Determinants of manufacturing firms' Research and Development investments: evidence from Kenya

Adan Guyo Shibia
Private Sector Development Department,
Kenya Institute for Public Policy Research and Analysis, Nairobi, Kenya

Received 1 July 2021
Revised 3 July 2021
12 July 2021
9 February 2022
26 February 2022
Accepted 4 March 2022

Abstract

Purpose – This study investigates effects of firm-level, sector-level and business environment factors on manufacturing firms' Research and Development (R&D) investment decisions in Kenya.

Design/methodology/approach – Panel Probit regression model is employed to analyse effects of the explanatory variables on manufacturing firms R&D investment decisions.

Findings – Access to external finance, lower informal sector competition, exports market participation, larger firm size and firms in high technology subsectors increase probabilities of undertaking R&D investment decisions.

Research limitations/implications – The findings underscore the need to consider institutional framework, aimed at easing business environment constraints related to access to finance, export promotion and competition from informal sector enterprises. Future research should consider cross-country analysis within the Sub-Saharan African (SSA) region to understand implications of institutional contexts that prove to be a challenge to address in a study based within a single country.

Practical implications – Policymakers need to consider addressing business environment constraints that impede R&D investments by private sector enterprises in developing countries. Formal private sector firms should design R&D investment strategies and lobby for policy interventions targeted at business environment constraints.

Originality/value – This study considers effects of variables underexplored in existing literature, notably competition from informal sector firms, R&D-intensity technological classification and an objective measure of access to finance. The study also utilises a panel survey data, which was underexplored in prior studies within SSA economies.

Keywords Investments, Business environment, Firm characteristics, Sector characteristics, Developing countries, Africa

Paper type Research paper

1. Introduction

Low Research and Development (R&D) investments amongst manufacturing firms in developing countries remain a significant policy concern. At the firm level, R&D investments enhance innovation and absorptive capacity for external knowledge through learning and assimilation (Cohen and Levinthal, 1989; O'Mahony and Vecchi, 2009; Lee, 2013). At the macroeconomic level, it accelerates growth of low and middle income countries and therefore convergence with high-income economies (Lee, 2013). Globally, R&D intensity as measured by the ratio of Gross Expenditure on R&D (GERD) to Gross Domestic Product (GDP) average 2.2% compared to Africa at 0.5% (UNECA, 2018). The ratio is estimated at 0.8% for Kenya (UNESCO, 2016; Sachs *et al.*, 2019), of which over 40% is financed from abroad (UNESCO, 2016).

Journal of Business and Socio-economic Development
Vol. 3 No. 2, 2023
pp. 134-149
Emerald Publishing Limited
e-ISSN: 2635-1692
p-ISSN: 2635-1374
DOI 10.1108/JBSED-07-2021-0089

Kenya, like other Sub-Saharan African (SSA) countries, prioritises development of manufacturing sector as part of national transformation strategies for employment and poverty alleviation. These countries have however faced dwindling performance of manufacturing, with the sector's average contribution to GDP falling from 17% in 1980 to 11% in 2019 (World Bank, 2021). Kenya is a typical of this example as articulated in its long-term development plan, the Kenya Vision 2030.

The R&D investment include creative and systematic activities for increasing stock of knowledge and creating new application of existing knowledge (OECD, 2015). The institutional sectors involved in R&D investments include government, higher education, business enterprises and private non-profit (OECD, 2015). The combined activities of these four institutional sectors constitute GERD. The focus of this paper is on the Business Enterprises Expenditure on R&D (BERD) within the manufacturing sector. In this study, R&D encompasses expenditures undertaken by manufacturing firms to generate knowledge for creating *new* or *improved* products or processes (Hall, 2008). A key policy challenge for developing countries particularly within SSA is how to promote private sector driven R&D investment that can support productivity growth and competitiveness (Cornel University, INSEAD, WIPO, 2019).

Low R&D investments in developing economies can be explained not only by internal capabilities of firms and industry-level constraints and opportunities but also by business environment factors. Business environment embodies policy, regulatory and physical infrastructure that support or impede operations of the firms (World Bank, 2004; Newman *et al.*, 2016). Much is however yet to be explored in terms of business environment-related variables affecting R&D investment decisions by firms in these economies. Unlike prior studies within SSA economies (Cirera, 2014), this study provides some added value. First, it considers variables that are overlooked in prior studies; notably competition from informal sector firms, R&D-intensity technological classification and an objective measure of access to finance. Objective measure of access to finance refers to whether a firm has received loan or has a line of credit, unlike subjective measure prone to measurement errors, that is based on perceptions such as the extent firms perceive access to finance is a constraint. Research on how competition from informal firms affect innovation process is increasingly getting policy interests (Pérez *et al.*, 2018; Mendi and Costamagna, 2017; Darbi *et al.*, 2018) given that formal manufacturing firms in developing countries cite it as a significant constraint to their operations (World Bank, 2014). Most of these studies however focus on product or service innovation with little attention given to input level of innovation process such as R&D investments. The results from the few studies on effects of informal sector competition on formal firms' R&D investments are also mixed, with some reporting positive results and others negative results (Mendi and Costamagna, 2017; Darbi *et al.*, 2018). The mixed results are attributed to different institutional contexts (Pérez *et al.*, 2018). The second contribution of this study relate to the use of panel survey data, which has been underexplored in prior studies (Pérez *et al.*, 2018) particularly within SSA economies. Panel data helps control for unobserved individual-level and time-related characteristics (Hsiao, 2014).

2. Literature review

2.1 Theoretical literature

The theoretical insights are anchored on key features of R&D investments in relation to firm behaviour. These features include the investment-nature of R&D as it is expected to generate stream of future benefits, uncertain outcome and market failures associated with non-rivalry of knowledge and information asymmetry between the firm and financial institutions (Bloch, 2005; Hall, 2008; OECD, 2015). The implications of these features vary with firm characteristics and the institutional contexts. The theoretical literature is synthesised into

four complementary thematic areas: neoclassical view, structure of the industry and firm characteristics, public policies and institutional factors, and learning behaviour of firms.

2.1.1 Neoclassical theory of firm investment. The neoclassical theory of optimal capital accumulation (Jorgenson, 1963; Jorgenson and Siebert, 1968) postulates that a profit maximising firm undertake R&D investments up to the point where expected marginal returns equate the marginal cost (Li and Hall, 2020). This theory anchors on cost of capital and expected marginal returns. Cost of capital and marginal returns depend on firm-specific, sectoral and business environment factors. Some of the channels through which these factors impact on cost of capital are adjustment costs, premium for information asymmetry and uncertainty of realising returns on investments. The neoclassical theory of firm investment serves as the foundation for other theories elaborated below, with insights on factors influencing cost of capital or expected marginal returns on capital investments.

