally, unlike other two-stage models that are applicable when the data collected is biased, like the Heckman model, double hurdles assume random collection of data, which is the case with the data utilized.

Equation 3.7 was estimated, and the results were used to answer the second research question:

$$R\ \&\ D_{ext} = \propto_0 + \propto_1 d1medium\_firm_i + \propto_2 d2large\_firm_i + \propto_3 skilled_i + \propto_4 inter\_mkt_i + \propto_5 \ln fage_i + \propto_5 ownershp_i + \propto_6 hres_i + \propto_7 faci_i + \propto_8 family\ own_i + \propto_9 tax_i + \propto_{10} political_i + \propto_{11} innov_i + \propto_{12} competn_i + \propto_{13} d1\ transport_{sect_i} + \propto_{14} d2\ Construction\_sect_i + \propto_{15} d3\ hotel\ rest\_sect_i + \propto_{16} d4\ IT\_sec_i + \varepsilon_i \varepsilon_i \ldots \quad 3.7$$

The difference between equation 3.6 and 3.7 is (1) dependent variable in equation 3.7 is R&D investment intensity, which reflects the actual investment made by a firm. (2) inclusion of access to industrial skills as an obstacle to firms' performance (3) exclusion of sales variable since the variable was used to scale down the extent of R&D investment.

Table 2: Variable label, description, and measurement

Variable	Description	Measurement
Dependent Variable		
R&D decn 1	Whether a firm reported having invested in R&D in the previous year	Nominal
R&D ext2	Previous year's R &D expenditure as a ratio of the current year sales	Ratio
Covariances		
Lnsales1	Financial resources are measured by natural logs of the previous 2 years annual sales	Ratio
Innov1 &2	Whether a firm introduced new or improved products or services in the previous 3 years 1=yes 0=No	Nominal
Sub-sector 1&2	Indicates the sub-sector of the firm 1= wholesale and retail 2= transport 3= construction 4=hotel and restaurant 5= IT	Nominal

Hres1 &2	Measures availability of R&D human resources. Whether the firm reports having trained employees on how to develop new products or processes in the previous 3 years 1=Yes 0=No	Nominal
Facility1 &2	Whether a firm used any of the incubation labs set up by the government, universities, or private sector in the previous 3 years 1=Yes 0=No	Nominal
Fimmsize1 &2	Measures firm size by employment 1= small enterprise (1-19 employees) 2= medium enterprises (20-99 employees) 3= large enterprise (>100 employees)	Nominal
lnfage1 &2	Natural logarithm of the firm age. Calculated as the year of existence since the firm establishment	Ratio
F_ownership1 &2	Natural logarithm of the proportion of the firm owned by foreigners	Ratio
Inter_ mmkt1 &2	The proportion of sales done through direct and indirect exports	Ratio
Family own1 &2	The proportion of the family ownership	Ratio
Competition	Whether a firm is competing against unregistered firms	Nominal
Political 1 &2	Perception on whether political stability is an obstacle to the performance of the establishment 1=political instability is an obstacle 0= political instability is not an obstacle	Nominal

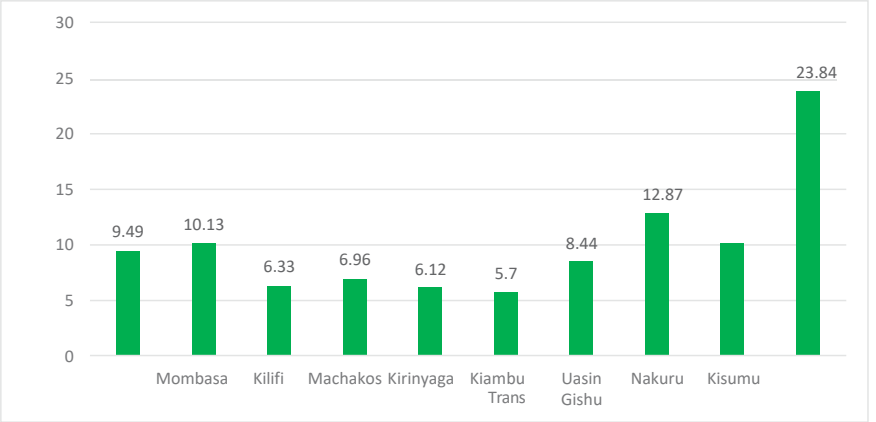
Tax 1 &2	Perception on whether the tax rate is an obstacle to the performance of the establishment 1=tax rate is an obstacle 0= tax rate is not an obstacle	Nominal
Skilled 2	Perception on whether access to industrial skill is an obstacle to the operation of the firm 1= access to industrial skills is an obstacle 0= access to industrial skills is not an obstacle	Nominal

