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What factors hamper innovation amongst SMEs in Kenya?

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ABSTRACT

While much of the evidence about innovation amongst SMEs in many developing countries have sought to examine the factors that enhance the propensity of a firm to innovate, far less effort has gone into assessing the factors that hamper it. This paper follows the latter literature to provide an explanation of firm innovation failure amongst SMEs in Kenya by focusing exclusively on external obstacles. By relying on the World Bank Enterprise Surveys and defining innovation as involving product and process innovation, we showed that factors such as political instability and infrastructure, measured as access to electricity, can be critical to firm innovation. We also found that the effects could be context-specific, as the results differ based on various firm characteristics, including firm type, sector, age and size. Our findings provide important policy implications about firm innovation in Kenya as well as the understanding that providing a more conducive business environment is not only critical to enhancing various firm activities but also enhancing innovation performance.

KEYWORDS

Kenya; firm innovation; obstacles

1. Introduction

The importance of innovation for various firm activities has been well established. For instance, it has been shown that innovation is essential for employment growth (Aghion and Howitt 1997; Garcia, Jaumandreu, and Rodriguez 2004; Harrison et al. 2014), firm productivity (Crépon, Duguet, and Mairesse 1998; Comin 2008; Criscuolo 2009; Mohnen and Hall 2013), firm exporting activities (Roper and Love 2002; Kirbach and Schmiedeberg 2008; Caldera 2010) and wage increases (Van Reenen 1996; Castillo et al. 2014). It has also been shown that innovation is crucial in enhancing firm survival and firm competitiveness (Brüderl, Preisendörfer, and Ziegler 1992; Leenen 2005).

As a result, various studies have committed to understanding the factors that account for firm innovation success. Much of the evidence thus far have focused on internal factors such as research and development (R&D) (Acs and Audretsch 1988; Acs and Audretsch 2003; Becheikh, Landry, and Amara 2006; de Jong and Vermeulen 2006), firm size (Pavitt, Robson, and Townsend 1987; Acs and Audretsch 1988; Acs and Audretsch 2003), firm age (Schumpeter 1942; Sørensen and Stuart 2000) training (Cohen and Levinthal 1990), access to finance (Hall 2002) and various firm information

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sources (Acs 2000; Foray 2000; Dosi 1982). Other studies have focused on technological opportunities, the degree of competition, the existence of appropriability instruments and a firm's capacity to benefit from innovation (Cohen 1995; Encaoua et al. 2000; Kleinknecht and Mohnen 2001). These studies typically encompass evidence for many developed economies.

What is probably less studied in the literature, and specifically for Africa, are the factors that hamper firm innovation. There are several advantages that may accrue from establishing this knowledge. First, evidence on the factors that hamper innovation can be context-specific in that the results from developing countries may not be entirely applicable to the case of Africa. Second, knowledge of the factors that hamper firm innovation can provide complementary explanations for firm innovation success. Studies such as Amara et al. (2016), D'Este et al. (2012), Savignac (2008), Chaminade and Edquist (2006), Woolthuis (2005) and Galia and Legros (2004), Mohnen and Röller (2005), Baldwin and Lin (2002) and Mohnen and Rosa (2001) have generally shown that identifying the factors that hamper innovation is important in explaining why some firms either do not innovate at all or do not innovate in more matured activities. From a policy point of view, the identification of such factors (i.e. the various barriers or obstacles) could be critical in shaping public policy towards a more holistic response to addressing issues of firm innovation failure in many economies.