2.1.2 Industry structure and firm characteristics. The Schumpeterian hypothesis (Schumpeter, 1942) postulates that larger firms in concentrated markets have higher incentives to invest in R&D owing to larger resource base and lower risks of adverse impacts for undertaking activities with uncertain outcomes. It argues that innovation is a source of market power in which firms compete to gain larger market share. An industry evolves from competitive to monopolistic tendency, and back to competitive as firms contest for profit and market share. An emerging issue is the role of competition from informal firms on the behaviour of formal firms. While early economic view was that formal and informal firms operate in a dual economy (Lewis, 1954), the parasitic view suggests the two segments of the enterprises compete in the same market with the latter eroding market share of the former due to advantages of operating outside regulatory and taxation framework (Farrell, 2004).

2.1.3 Public policies and institutional factors. The early work in this strand of literature has foundations in externalities and market failures of R&D outcomes in form of innovation, calling for incentives and institutional support to attract private investments (Nelson, 1959; Arrow, 1962). This theory argues that because knowledge can be imitated at lower costs than the original costs, lower private benefits relative to social benefits lead firms to undertake less than optimal investments.

2.1.4 Learning behaviour of firms. The "learning-by-doing" theory (Spence, 1981) argues that firms learn to be more efficient through practice and interactions with customers and other firms. The "learning by exporting" theory argues that participation in international trade creates exposure to the knowledge base present in other economies (Grossman, 1991; Yeoh, 2004). Firms' participation in the export markets present stiff competition and international customer demands that create incentives for innovation (Love and Ganotakis, 2013) and scale effects by spreading R&D investments over large output (Aw *et al.*, 2008).

2.2 Empirical literature

Within the realm of public policies and institutional factors, empirical evidence suggests private rate of return is lower than the social rate of return (Griliches, 1998; Appelt *et al.*, 2016). This means that the spill over of knowledge to other firms results to private sector underinvestment in R&D.

Access to finance constrains development of firms in SSA (Fowowe, 2017) due to underdeveloped financial markets (Allen *et al.*, 2011). Firm characteristics such as size create significant barriers for micro and small enterprises (MSEs). The R&D financing challenges emanate from its key features including non-rivalry in usage of knowledge; high risk premium demanded by financiers and information asymmetry as firm owners and managers possess superior information than lenders (Hall and Lerner, 2010).

The World Bank Enterprise Survey reveals that over 40% of manufacturing firms in SSA report competition from informal firms pose constraints to their operations, which is higher than the average for all countries at 29% (World Bank, 2019a). Informal firms operate outside

regulatory costs and taxation purview (Pérez *et al.*, 2018), and their effects on strategic decisions of formal firms depend on institutional contexts and the economic sector of operations (Mendi and Costamagna, 2017; Pérez *et al.*, 2018).

Research on firm-specific characteristics reveal that availability of internal financial resources and larger firm size positively influence firms' R&D investment decisions (Cohen, 1995; Bloch, 2005; Becker and Pain, 2008; Baumann and Kritikos, 2016). Firms prefer to utilise internal finances for R&D as opposed to borrowings so as to conceal its technological plans from competitors (Teece, 1980) and evade costs of information asymmetry between the firm and the lenders (Myers and Majluf, 1984; Hall and Lerner, 2010; Jung and Kwak, 2018).

Over time a firm undergoes different growth phases, and this is expected to affect its investment behaviour along the life cycle. Older firms are expected to invest more in R&D to compensate for the obsolescence of their growth-phase advantages (Cuervo-Cazurra and Un, 2010). Age impacts on R&D investment through learning effects by allowing more mature firms to leverage on experiences, accumulated resources and capabilities (Cuervo-Cazurra and Un, 2010; Fan and Wang, 2021). Other studies have however established R&D investment is relatively higher amongst younger firms compared to older firms (Cirera, 2014; Fan and Wang, 2021).

Sub-sector heterogeneity also serves a crucial role in R&D investments. Different subsectors are subject to varying levels of learning effects and the need to keep abreast with technological and competitive pressures (Pavitt, 1984; Jung and Mah, 2013; Galindo-Rueda and Verger, 2016). Firms in different subsectors rely on diverse sources of productivity growth such as R&D investments, human capital and investments in capital assets to different extents depending on the levels of economic development (Goedhuys *et al.*, 2014).

3. Methods

3.1 Data

The study utilises a short panel data of the World Bank Enterprise Surveys for Kenya of 2013 and 2018. While the panel is available for three waves of the survey 2007, 2013 and 2018, the analysis is restricted to the most recent two waves (2013 and 2018) since the sample size significantly reduces for the variables considered if the 2007 wave is included. This limitation is due to the methodological changes and survey evolution that limit matching all variables across the three waves (World Bank, 2019b). The World Bank Enterprise Survey covers formal private sector enterprises with 5+ employees, including those in manufacturing and service sectors. The 2013 wave of the survey covered 781 firms, of which 414 firms were in the manufacturing sector, while the 2018 survey covered 1,001 firms of which 455 were in the manufacturing sector.

3.2 Econometric model

The binary R&D investment decisions can be analysed by either logit or Probit model. While results from the two econometric models yield similar conclusions, Probit is favoured and utilised in this study because of its assumption of the normality of the error distribution that make it convenient to address specification problems (Wooldridge, 2016). The Probit econometric model is derived from an underlying latent variable, y^*, which reflects the propensity of firms to undertake R&D investment decision (Long, 1997). The latent variable, y^*, which can range from $-\infty$ to $+\infty$, generates the actual outcomes as to whether firms undertake R&D investment decision ($y = 1$) or not ($y = 0$). At some level, the propensity would cross a threshold, τ, that would result in the firm's observed decision to undertake R&D investment. The observed outcome variable, y, is related to the underlying latent variable, y^*, by the following measurement equation (Long, 1997):

$$y_{it} = \begin{cases} 1 \, if \, y_{it}^{*} > \tau \\ 0 \, if \, y_{it}^{*} \leq \tau \end{cases}$$

The explanatory variables included in the analyses are based on the theoretical and empirical literature reviewed in earlier sections of this study. The following econometric model is estimated for the R&D investment decisions.