Source: Authors compilation. Where "1" implies that the variable applies to the first hurdle and "2" implies that the variable applies to the second hurdle.

3.3 Data Sources

The study uses the World Bank Enterprise Survey 2018 for Kenya. The data was collected through stratified random sampling to ensure unbiased estimates for different sub-divisions and populations. The survey covers formal sector enterprises with over five employees from the manufacturing and service sectors. The survey included 455 enterprises from the manufacturing firms and 546 enterprises from the services sector, which were utilized in this study. The survey covers urban areas in 10 different counties in Kenya. They include: Trans Nzoia, Mombasa, Kirinyaga, Kisumu, Nakuru, Nairobi, Machakos, Uasin Gishu, Kiambu and Kilifi. As indicated in Figure 3, most of the services firms included are from Nairobi City County, accounting for 23.84 per cent of the firms surveyed.

Figure 3: Distribution of services firms by county



Data Source: Authors' compilation

The services firms covered were from seven main industries: retail, wholesale, construction, hotels, and restaurants, transport, IT, and services to motor vehicles. In terms of distribution of the firms by sub-sector, 34.39 per cent of the firms belong to the retail sub-sector and 27.00 per cent belong to the hotels and restaurants sub-sector (Table 3).

Table 3: Distribution of the services firm by sub-sector

Sub-Sector	No.	Frequency
Construction	48	10.13
Services of Motor Vehicles	53	11.18
Wholesale	45	9.49
Retail	163	34.39
Hotel and Restaurants	128	27.00
Transport	26	5.49
IT	11	2.32

Source: Authors' compilation

3.4 Descriptive Statistics

This section provides descriptive statistics for the data used in the analysis. From the table, R&D intensity ranged from 0 to 27.78 per cent of annual sales. Other non-nominal variables such as firms' participation in the international market(inter_market) ranged from 0 to 100, with a mean of 4.493.

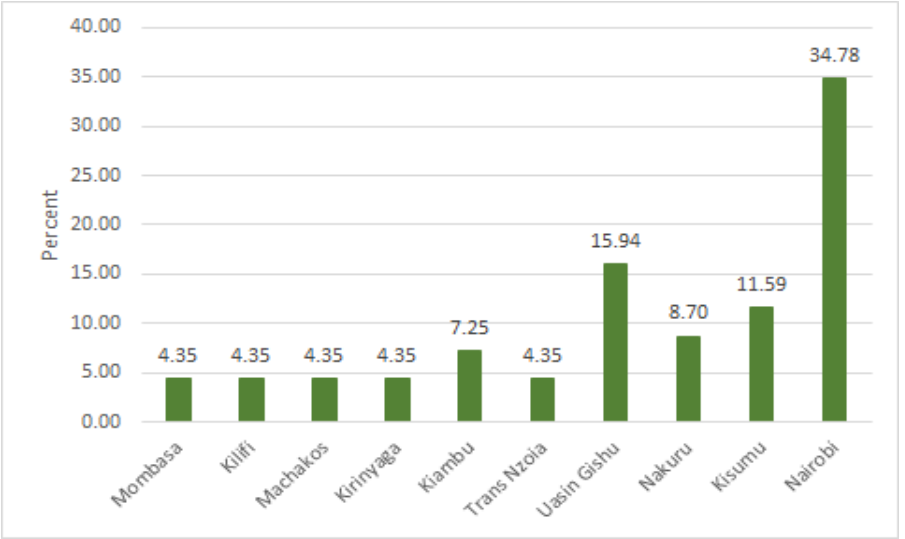
Table 4: Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
R&D intensity	474	0.277	1.872	0	27.778
R&D decision	474	0.146	0.353	0	1
Firm size	474	1.544	0.666	0	3
Ln family age	466	2.556	0.849	0	4.718
Family ownership	464	83.088	32.727	0	100
Innovation	474	0.447	0.498	0	1
Human resource	474	0.451	0.498	0	1
Facility	474	0.082	0.275	0	1
Informal competition	467	0.642	0.48	0	1
Skilled	474	0.017	0.129	0	1
International market	473	6.803	20.57	0	100
Family ownership	417	4.493	0.308	1.609	4.605
Political instability	474	0.2	0.401	0	1