Quite often, and within the extant literature, the factors or obstacles that have been identified to hamper firm innovation is classified variously. For instance, there are some obstacles that are peculiar to a firm, and to some extent within the firm's immediate control (internal obstacles) such as inadequate access to finance, low use of technology, poor understanding of market needs, lack of skilled workers, insufficient and ineffective interaction, and organizational inertia (Mohnen and Röller 2005; D'Este et al. 2012; Amara et al. 2016; D'Este, Amara, and Olmos-Peñuela 2016; and Baldwin and Lin 2002). There are some other obstacles that are beyond the firm's control (external obstacles) and include informal competition, the lack of skilled manpower (Mendi and Costamagna 2017; Mendi and Mudida 2018) and lack of appropriability instruments (D'Este et al. 2012). D'Este et al. (2012) also distinguished between revealed and deterring barriers or obstacles to firm innovation. While the revealed barriers refer to the firm's awareness of the difficulties arising from its engagement in innovation activities (pointing to a 'disclosing' or 'learning' outcome based on direct experience), the deterring barriers refer to factors regarded by firms as being insurmountable. Baldwin and Lin (2002) also classified innovation obstacles by aggregating them based on cost, institution, labour, organization, and information.

In this paper, we extend the literature by exploring factors that are beyond a firm's control (external obstacles) and more particularly political instability and infrastructure (which we measure using access to electricity). The effects of these variables on a firm's innovation propensity have not been adequately explored. It is quite often the case that owing to the lack of sufficient context-specific empirical evidence, innovation policies in developing economies may not be evidence-based and tend to gravitate towards one-size-fits-all approaches. The study of these factors, therefore, remain critical especially within the context of Africa for a number of reasons. First, political instability is a common phenomenon in many African countries and its effects on innovation is unclear. Political instability may deter innovation propensity because of the fear or uncertainty associated

with investment outturns. Conversely, firms may realize an increase in their innovation propensity during periods of instability owing to the ties they have with political leaders and their access to privileged information that may be useful for innovation. Again, Africa generally performs low when relying on various indicators of infrastructure. With regards to our measure of infrastructure (access to electricity), it is a key input that affects innovation propensity drastically. The lack or inadequate access to electricity delays the production process, discourage the introduction of new products and undermines investor confidence.

Particularly for our paper, Kenya presents a unique context for exploring these issues with potential lessons for developing economies within and outside Africa. The country has experienced its fair share of highs and tragic lows in political activities, most of which have been tied to some economic or ethnic interest. Over time, these events have left in their wake a winner-takes-all mindset, having some implications for economic activities and access to resources. There is a growing dominance of a few elite business people, who are often linked to some political leaders. With regards to electricity, Kenya happens to be one of the relatively few countries in Africa with a very high share of the population with access to grid energy. Based on data from the World Development Indicators, close to 70 percent of the population have access to electricity and this is higher than the average of 45 percent for sub-Saharan Africa (SSA). In terms of innovation, Kenya is amongst the few countries in SSA that rank highest in firm innovation based on data from the Global Competitiveness Index of the World Economic Forum. Yet, there are some heterogeneities in this evidence; most small/medium firms are amongst the firms with the lowest innovation propensities (Cirera 2015). There are also substantial differences in the use of innovation by manufacturing and services firms (Cirera 2015). Besides, firm innovation in Kenya is generally labelled incremental and not radical (Cirera 2015). It would therefore be interesting to explore the extent to which external obstacles such as political instability and access to electricity have hampered or enabled innovation propensity.

In exploring the factors that hamper innovation in Kenya, we utilize the 2018 World Bank Enterprise Survey for the country. We also attempt to account for the differences that may exist between sectors, the size of a firm, and the newness of firms (start-ups versus incumbent firms). Given that the innovation profile of various firm classifications differs, we argue that recognizing these differences remain key to improving innovation policy. By defining innovation as involving product and process innovation, we find that factors such as political instability and access to electricity remain critical in enhancing firm innovation success or otherwise. We also find other external obstacles to be having interesting and differing effects on firm innovation. Our findings provide important insights for policy on firm innovation success in Kenya and potentially other developing economies with similar characteristics. The results of our paper suggest that building a more conducive business environment is not only critical to enhancing various firm activities but also their innovation tendencies.

The rest of the paper is structured as follows. The next section provides a conceptual background of the paper. This is followed by a discussion on the methods used for the estimation as well as the main results. The last section provides some concluding remarks and implications for policy.