$$\begin{aligned} R\&Ddec_{it} = {} & \beta_0 + \beta_1 credit_{it} + \beta_2 informalcomp_{it} + \beta_3 fsize\_employ_{it} + \beta_4 fsize\_lnsales_{it} \\ & + \beta_5 fsize\_lnsalessq_{it} + \beta_6 lnexport_{it} + \beta_7 lnforeign_{it} + \beta_8 lnproductdivers_{it} \\ & + \beta_9 judicial_{it} + \beta_{10} lnfirmage_{it} + \beta_{11} lnfirmagesq_{it} + \beta_{12} legal_{it} + \beta_{13} political_{it} \\ & + \beta_{14} tax_{it} + \beta_{15} subsector_i + u_{it} \end{aligned}$$

3.3 Variables and their measurements

The variables used in the econometric model and their descriptions are provided in the Table 1. The dependent variable reflects the firms' R&D investments decisions and related activities (*R&D_dec*) over a three-year period. It reflects whether the firms reported to have undertaken R&D investment and/or reported to have provided formal training or gave time to employees for development of new products or processes, coded 1, 0 otherwise. The

Dependent variable
R&Ddec: Whether the firm reported to have invested in R&D investment; and/or reported to have provided formal training or gave time to employees for development or introduction of new products or processes: 1 = Invested in R&D; 0 = Did not invest in R&D

Explanatory variables
credit: Whether the firm reported to have a line of credit or loan from a financial institution at the time of the survey: 1 = Has a line of credit or loan; 0 = Don't have a line of credit or loan
informalcomp: Whether the firm reported it competes against unregistered (informal) enterprises:1 = Competes against informal enterprises; 0 = Don't compete against informal enterprises
fsize_employ: Firm size by employment:1 = Micro enterprises (1–9 employees)
2 = Small enterprises (10–49 employees); 3 = Medium and large enterprises (≥50 employees)
fsize_lnsales: Firm size as measured by natural log of annual sales
fsize_lnsalessq: Firm size as measured by natural log of annual sales squared
lnexport: Natural log of % of the firm's export in its total sales
lnforeign: Natural log of % of firm's foreign ownership
lnproductdivers: Natural log of % of the firm's main product in its total sales
judicial: Firm's perception on fairness and impartiality of courts: 1 = Agree courts are fair and impartial; 0 = Disagree courts are fair and impartial
lnfirmage: Natural log of the firm age. Firm age is calculated as the number of years since its establishment
lnfirmagesq: Natural log of the firm age squared
legal: Registration form of the firm: 1 = Sole proprietorship; 2 = Partnership; 3 = Company
political: Perceptions on whether political instability is an obstacle to the performance of the establishment: 1 = Political instability is an obstacle; 0 = Political instability is not an obstacle
tax: Perception of whether taxation (tax rates) in the country is an obstacle to business operations: 1 = Taxation is an obstacle; 0 = Taxation is not an obstacle
subsector: Firms' technological intensity based on UNIDO classification: 1 = Medium-high and high technology; 2 = Medium-Low technology; 3 = Low technology

Table 1. Variables and their measurement[1]

Note(s): [1]Taking logs for the continuous variables was necessary to rescale the values, minimise the variances and mitigate against outliers
Source(s): Author's compilations

inclusion of R&D-related activities such as training or giving employees time for development of new products or processes is in line with previous studies in developing-country contexts (Cirera, 2014). This approach is helpful where the proportion of firms undertaking R&D investment is low, as in the case of data utilised for this study.

The covariates used follow the Schumpeterian literature on factors determining knowledge investment activities that include firm-level, sector and market level variables. The firm-level variables include employment-related firm size (*firmsize*), export markets participation (*lnexport*), proportion of foreign ownership (*lnforeign*), product diversification (*lnproductdivers*), age of the firm (*lnfirmage*) and its squared term (*lnfirmagesq*), registration type (*legal*), annual sales (*lnsales*) and its squared term (*lnsalessq*). Firm size is measured by number of employment and sales to consider production technology utilised: Some firms are labour-intensive, while others can have large output and relatively fewer employees. Besides firm size, sub-sectoral heterogeneity can affect R&D investment through channels such as technological opportunities owing to growth phase of the sector and ability to appropriate returns (Ortega-Argilés *et al.*, 2015). The export market participation is hypothesised to have effects on R&D investment through learning from demand of foreign consumers. Product diversifications have implications for firms' decisions in terms of the extent to which the managers can assume risk and therefore resource commitments for investments. Ownership features may also have strategic implications for firms through mechanisms like resource pooling, flexibility of decision-making, agency costs, risk attitude and ownership horizon. The uncertain nature of R&D investment payoff makes implications of these factors vital considering entrepreneurial preferences (Lee and O'Neill, 2003; Fan and Wang, 2021).

The quadratic terms in regression are used to capture non-linear effects of explanatory variables on the dependent variable (Wooldridge, 2016). Younger firms are observed to intensify investments in knowledge activities for innovation and survival (Fan and Wang, 2021), but with time they face the dynamics of age-linked structural inertia (Le Mens *et al.*, 2015) which suggests that older firms face relatively higher costs of adjustments and adaptation to changes. An alternative view is that older firms have the advantage of learning effects gained through accumulation of experiences, resources and capabilities that have positive influence. The R&D investment-firm age relationship is therefore expected to exhibit a *U*-shaped relationship with younger and much older firms demonstrating higher propensity in undertaking the investment decisions. The non-linear term for sales is added to take into account possibility of increasing R&D investment initially owing to economies of scale over which to spread costs of investments (Cohen and Levin, 1989), but which eventually diminishes owing to dampened marginal productivity and loss of managerial efficiency (Cohen and Levin, 1989).

The sub-sector variable is represented by the technological groupings of the United Nations Industrial Development Organization (UNIDO) on R&D intensities (*subsector*), while market level variables are accounted for by access to external finance (*credit*), competition from informal sector firms (*informalcomp*), perceptions on the fairness and impartiality of the courts (*judicial*), managerial perceptions regarding political stability (*political*) and the perceptions regarding taxation as an obstacle (*tax*). The variable on subsector technological classification controls for variations in technological demands. The market level variables are related to the business environment aspects, with transmission mechanisms through costs of doing business and uncertainty of appropriating returns.