Source: Authors' compilation

Most of the firms investing in R&D are from Nairobi City County, and accounting for 34.78 per cent, Uasin Gishu 15.94 per cent, and Kisumu at 11.59 per cent. The counties with the least firms investing in R&D are Mombasa, Kilifi, Machakos, Kirinyaga, and Trans Nzoia at 4.35 per cent (Figure 4).

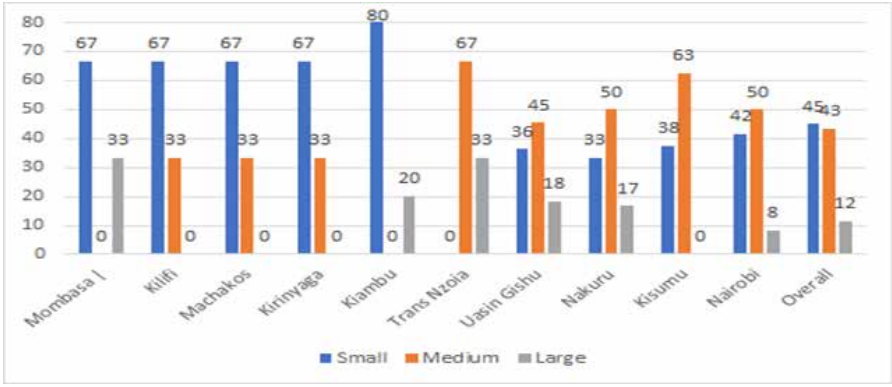
Figure 4: Distribution of services firms investing in R&D by county



Source: Authors' compilation

Overall, small service firms invest more in R&D compared to large and small firms by 45 per cent. However, medium service firms invest more in R&D in Trans Nzoia, Uasin Gishu, Nakuru, Kisumu, and Nairobi compared to small and large firms. Large firms are, however, investing least in R&D in all counties (Figure 5). This contradicts the Schumpeter Theory that large firms are likely to invest more in R&D.

Figure 5: Distribution of services firms investing in R&D by county and size

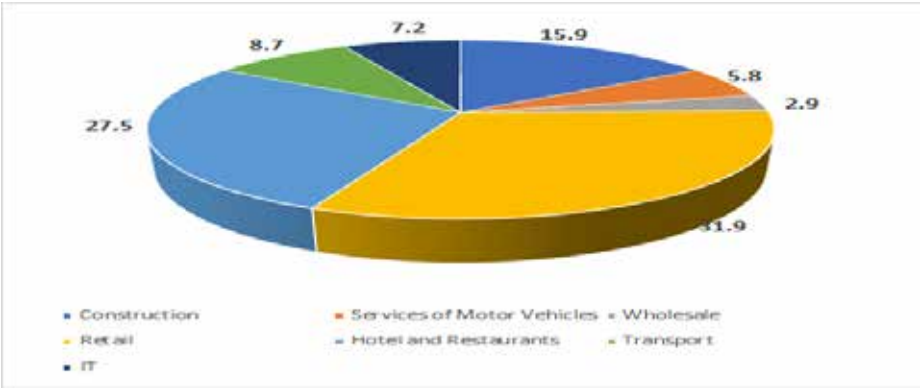


Source: Authors' compilation

Retail firms are major investors in R&D among the services sector, accounting for 31.9 per cent of R&D investment. This is followed by hotels and restaurants

at 27.5 per cent of R&D investment. Wholesale sub-sector invested least in R&D among the services firms, accounting for 2.9 per cent of total R&D investment in the services sector (Figure 6).