4. Findings and discussions

4.1 Descriptive results

The descriptive statistics are shown in Table 2, with 59.9% of the sampled firms reporting to have undertaken R&D investment activities. Further, 58.8% of the firms indicated they had

Variable	Variation	Mean	Std dev	Min	Max	Observations
R&Ddec (R&D investment decision)	Overall	0.5986	0.4905	0.0000	1.0000	$N = 862.0000$
	Between	–	0.4771	0.0000	1.0000	$n = 735.0000$
	Within	–	0.1598	−0.0986	0 0.7960	T-bar = 1.1728
credit (Access to loan/line of credit)	Overall	0.5883	0.4924	0.0000	1.0000	$N = 855.0000$
	Between	–	0.4797	0.0000	1.0000	$n = 729.0000$
	Within	–	0.1530	0.0883	1.0883	T-bar = 1.1728
informalcomp (Informal sector competition)	Overall	0.5351	0.4991	0.0000	1.0000	$N = 841.0000$
	Between	–	0.4808	0.0000	1.0000	$n = 721.0000$
	Within	–	0.1776	0.0351	1.0351	T-bar = 1.1664
fsize_employ (Firm size by employment)	Overall	2.2133	0.7499	1.0000	3.0000	$N = 858.0000$
	Between	–	0.7534	1.0000	3.0000	$n = 731.0000$
	Within	–	0.1323	1.7133	2.7133	T-bar = 1.1737
fsize_sales (Annual sales, Ksh million)	Overall	1890.0000	16900.0000	0.1000	425000.0000	$N = 772.0000$
	Between	–	18100.0000	0.1000	425000.0000	$n = 671.0000$
	Within	–	689.0000	−6570.0000	10400.0000	T-bar = 1.1505
export (% of sales exported)	Overall	23.1542	35.3726	0.0000	100.0000	$N = 856.0000$
	Between	–	34.9536	0.0000	100.0000	$n = 731.0000$
	Within	–	9.6929	−26.8458	73.1542	T-bar = 1.1710
foreign (% share of foreign ownership)	Overall	10.5723	27.0158	0.0000	100.0000	$N = 858.0000$
	Between	–	27.0857	0.0000	100.0000	$n = 730.0000$
	Within	–	7.4826	−39.4277	60.5723	T-bar = 1.1753
productdivers (% of main product in total sales)	Overall	89.0776	17.1398	20.0000	100.0000	$N = 864.0000$
	Between	–	16.7168	20.0000	100.0000	$n = 736.0000$
	Within	–	5.4075	59.0776	119.0775	T-bar = 1.1739
judicial (Courts fair and impartiality)	Overall	0.4825	0.5000	0.0000	1.0000	$N = 800.0000$
	Between	–	0.4806	0.0000	1.0000	$n = 689.0000$
	Within	–	0.1821	−0.0175	0.9825	T-bar = 1.1611
firmage (Firm's age, years)	Overall	28.4767	18.9128	0.0000	107.0000	$N = 860.0000$
	Between	–	18.7838	0.0000	107.0000	$n = 732.0000$
	Within	–	1.4872	15.9767	40.9767	T-bar = 1.1749
legal (Firm's legal status)	Overall	2.0658	0.7015	1.0000	3.0000	$N = 851.0000$
	Between	–	0.6788	1.0000	3.0000	$n = 724.0000$
	Within	–	0.2401	1.0658	3.0658	T-bar = 1.1754
political (Political instability obstacle)	Overall	0.8126	0.3905	0.0000	1.0000	$N = 859.0000$
	Between	–	0.3782	0.0000	1.0000	$n = 734.0000$
	Within	–	0.1428	0.3126	1.3126	T-bar = 1.1703
tax (Taxation constraint)	Overall	0.7995	0.4006	0.0000	1.0000	$N = 858.0000$
	Between	–	0.3948	0.0000	1.0000	$n = 733.0000$
	Within	–	0.1301	0.2995	1.2995	T-bar = 1.1705
subsector (Subsector based on technology content)	Overall	2.4867	0.8051	1.0000	3.0000	$N = 865.0000$
	Between	–	0.7840	1.0000	3.0000	$n = 737.0000$
	Within	–	0.2083	1.4867	3.4867	T-bar = 1.1737

Note(s): n is the number of observations, N is the total number of individual-time observations, and T-bar is the waves or the average number of time periods a variable is observed, equivalent to N/n
Source(s): Author's calculations based on the World Bank enterprise surveys

Table 2.
Summary statistics

access to credit while 53.5% reported they face competition from informal sector enterprises. The value of exports accounts for 23.2% of the firms' sales on average. Only a third of MSEs report to participate in export trade, compared to 70% for medium and large enterprises. The average share of foreign ownership was reported at 10.6%. The share of main products in firms' total sales was 89.1%, an indication of product concentration and limited product diversification. Only 48.3% of the firms perceive the court system to be fair and impartial. With regards to R&D intensity technological content, a mean of 2.5 suggests majority of the firms fall in low-technology sub-sectors such as food and beverages, textiles and leather. For the firm size as measured by employment, the mean of 2.2 implies that the firms are mostly

small-size category. While the Kenyan firms are largely micro-level in size, the World Bank Enterprise Survey targets formal firms with 5+ employees, and this explains why the average in this case reflects dominance of small firms (10–49 employees). With regards to the legal forms of registration, the mean of 2.0 suggests that most of the sampled firms are partnerships.

In panel data, both the dependent variable and covariates can vary across observations ("between variations") and over time ("within variations"). The standard deviations in Table 2 suggest that there is more between variations compared to within variations, an indication that over the survey cycle not much changes have been experienced at firm level relative to changes between the firms. The minimum and the maximum values for the within variation for the dependent variable as shown in Table 2 reveal that on average more firms reported to have undertaken R&D investments in 2013 compared to 2018. This means a slowdown in R&D investment activities. The T-bar in Table 2 shows that on average the sampled firms performed R&D investment about 1.2 times across the two waves of the survey, thus showing limited continuity in R&D investments across the years.

Except for micro enterprises, a larger share of the sampled firms reported to have undertaken R&D investment activities during the 2013 wave of the survey compared to 2018. Amongst the micro enterprises, 51.8% reported to have undertaken R&D investments during the 2018 wave of the survey compared to 46.4% in 2013. Within the small enterprises category, 63.0% reported they had R&D investments during the 2013 wave of the survey compared to 53.3% in 2018. Further, amongst the medium and large enterprises category the proportion of those with R&D investments declined from 73.7% to 61.2% over the two waves of the survey. The improved performance for micro enterprises is driven by training of employees for development or introduction of new products or processes. The general decline in R&D investment decisions reflects increasing barriers for R&D investment environment, including difficulties in access to finance due to interest rate capping introduced in Kenya between September 2016 and November 2019. The findings from these analyses reveal that there is a size phenomenon displayed by manufacturing firms in the decision to undertake R&D investments, and this is observed across both the 2013 and 2018 waves of the survey. With larger size, firms tend to have better human and non-human resources that support investment in R&D.

Firms with access to finance tend to have higher incidence of undertaking R&D investment decisions. During both the 2013 and 2018 waves of the survey, the proportion of all the surveyed enterprises with access to credit who reported to have undertaken R&D investments was higher than those without R&D investments by 21.6% points. The difference is larger amongst the MSEs (24% points) compared to medium and large enterprises at about 13% points. These results suggest that access to external finance can be an important input to R&D, particularly amongst the MSEs, as it complements limited internal financing opportunities.

The analyses across the two waves of the survey further reveal that, based on UNIDO's classification of technological intensity, amongst the surveyed firms classified as medium high and high technology intensity, 67.8% reported to have undertaken R&D activities, compared to 61.0% of those classified as medium low technology and 57.4% for those classified as low technology. The level of technological deepening in SSA as measured by the share of medium and high technology manufacturing value added in total manufacturing value added is generally low: Consequently the region accounts for less than 1% of global medium-high technology manufacturing exports (UNIDO, 2017). While low technology sub-sectors such as food and beverages, textile and apparel manufacture are labour intensive, they may not provide much in terms of attracting R&D investments towards achievement of policy targets such as those envisaged in the Sustainable Development Goal (SDG) 9. The UNIDO's Industrial Development Report 2020 reveals that the overall share of medium and

high-technology manufacturing value added share in total manufacturing GDP for Kenya is only 15%, unfavourably comparing to competitor and aspirator economies such as China (41%), India (43%) and Singapore (78%) (UNIDO, 2019).

4.2 Regression results

Table A1 in Appendix shows the Spearman's rank correlation matrix. There are positive association between R&D decisions and access to external finance, employment-related firm size, export market participation and sales. The associations amongst the explanatory variables are generally low at 0.30 or less, save for firm size by employment and sales (+0.64) and the squared terms with their level counterparts. Increase in share of sales exported demonstrate positive association with age of the firm, joint ownership and firm size. Firms with higher share of foreign ownership tends to be larger firms.

Continuous explanatory variables are transformed by taking logarithms for scaling purposes, aimed at making estimates less sensitive to outliers (Wooldridge, 2016). The individual variance inflation factor (VIF) lie between 1.02 and 3.56 with a mean of 1.62. This suggests therefore no sufficient evidence of high multicollinearity amongst the covariates, given that the VIF values are below the threshold of 10 (Wooldridge, 2016). The regression results are shown in Table 3 for Probit coefficients and Table 4 for Probit marginal effects. For non-linear econometric models such as Probit, the focus for interpretations is on the marginal effects, which reflects the relationships between explanatory variables and the observed binary outcomes for the dependent variable. The coefficients in Table 3 that shows the relationship between explanatory variables and the underlying continuous latent dependent variable is important only as far as understanding the signs and significance of the quadratic terms, log of firm age squared and log of sales squared are concerned. Using the

Variables		Coefficients
credit: Has access to a line of credit or loan		0.3830*** (0.1090)
informalcomp: Competes against informal enterprises		−0.2190** (0.1030)
fsize_employ : Firm size by employment	Small enterprises	0.0617 (0.1660)
	Medium and large enterprises	−0.0769 (0.1950)
fsize_lnsales : Natural log of annual sales		0.4870* (0.2530)
fsize_lnsalessq : Natural log of annual sales squared		−0.0116* (0.0067)
lnexport: Natural log of % of the firm's exports it its total sales		0.1130*** (0.0317)
lnforeign: Natural log of % of firm's foreign ownership		−0.0088 (0.0362)
lnproductdivers: Natural log of % of firm's main product in its total sales (Product diversification)		−0.2580 (0.2050)
judicial: Agree courts are fair and impartial		−0.0044 (0.1010)
lnfirmage: Natural log of firm age		−0.8250** (0.3660)
lnfirmagesq: Natural log of firm age squared		0.1750*** (0.0655)
legal: Registration form of the firm	Partnership	−0.1120 (0.1510)
	Company	0.0948 (0.1650)
political: Political instability is an obstacle		0.1400 (0.1400)
tax: Taxation is an obstacle		−0.0509 (0.1330)
subsector: Firms technological intensity based on UNIDO classification	Medium technology	−0.2560 (0.2080)
	Low technology	−0.3450** (0.1450)
Constant		−2.8150 (2.3340)
Observations		666

Note(s): Standard errors in parentheses ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$
Source(s): Author's estimates based on the World Bank enterprise surveys

Table 3.
Panel Probit coefficients for R&D investment decision

Variables		Marginal effects
credit: Has access to a line of credit or loan		0.1340*** (0.0385)
informalcomp: Competes against informal enterprises		−0.0748** (0.0351)
fsize_employ : Firm size by employment	Small enterprises	0.0206 (0.0556)
	Medium and large enterprises	−0.0261 (0.0655)
fsize_lnsales : Natural log of annual sales		0.0233** (0.0105)
lnexport: Natural log of % of the firm's exports it its total sales		0.0383*** (0.0104)
lnforeign: Natural log of % of firm's foreign ownership		−0.0030 (0.0123)
lnproductdivers: Natural log of % of firm's main product in its total sales (Product diversification)		−0.0876 (0.0697)
judicial: Agree courts are fair and impartial		−0.0015 (0.0345)
lnfirmage: Natural log of firm age		0.0844*** (0.0281)
legal: Registration form of the firm	Partnership	−0.0386 (0.0512)
	Company	0.0317 (0.0557)
political: Political instability is an obstacle		0.0480 (0.0484)
tax: Taxation is an obstacle		−0.0172 (0.0448)
subsector: Firms technological intensity based on UNIDO classification	Medium technology	−0.0842 (0.0691)
	Low technology	−0.1150** (0.0466)
Observations		666

Note(s): Standard errors in parentheses ***$p < 0.01$, **$p < 0.05$, *$p < 0$
Source(s): Author's estimates based on the World Bank enterprise surveys

Table 4.
Panel Probit marginal effects

factor-variable notation (#) in Stata 16, marginal effects for quadratic or interaction terms are not generated. This is because the value of the quadratic or interaction term cannot vary exogenous of the values of its constituent terms (Ai and Norton, 2003; Williams, 2012). It would be inappropriate to estimate separate marginal effects for the quadratic or interaction terms separately by manually generating these terms and including them as regressors. The marginal effects of the quadratic terms are therefore not displayed in Table 4. Margins plot (Royston, 2013) are generated for the quadratic terms to demonstrate possibilities and nature of non-linear relationship. The marginal effects for continuous variables show instantaneous rate of change and tend to confound some important relationships, which can be overcome by using margins plot (Royston, 2013).