Figure 6: Distribution of services firms investing in R&D by sub-sector



Source: Authors' compilation

4. Discussion of Results

This section presents the results and discussion based on the study objectives.

4.1 Factors Affecting Service Firm's Decision and Intensity to Invest in R&D

To achieve this objective, the study estimated equation 3.6 and 3.7 using double hurdle model, which employs probit and tobit model as explained in section 3. Unlike the probit and tobit results, double hurdle model results are interpreted by combining the two stage results: (1) participatory decision; and (2) extent of participatory; that is, what influences participatory decision and then if the the participatory decision is positive, how much does the factor that influenced participatory decision influences the extent to participate? In this study, the participatory decision is the decision of a services firm to invest in R&D, which can be yes or no. Then the extent of participatory is the intensity of R&D investment by a services firm, which can be zero if the participatory decision was negative(no) or a value in percent (measured as R&D investment as a percent of current sales) if the participatory decision to invest in R&D was positive(yes). For instance, if the age of the firm is found to be a significant factor that influences firms decision to invest in R&D positively and intensity of R&D negatively, holding other factors constant, the interpretation of the result will be: an older firm is more likely to invest in R&D than a younger firm (participatory decision), and if it does, it is likely to invest less amount in R&D than a younger firm (intensity) holding other factors constant. Then, the marginal effects on intensity to invest are used to interpret the probability (magnitude) of older firms investing less than younger firms.

The double hurdle results for the two study objectives are as presented in Table 5.

Table 5: Double hurdle results on the factors that influence service firms decision and intensity to invest in R&D in Kenya

Variables	Probit Estimates	Tobit Estimates	Tobit Marginal Effects (dy/dx)
Previous innovation	2.266*** (0.736)	-2.456 (1.505)	-2.456 (1.505)
R&D human resource	0.903** (0.620)	4.955*** (1.403)	4.955*** (1.403)
informal competition	1.879** (0.885)	-0.879 (1.483)	-0.879 (1.483)
log age of the firm	0.512 (0.378)	1.903** (0.823)	-1.903** (0.823)
International market	0.032* (0.017)		

Medium firm	0.875 (0.665)		
Large firm	1.696* (0.934)		
family-owned	-3.468*** (1.199)		
political obstacle	-1.868** (0.901)		
Tax	-1.028* (0.514)		
Innovation facilities	0.099* (1.366)		
Skilled		6.013** (3.019)	6.013** (3.019)
Ln sales		-0.179 (0.344)	-0.179 (0.344)
Transport sub-sector		1.013 (1.715)	1.013 (1.715)
Construction sub-sector		2.655 (1.776)	2.655 (1.776)
Hotel and restaurant sub sector		3.761** (1.515)	3.761** (1.515)
IT sub sector		6.346**	6.346**
		(3.123)	(3.123)

*N/B *** implies significant at 1%, ** at 5 % and * at 10%; Std errors in parenthesis*

Source: Authors' compilation

Based on the results presented in Table 5, a large services firm is more likely to invest in R&D than a small firm, holding other factors constant. These results are in line with Schumpeter's theory of R&D investment, which explains that large firms are likely to invest in R&D than small firms due to their financial position and ability to absorb shocks as R&D investment is uncertain. In addition, they enjoy economies of scale, market power and face a low incidence of risk failure since they can diversify the R&D projects. In addition, these findings support the results by (Galende and de la Fuente, 2003 and Costa, 2014) However, the results contradict the results by Fishman and Rob (1999), which found out that small firms are more likely to invest in R&D flexibility and specialization nature.

A service firm participating in the international market is more likely to invest in R&D than a firm that does not, holding other factors constant. This is because a firm that engages in the international market through exports products can face inter-country or regional competitions, which motivates them to invest in R&D for innovation to maintain a competitive edge in the market and meet customer demands. These results support results by Shibia (2021) and Girma, Görg, and

Hanley (2008) that concentrated on the manufacturing sector in Kenya and British and Irish firms, respectively.