The results show that factors affecting R&D investment decisions include access to external finance, competition from informal sector enterprises, firm size as measured by sales, export market participation, age of the firm and subsector technological classifications. The marginal effects presented refer to average marginal effects (AMEs), which is preferable to marginal effects at means (MEMs) given the numbers obtained better reflects observations in the data set (Long and Freese, 2014). Firms with access to external finance have 13.4% point higher probability of undertaking R&D investment compared to firms without access to external finance. Firms that face competition from informal sector enterprises have 7.5% point lower probability of undertaking R&D investments, compared to those who reported they do not face competition from informal sector enterprises. There is a 2.3% point higher probability of undertaking R&D investment for a marginal increase in the log of sales. There is however a non-linear relationship as revealed by the margins plot (Royston, 2013). The effects initially increase for a substantial range of log of sales, peaks and falls thereafter. As firm size increases there could be inefficiencies in managerial effectiveness due to bureaucratic decisions. The initial positive effects of firm size on R&D investment decisions can be explained by advantages of internal resource capability and ability to bear uncertainties involved in R&D investments. Furthermore, larger firms can benefit from economies of scale because of spreading R&D investment costs over larger outputs

(Cohen and Levin, 1989). These findings suggest that advantages of firm-size effects may be dominated by inefficiencies in managerial control beyond some level.

Firms in low technology subsectors have 11.5% point lower probability of undertaking R&D investments compared to firms in the medium-high and high technology subsectors. It is, therefore, a concern for developing countries such as Kenya where low technology subsectors account for a large share of manufacturing GDP (UNIDO, 2019). Weak R&D investments in developing countries make it much harder for them to catch up with developed economies (Lee, 2013; Goñi and Maloney, 2017). For a marginal increase in the log of share of exports, the probability of undertaking R&D investment increases by 3.8% points. The positive effects of exporting behaviour on the decision to undertake R&D investment can be due to learning by exporting hypothesis (Grossman, 1991) and exposure to international consumer demands (Aw *et al.*, 2007; Girma *et al.*, 2008). Constrains to SSA economies' exports include high costs of production and non-tariff barriers such as conformity requirements and high transaction costs (International Trade Centre, 2014; Were, 2016).

Age of the firm initially has negative effects on the decisions to undertake R&D investment, but the effects turn out to be positive, at much higher levels as revealed by its squared term in the regression using margins plot (Royston, 2013). The predicted probability of the decision to undertake R&D investment decreases with increase in average age of the firm up to about log age 2.3 years (about 9.8 years in level), beyond which the margins steadily increases. Explanations for these findings can be linked to innovation opportunities at much younger age and resource accumulation and learning by doing, which increases efficiency of R&D, with more years of operations (Coad *et al.*, 2016).

5. Conclusion

This study sought to analyse determinants of R&D investment decisions amongst manufacturing firms in Kenya, focusing on the effects of firm, industry and business environment variables. The regression results reveal that access to external finance, export markets participation, larger firm size and firms in medium-high and high technology subsectors increases probabilities of undertaking R&D investment decisions. Competition from informal sector enterprises lowers R&D investment decisions while firm age has a *U*-shaped relationship with R&D investment decisions. Firm size (measured by sales) has positive effects that eventually diminishes. The two findings regarding firm age and size effects together signal the importance of unlocking constraints faced by MSEs. For policymakers, the findings from this study point at the importance of addressing business environment constraints that impede R&D investments by private sector enterprises in developing countries. It also points at the importance of supporting MSEs in overcoming barriers to R&D investments. Further, measures towards facilitation of export market participation are imperative, as it can serve as a conduit for learning by exporting, possibly due to international exposure such as customer demands and competition. For management practice, the findings from this paper suggest that managers need to integrate life cycle of the firm, export markets participation and diversification into medium and high technology activities to overcome the business environment constraints that characterise developing counties such as Kenya. Moreover, private sector firms through their relevant associations can lobby the policymakers on ways to mitigate business environment constraints such as access to finance and competition from informal sector as strategies towards boosting R&D investments. To provide more insights on R&D investments by private sector firms in developing country contexts, a number of research areas can be explored. Future surveys by the World Bank and other institutions in developing countries should seek to build longer panel data to support analysis with more insights. Future research should also consider cross-country analysis involving multiple SSA economies to understand implications of

institutional contexts that prove to be a challenge to address in a study based within a single country.

References

Ai, C. and Norton, E.C. (2003), "Interaction terms in logit and probit models", *Economic Letters*, Vol. 80 No. 1, pp. 123-129.

Allen, F., Otchere, I. and Senbet, L.W. (2011), "African financial systems: a review", *Review of Development Finance*, Vol. 1 No. 2, pp. 79-113.

Appelt, S., Bajgar, M., Criscuolo, C. and Galindo-Rueda, F. (2016), *R&D Tax Incentives: Evidence on Design, Incidence and Impacts*, OECD Science, Technology and Industry Policy Papers, No. 32, OECD Publishing, Paris.

Arrow, K. (1962), "Economic welfare and the allocation of resources for invention", in Nelson, R.R. (Ed.), *The Rate and Direction of Inventive Activity*, Princeton University Press, Princeton, NJ, pp. 609-625.

Aw, B.Y., Roberts, M.J. and Winston, T. (2007), "Exports market participation, investments in R&D, and worker training, and the evolution of firm productivity", *The World Economy*, Vol. 30 No. 1, pp. 83-104.

Aw, B.Y., Roberts, M.J. and Xu, D.Y. (2008), "R&D investments, exporting, and the evolution of firm productivity", *American Economic Review*, Vol. 98 No. 2, pp. 451-456.

Baumann, J. and Kritikos, A.S. (2016), "The link between R&D, innovation and productivity: are micro firms different?", *Research Policy*, Vol. 45, pp. 1263-1274.

Becker, B. and Pain, N. (2008), "What determines industrial R&D expenditure in the UK?", *The Manchester School*, Vol. 76 No. 1, pp. 66-87.

Bloch, C. (2005), "R&D investment and internal finance: the cash flow effect", *Economics of Innovation and New Technology*, Vol. 14 No. 3, pp. 2013-2223.

Cirera, X. (2014), *Catching up to the Technological Frontier? Understanding Firm-level Innovation and Productivity in Kenya*, s.l.: World Bank Working Paper 94671.

Coad, A., Segarra, A. and Teruel, M. (2016), "Innovation and firm growth: does firm age play a role?", *Research Policy*, Vol. 45 No. 2, pp. 387-400.

Cohen, W. (1995), "Empirical studies of innovation activity and performance", in Stoneman, P. (Ed.), *Handbook of the Economics of Innovation and Technological Change*, Wiley-Blackwell, Oxford, pp. 182-264.

Cohen, W.M. and Levin, R.C. (1989), "Empirical studies of innovation and market structure", in Schmalensee, R. and Willing, R. (Eds), *Handbook of Industrial Organization*, Elsevier Science Publishers B.V, Amsterdam, pp. 1059-1107.

Cohen, W.M. and Levinthal, D.A. (1989), "Innovation and Learning: the two faces of R&D", *The Economic Journal*, Vol. 99 No. 397, pp. 569-596.

Cornel University, INSEAD, WIPO (2019), *The Global Innovation Index 2019: Creating Healthy Lives - the Future of Medical Innovation*, 12th ed., Cornel University, INSEAD, and WIPO, Ithaca, Fontainebleau, and Geneva.

Cuervo-Cazurra, A. and Un, C.A. (2010), "Why some firms never invest in formal R&D", *Strategic Management Journal*, Vol. 31, pp. 759-778.

Darbi, W.P., Hall, C.M. and Knott, P. (2018), "The informal sector: a review and agenda for management research", *International Journal of Management Reviews*, Vol. 20 No. 2, pp. 301-324.

Fan, S. and Wang, C. (2021), "Firm age, ultimate ownership, and R&D investments", *International Review of Economics and Finance*, Vol. 76, pp. 1245-1264.

Farrell, D. (2004), "The hidden dangers of the informal economy", *The McKensey Quarterly*, Vol. 3, pp. 27-37.

Fowowe, B. (2017), "Access to finance and firm performance: evidence from African countries", *Review of Development Finance*, Vol. 7, pp. 6-17.

Galindo-Rueda, F. and Verger, F. (2016), *OECD Taxanomy of Economic Activities Based on R&D Intensity*, OECD Publications, Paris.

Girma, S., Görg, H. and Hanley, A. (2008), "R&D and exporting: a comparison of British and Irish firms", *Review of World Economics*, Vol. 144 No. 4, pp. 750-773.

Goedhuys, M., Janz, N. and Mohnen, P. (2014), "Knowledge-based productivity in 'low-tech' industries: evidence from firms in developing countries", *Industrial and Corporate Change*, Vol. 23 No. 1, pp. 1-23.

Goñi, E. and Maloney, W.F. (2017), "Why don't poor countries do R&D? Varying rates of factor returns across the development process", *European Economic Review*, Vol. 97, pp. 126-147.

Griliches, Z. (1998), *R&D and Productivity: the Econometric Evidence*, University of Chicago Press, Chicago, IL.

Grossman, G.M. (1991), "Trade, knowledge spillovers, and growth", *European Economic Review*, Vol. 35 Nos 2-3, pp. 517-526.

Hall, B.H. (2008), "Research and development", in Darity, W.A.Jr (Ed.), *International Encyclopedia of the Social Sciences*, 2nd ed., Macmillan Reference Detroit, pp. 199-201.

Hall, B.H. and Lerner, J. (2010), "The financing of R&D and innovation", in Hall, B.H. and Rosenberg, N. (Eds), *Handbooks of the Economics of Innovation*, s.n., Amsterdam, pp. 609-639.

Hsiao, C. (2014), *Analysis of Panel Data*, 3rd ed., Cambridge University Press, New York.

International Trade Centre (2014), *Kenya: Company Perspectives - an ITC Series on Non-tariff Measures*, International Trade Centre, Geneva.

Jorgenson, D.W. (1963), "Capital theory and investment behaviour", *American Economic Review*, Vol. 53, pp. 247-259.

Jorgenson, D.W. and Siebert, C.D. (1968), "Optimal capital accumulation and corporate investment behavior", *Journal of Political Economy*, Vol. 76 No. 6, pp. 1123-1151.

Jung, S. and Kwak, G. (2018), "Firm charateristics, uncertainty and research and development (R&D) investment: the role of size and innovation capacity", *Sustainability*, Vol. 10 No. 5, p. 1668.

Jung, J. and Mah, J.S. (2013), "R&D policies of Korea and their implications for developing countries", *Science, Technology and Society*, Vol. 18 No. 2, pp. 165-188.

Le Mens, G., Hannan, M.T. and Pólos, L. (2015), "Age-related structural inertia: a distance-based approach", *Organization Science*, Vol. 26 No. 3, pp. 756-773.

Lee, K. (2013), *Schumpeterian Analysis of Economic Catch-Up: Knowlege, Path-Creation, and Middle-Income Trap*, Cambridge University Press, Cambridge.

Lee, P.M. and O'Neill, H.M. (2003), "Ownership structures and R&D investments of U.S. and Japanese firms: agency and stewardship perspectives", *The Academy of Management Journal*, Vol. 46 No. 2, pp. 212-225.

Lewis, W.A. (1954), "Economic development with unlimited supplies of labour", *The Manchester School*, Vol. 22 No. 2, pp. 139-191.

Li, W.C.Y. and Hall, B.H. (2020), "Depreciation of business R&D capital", *Review of Income and Wealth*, Vol. 66 No. 1, pp. 161-180.

Long, J.S. (1997), *Regression Models for Categorical and Limited Dependent Variables*, Sage Publications, Inc, Thousand Oaks.

Long, J.S. and Freese, J. (2014), *Regression Models for Categorical Dependent Variables Using Stata*, 3rd ed., Stata Press, Texas.

Love, J.H. and Ganotakis, P. (2013), "Learning by exporting: lessons from high technology SMEs", *International Business Review*, Vol. 22, pp. 1-17.

Mendi, P. and Costamagna, R. (2017), "Managing innovation under competitive pressure from informal producers", *Technological Forecasting and Social Change*, Vol. 114, pp. 192-202.