A services firm facing informal competition from other firms is more likely to invest in R&D than a firm that does not face informal competition, and if it does it is likely to invest less amount in R&D by 0.89 per cent of their sales relative to firms that do not face informal competition, holding other factors constant. Informal competition encourages services firms to be innovative to maintain a competitive edge in the local market by investing in R&D. However, after making the decision to invest in R&D, they invest less amount to maintain financial liquidity, given the uncertain nature of R&D. Additionally, there is a possibility of spillover in return of R&D investment from one firm to another, which may discourage services firms to invest more in R&D. Besides, competition from informal firms can discourage formal services firms due to differences in costs such as taxes and regulation imposed. The results agree with the findings by Shibia (2021) on Kenyan manufacturing firms and Pérez et al. (2018) in emerging markets' firms. However, the marginal effects between the services firms and manufacturing firms presented by Shibia (2021) differ. This can be explained by the cross-sector differences and homogeneity nature of each sector.

A service firm with more family ownership is less likely to invest in R&D compared to firms with less family ownership, holding other factors constant. This is because family-owned firms are faced with two main goals: meeting family needs and ensuring the continuity of the business. However, as family ownership increases families tend to focus more on meeting their household needs. These results support the findings by Choi et al. (2015) on the role of family ownership in R&D investment. According to Choi et al. (2015), family ownership had a negative influence on R&D investment up to a point where R&D investment prospects became positive.

A service firm with access to innovation facilities such as incubation hubs is more likely to invest more in R&D than a firm that does not, holding other factors constant. The availability of infrastructure supports innovation activities such as R&D investment by enhancing coordination and collaborations in research and development. Similarly, services firms that had previously trained their employees on the development and introduction of new products and processes are more likely to invest in R&D than services firms that never did, and if they do, they are likely to invest larger amounts in R&D compared to firms that did not train their employees by 4.95 per cent of their sales, holding other factors constant. Given the uncertain nature of R&D, skilled human resources motivate the management to invest in R&D due to assured returns.

Services firms that had previously introduced new products or processes into the market are less likely to invest in R&D relative to firms that did not, and if they do invest in R&D, they are likely to invest less amount in R&D compared to firms that have not by 2.45 percent of their sales, holding other factors constant. This can be explained by the nature of firms to prioritize other investments rather than R&D. In addition, the firm could still be enjoying the returns of previous R&D investments that resulted in innovation.

A services firm that reported tax and political instability as an obstacle is less likely to invest in R&D relative to firms that did not, holding other factors constant. This can be explained by the fact that political instability adversely affects the business environment, which in turn discourages R&D investment. In addition, tax cost reduces the revenues at hand for R&D investment.

While the services sub-sector is an insignificant factor in influencing the firms' decision to invest in R&D, services firms in the hotel and restaurant and Information and Technology (IT) sub-sectors are more likely to invest more in R&D compared to firms in wholesale and retail sub-sector by 3.76 and 6.35 percent of their sales, holding other factors constant.

Firm age and sales were found to be insignificant factors in explaining the firms decision to invest in R&D. Skilled human resources, firm age, innovation facility, transport and construction sub-sectors were found to be insignificant variables in explaining the firms R&D investment intensity. Sales variable was found to have a high correlation with R&D intensity (measured as R&D invested as a percentage of sales) variable and it was therefore dropped. Due to the magnitude of insignificance, variables such as skilled human resource, firm's age, and innovation facility were dropped from the second hurdle, while sales were dropped from the first hurdle to ensure a well fitted mode.