Myers, S.C. and Majluf, N.S. (1984), "Corporate financing and investment decisions when firms have information that investors do not have", *Journal of Financial Economics*, Vol. 13 No. 2, pp. 187-221.

Nelson, R.R. (1959), "The simple economics of basic scientific research", *Journal of Political Economy*, Vol. 77 No. 3, pp. 297-306.

O'Mahony, M. and Vecchi, M. (2009), "R&D, knowledge spillovers and company productivity performance", *Research Policy*, Vol. 38, pp. 35-44.

Newman, C., Page, J., Rand, J., Shimeles, A., Söderbom, M. and Tarp, F. (2016), *Made in Africa: Learning to Compete in Africa*, Brookings Institution Press, Washington, DC.

OECD (2015), *Guidelines for Collecting and Reporting Data on Research and Experimental Development - the Measurement of Scientific, Technological and Innovation Activities*, OECD Publishing, Paris.

Ortega-Argilés, R., Piva, M. and Vivarelli, M. (2015), "The productivity pmpact of R&D investment: are high-tech sectors still ahead?", *Economics of Innovation and New Technology*, Vol. 24 No. 3, pp. 204-222.

Pavitt, K. (1984), "Sectoral patterns of technical change: towards a taxonomy and a theory", *Research Policy*, Vol. 13, pp. 343-373.

Pérez, J.A.H., Kunc, M.H., Durst, S., Flores, A. and Geldes, C. (2018), "Impact of competition from unregistered firms on R&D investment by industrial sectors in emerging economies", *Technological Forecasting and Social Change*, Vol. 133, pp. 179-189.

Royston, P. (2013), "Marginscontplot: plotting the marginal effects of continous predictors", *Stata Journal*, Vol. 13 No. 3, pp. 510-527.

Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G. and Fuller, G. (2019), *Sustainable Development Report 2019*, Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN), New York.

Schumpeter, J.A. (1942), *Capitalism, Socialism, and Democracy*, Harper & Row, New York.

Spence, A.M. (1981), "The learning curve and competition", *The Bell Journal of Economics*, Vol. 12 No. 1, pp. 49-70.

Teece, D.J. (1980), "Economies of scope and the scope of the enterprise", *Journal of Economic Behavior and Organization*, Vol. 1 No. 3, pp. 223-247.

UNECA (2018), *Towards Achieving the African Union's Recommendation of Expenditure of 1% of GDP on Research and Development*, UNECA, Addis Ababa.

UNESCO (2016), *UNESCO Science Report towards 2030*, Second revised edition ed, UNESCO, Paris.

UNIDO (2017), *Competitive Industrial Performance Report*, UNIDO, Vienna, Vol. 1.

UNIDO (2019), *Industrial Development Report 2020: Industrializing in the Digital Age*, UNIDO, Vienna.

Were, A. (2016), *Manufacturing in Kenya: Features, Challenges and Opportunities*, Overseas Development Institute, Nairobi.

Williams, R. (2012), "Using the margins command to estimate and interpret adjusted predictions and marginal effects", *Stata Journal*, Vol. 12 No. 2, pp. 308-331.

Wooldridge, J.M. (2016), *Introductory Econometrics: A Modern Approach*, 6th ed., Cengage Learning, Boston, MA.

World Bank (2004), *World Development Report 2005: A Better Investment Climate for Everyone*, World Bank/Oxford University Press, New York.

World Bank (2014), *Kenya Enterprise Survey 2013*, World Bank, Washington DC.

World Bank (2019a), "Enterprise surveys", available at: http://www.enterprisesurveys.org (accessed 31 May 2019).

World Bank (2019b), *General Structure of the Enterprise Surveys Panel Datasets*, World Bank, Washington, D.C.

World Bank (2021), "Manufacturing, value added (% of GDP): Sub-Saharan Africa", available at: https://data.worldbank.org/indicator/NV.IND.MANF.ZS?locations=ZG (accessed 3 March 2021).

Yeoh, P.-L. (2004), "International learning: antecedents and performance implications among newly internationalizing companies in an exporting context", *International Marketing Review*, Vol. 21 Nos 4/5, pp. 511-535.

Corresponding author
Adan Guyo Shibia can be contacted at: ashibia@kippra.or.ke

Appendix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. *R&Ddec*	1.0000															
2. *credit*	0.2146	1.0000														
3. *subsector*	−0.0836	−0.0693	1.0000													
4. *informalcomp*	−0.0755	0.0221	−0.0631	1.0000												
5. *fsize_employ*	0.1388	0.2647	−0.1490	−0.0567	1.0000											
6. *lnexport*	0.2102	0.1065	0.0163	−0.1440	0.1920	1.0000										
7. *lnforeign*	0.0464	0.0179	−0.0776	−0.0881	0.1866	0.1547	1.0000									
8. *lnproductdivers*	−0.0513	−0.1292	0.1479	−0.0674	−0.0872	0.0493	−0.0697	1.0000								
9. *judicial*	0.0068	−0.0564	0.0331	0.0619	0.0068	−0.0342	0.0274	−0.0440	1.0000							
10. *lnfirmage*	0.1348	0.0873	0.0292	−0.0631	0.2361	0.2439	0.0018	−0.0239	−0.0569	1.0000						
11. *lnfirmagesq*	0.1455	0.0838	0.0317	−0.0576	0.2277	0.2454	0.0121	−0.0246	−0.0664	0.9800	1.0000					
12. *legal*	0.1058	0.0632	0.0233	−0.0545	0.1340	0.2977	0.1819	−0.0370	−0.0209	0.1920	0.1947	1.0000				
13. *fsize_lnsales*	0.2103	0.2349	−0.1936	−0.1109	0.6487	0.2762	0.2887	−0.0649	−0.0284	0.3036	0.2966	0.2612	1.0000			
14. *fsize_lnsalessq*	0.2010	0.2254	−0.1932	−0.1046	0.6380	0.2768	0.2994	−0.0676	−0.0229	0.2875	0.2840	0.2494	0.9958	1.0000		
15. *political*	0.0424	0.0545	−0.0082	−0.0001	0.0300	−0.0695	−0.0825	0.0041	−0.0370	−0.0217	−0.0088	−0.0033	−0.0351	−0.0403	1.0000	
16. tax	−0.0298	0.0075	−0.0181	0.0654	0.0644	0.0016	−0.0044	0.0095	−0.0453	−0.0026	0.0005	0.0175	0.0359	0.0354	0.2081	1.0000

Source(s): Author's estimates based on the World Bank enterprise surveys

Table A1.
Correlation matrix