5. Conclusion and Policy Recommendations

Research and Development (R&D) plays a vital role in a country's economy, especially at the firm level, to promote innovation as part of the development plan. However, Kenya's investment in R&D has been very low at an average of 0.79 per cent of GDP, which is below the country's target of 2 per cent. In addition, while R&D investment in business enterprises is vital for the innovativeness of the country as they are major drivers to innovation, Kenya's business enterprises' contribution to GERD remains low at 8.66 per cent compared to its aspirator countries such as Malaysia at 43.92 per cent, South Africa at 40.95 per cent, and Korea at 80.3 per cent. While vast literature exists on R&D, more focus has been on manufacturing sector firms, neglecting the services sector firms, which are equally important for Kenya's economic growth, employment, and realization of the Kenya Vision 2030 annual growth target of 10 per cent.

Despite the government efforts to support R&D investments through the establishment of various institutions, policies and legal frameworks, challenges such as inadequate funding, lack of coordination between research institutions and disjointed academic research, policy institution and industry exists. Therefore, there is need to harmonize and link academic research and the industry by encouraging or even finding institutions that are collaborating with industries on research. In addition, only few services sector firms invest in R&D, and more attention needs to be on services firms given their significant importance to the contribution of economic growth and employment creation. In terms of the services sub-sector, retail firms account for the highest R&D investment. This is followed by hotels and restaurants, while wholesalers invest the least. Therefore, the government and other research stakeholders could use this information on the diversity of service sub-sectors to support the sub-sectors that invest less on R&D and encourage the sub-sectors that invest more in increasing their intensity.

This study sought to analyze the factors influencing services firm's decision and intensity to invest in R&D in Kenya. The study found that firms participating in international markets, firm size, family ownership, skilled human resource in R&D, innovation facilities, informal competition, previous innovation, tax and political instablility obstacles influenced firms' decision to invest in R&D. Firms in IT, hotel, and restaurant sub-sectors, services firms with skilled human resource in R&D, and trained human resources in R&D are more likely to invest more in R&D. This confirms the importance of investing on human skills, and that for firms to efficiently engage in research and development, then there is need to also train and impact the staff with the required skills. Firm age and informal competition was found to influence R&D investment intensity negatively.

To accelerate R&D investment in service firms, the government could consider increasing government funding to 2 per cent of GDP; introduce R&D grants and subsidies to encourage service firms to undertake R&D especially in the IT and hotel and restaurant sub-sector which were found to have high R&D potential; encourage R&D investment at county level by sensitizing firms on the benefit of R&D and setting a specific budget aside to support R&D investment campaigns; introduce more innovation facilities (hubs) to foster R&D investment, and thus

innovation; enhance coordination between research institutions and academic research; and provide favourable export policies such as lowering export duties to motivate firms to participate in international markets. In addition, the government could consider introducing innovation-related capacity building as services firms with trained R&D human resources were found to invest more in R&D. The National Treasury could also consider reducing taxes to R&D investing service firms to encourage more R&D investment at firm level.

Areas for Further Research

The study concentrated on the factors that influence services firms investment in R&D using cross-sectional data. However, the study did not analyze how firms location affects its decision to invest in R&D. Additionally, it is critical to analyze the level of R&D investment that is favourable to firms. Therefore, this study proposes a study to determine if firms location matters in R&D investment, and estimating services firms R&D investment threshold in Kenya.

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Annex

Table A1: R&D policy review

Policy	Objective	Focus on R&D	What has been Done	Gaps
ST& I Act, 2013	National Commission for Science Technology and Innovation (NACOSTI)	NACOSTI expects every institution to spend at least 2% of turnover on research, with the objective of leveraging these funds to create partnerships, develop research collaborations and attract external funding NACOSTI develops the national STI priorities, leads inter-agency efforts to implement the policy, accredits research institutes and grants licenses to undertake research, decides on funding priorities, develops, and enforces relevant regulations, and monitors progress in STI	The allocations of research funds to NACOSTI, NRF and KENIA to ensure the implementation of the government's agenda in R&D NACOSTI has registered all research organizations in the country NRF has managed to strategically partner in transformative innovation policy programmes such as Horizon 2020 of the European Union for research	R&D activities remain underfunded at 0.79 per cent of GDP against target of 2%, hence the need to encourage private sector participation Research institutes are scattered in different ministries, hence a challenge of coordination of national research activities
	Established the national institutional framework for research.	Advisory Research Committees (ARCs): advise NACOSTI on the programmes and projects required to implement the priorities identified in the national STI policy and maintain a database of existing research		

		programmes, projects, and facilities		
	Kenya Innovation Agency (KENIA)	KENIA is tasked with institutionalising relationships among research actors and between those and non-research actors, designating centres of excellence, disseminating scientific knowledge or technology, and developing the national capacity and infrastructure to protect and exploit research IP.		
	National Research Fund (NRF)	NRF awards research contracts, grants and scholarships, finances the acquisition or establishment of research facilities and supports research capacity building across the country.		
University Act of 2014 and the TVET Act of 2014	To strengthen STI governance and coordination within the Academia development of university-based incubators for and improved focus on entrepreneurship	Contribute to the establishment of strong links between academic research and the private sector actors	Kenya National Educational and Research Network (KENET) facilitates the sharing of educational and research resources through broadband infrastructure and services	The relationships between research institutions and industry remains disjointed

Annex 2: Raw results

dhreg rdintensity sectordm2 sectordm3 sectordm4 sectordm5 lnagenw innov hrdev comptn skilled lnsales , hd(lnagenw mmkt firmsize_d2 firmsize_d3 comptn familyown political innov hrdev facility)

starting values for hurdle

Iteration 0: log likelihood = -157.01017
Iteration 1: log likelihood = -118.36108
Iteration 2: log likelihood = -116.58841
Iteration 3: log likelihood = -116.58349
Iteration 4: log likelihood = -116.58349

Probit regression

Log likelihood = -116.58349

Number of obs=404
LR chi2(10)= 80.85
Prob > chi2=0.0000
Pseudo R2=0.2575

___000002	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
lnagenw	-.153738	.1141668	-1.35	0.178	-.3775008	.0700247
mmkt	.0087316	.0044597	1.96	0.050	-9.39e-06	.0174725
firmsize_d2	.3305621	.2072485	1.60	0.111	-.0756375	.7367616
firmsize_d3	.5801418	.306653	1.89	0.059	-.0208871	1.181171
comptn	.3709021	.2104979	1.76	0.078	-.0416662	.7834704
familyown	.6714332	-1.23942	.29	-4.28	0.000	-1.807401

political	-.431303	.2566114	-1.68	0.093	-.934252	-.0716461
innov	.6825918	.2001058	3.41	0.001	.2903918	1.074792
hrdev	.477963	.1940088	2.46	0.014	.0977128	.8858231
facility	.9326762	.2601491	3.59	0.00	.422793	1.442559
_cons	3.576156	1.32789	2.69	0.007	.9735481	6.178764

starting values conditional on hurdle being passed

Tobit regression
Limits: lower=0
Upper=+inf

Log likelihood = -290.04725

Number of obs =459
Uncensored =64
Left-censored =395
Right-censored =0
LR $chi^2(10)$ = 52.90
Prob > chi^2 = 0.0000
Pseudo R^2 =0.0836

rdintensity	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Sectordm2	.1823216	1.358536	0.13	0.893	-2.487558	2.852201
sectordm3	2.687096	1.47135	1.83	0.068	-.204492	5.578684
sectordm4	1.646496	1.153855	1.43	0.154	-.6211311	3.914122
Sectordm5	7.567615	2.235014	3.39	0.001	3.175228	11.96
lnagenw	-.835970	.5932658	-1.41	0.159	-2.001893	.329952
innov	3.643225	1.686951	.9954268	1.69	0.091	-.2693227
hrdev	3.94458	1.044669	3.78	0.000	1.891531	5.997628

comptn	1.378638	.9724363	1.42	0.157	-.5324539	3.289729
skilled	5.353052	2.565677	2.09	0.038	.3108263	10.39528
lnsales	.0157812	.2649073	0.06	0.953	-.5048309	.5363933
_cons	-10.24011	4.68658	-2.18	0.029	-19.45046	-1.02975
/sigma	5.790477	.5637156			4.682628	6.89832

estimation assumingindependence----------

maximum likelihood estimates of double hurdle model

(70 missing values generated)

N = 404

log likelihood = -225.60415

chi square hurdle equation = 32.379015

p hurdle equation = .00211016

chi square above equation = 29.77885

p above equation = .00093096

chi square overall = 50.250697

p overall = .00020389

---

	coef	se	z	p	lower CI	upperCI
hurdle						
lnagenw	.5116221	.3778138	1.354165	.1756838	-.2288793	**1.252124**
Mmkt	.0323537	.0170416	1.898514	.057628	-.001047	**.0657547**
firmsize_d2 |	.874989	.665471	1.314841	.188563	-	**2.17929**

	8	7		2	.4293109	
firmsize_d3 |	.696136	.9344086	1.815197	.0694937	-.1352716	**3.527543**
comptn	**1.8793**	**.8845125**	**2.124673**	**.0336139**	**.1456872**	**3.612912**
familyown |	-3.467593	1.199271	-2.891416	.0038351	-5.818121	-1.117064
political |	-1.867797	.9009472	-2.073148	.0381585	-3.633621	-.1019727
innov |	2.265636	.7363547	3.076828	.0020922	.8224078	3.708865
hrdev |	-.902835	.6195186	-1.457317	.1450289	-2.117069	.3113991
facility |	8.09905	231.3664	.0350053	.9720755	-445.3707	461.5688
_cons	**11.93706**	**5.208784**	**2.291717**	**.021922**	**1.728032**	**22.14609**
above						
sectordm2	1.013401	1.71497	.5909143	.5545778	-2.34788	**4.374681**
sectordm3	2.654727	1.776199	1.494612	.1350159	-.8265585	**6.136013**
sectordm4	3.761211	1.515421	2.481958	.0130663	.791041	**6.731382**
sectordm5	6.346355	3.122605	2.032391	.0421141	.2261605	**12.46655**
lnagenw	-1.902623	.8232393	-2.311142	.020825	-3.516143	**-.2891037**
innov	-2.456391	1.504649	-1.632534	.1025671	-5.40545	**.4926675**
hrdev	4.954683	1.403306	3.530721	.0004144	2.204253	**7.705113**
comptn	-.8788854	1.482661	-.5927756	.5533313	-3.784848	**2.027077**
skilled	6.013179	3.019218	1.991635	.0464111	.0956211	**11.93074**
lnsales	-.1787809	.3437905	-.5200287	.603044	-.85259	**.4950361**
_cons sigma	1.59965	6.448602	.2480615	.8040868	-11.03938	**14.23868**
_cons	**5.317891**	**.5627895**	**9.449165**	**0.000**	**4.214844**	**6.420939**

. margins, dydx(*)
Average marginal effects Number of obs = 404
Model VCE : OIM

Expression : Linear prediction, predict()
dy/dx w.r.t. : sectordm2 sectordm3 sectordm4 sectordm5 lnagenw innov hrdev comptn skilled lnsales mmkt firmsize_d2 firmsize_d3 familyown political facility

Delta-method

dy/dx	Std. Err.	z	P>|z|	[95% Conf.	Interval]
sectordm2	1.013401	1.71497	0.59	0.555	-2.34788	4.374681
sectordm3	2.654727	1.776199	1.49	0.135	-.8265585	6.136013
sectordm4	3.761211	1.515421	2.48	0.013	.791041	6.731382
sectordm5	6.346355	3.122605	2.03	0.042	.2261605	12.46655
lnagenw	-1.902623	.8232393	-2.31	0.021	-3.516143	-.2891037
innov	-2.456391	1.504649	-1.63	0.103	-5.405449	.4926674
hrdev	4.954683	1.403306	3.53	0.000	2.204253	7.705113
comptn	-.8788854	1.482661	-0.59	0.553	-3.784848	2.027077
skilled	6.013179	3.019218	1.99	0.046	.0956211	11.93074
lnsales	-.1787809	.3437905	-0.52	0.603	-.852598	.4950361
mmkt	0	(omitted)				
firmsize_d2	0	(omitted)				
firmsize_d3	0	(omitted)				
familyown	0	(omitted)				
political	0	(omitted)				
facility	0	(omitted)				

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