2. Related literature

The extant literature exploring the obstacles to firm innovation is varied. Appendix 1 provides a conceptual understanding of how these obstacles affect the innovation decision-making process. This notwithstanding, different classifications of these obstacles can be found in the literature. Amara et al. (2016), for instance, distinguished between internal and external obstacles. While the internal obstacles are generally associated with the difficulties in implementing internal changes such as difficulties with managerial or organizational practices (e.g. lack of skilled personnel, lack of management training and cultural rigidness), the external obstacles are beyond the firm's control and this includes factors such as lack of finance, informal competition and the lack of appropriability instruments to protect innovative products. D'Este et al. (2012) also distinguished between revealed and deterring barriers. While the former refers to the firm's awareness of the difficulties associated with engaging in innovation activities (pointing to a 'disclosing' or 'learning' outcome based on direct experience), the latter refers to a barrier that is regarded by firms as being insurmountable. Baldwin and Lin (2002) also classified innovation obstacles by aggregating them based on cost, institution, labour, organization, and information.

We extend the extant literature on external obstacles by exploring potential barriers that have been relatively less explored in the literature particularly within the context of developing economies in Africa. These factors include political instability and infrastructure (access to electricity).

2.1. Role of political instability and infrastructure

Political instability presents an interesting situation for firm innovation as it may act both as an obstacle and an enabler. As an obstacle, political instability may discourage the attraction of foreign investments, which often serve as an important source of innovation in many developing countries that are not able to invest in R&D, when compared to the case of advanced economies. Political instability can also discourage the human capital needed to develop domestic technological capabilities (Allard, Martinez, and Williams 2012). Political instability may potentially discourage firm innovation that requires significant financial outflow because of the fear that the outturn could be zero. Wu, Rui, and Cumming (2014) have argued that during periods of political instability, banks may be discouraged from funding firms and their innovative activities because of the risk of default. Political instability can also undermine public policies intended to encourage firm innovation (Courvisanos 2009).

As an enabler, political instability can serve as a 'helping hand' in increasing innovative activities especially for firms that are politically connected (Díaz-Díaz, López-Iturriaga, and Santana-Martín 2021). Typically, such firms have access to some form of information or resources that may be useful for innovation but may not be easily accessible or available to other firms. They also have access to networks of political decision-makers that can influence political decisions and actions in their favour. Díaz-Díaz, López-Iturriaga, and Santana-Martín (2021) showed that political connectedness can be more useful for the acquisition of patents and not necessarily the usual corporate investments into new products and services. Díaz-Díaz, López-Iturriaga, and Santana-

Martín (2021) explained this by suggesting that politically connected corporate firms are less likely to list on the stock market nor seek external finance to avoid scrutiny.

While the evidence from Díaz-Díaz, López-Iturriaga, and Santana-Martín (2021) is instructive, it is overly focused on corporate firms. Typically, the evidence for small and medium enterprises that face less scrutiny and are largely informal will be different. Such firms are less likely to invest in innovative activities because of the fear of losing their investments outturns in a polarized political environment. Consistent with this view, we hypothesize that political instability may deter firm innovation, but the effect may be minimal for smaller firms as well as new firms since their investment outlays may typically be marginal.

With regards to infrastructure, we focus our argument on access to electricity. Electricity, as energy infrastructure, remains a key input to a firm's production process. Like other infrastructural inputs, the lack of reliable and efficient energy sources poses a significant drawback to firms' product and process innovation as firms may be compelled to pursue more labour-intensive innovations which may be relatively less efficient rather than the more efficient capital-intensive types, especially when access becomes an issue. For firms that decide to seek alternatives, there are significant cost implications. Usually, within the context of developing countries, these alternative sources may be relatively more expensive and, therefore, debilitating to the innovation activities of firms.

Studies that highlight the role of infrastructure in the form of access to electricity as an obstacle to firm innovation activities are quite scarce. The extant literature has focused largely on other types, particularly, public infrastructure like transport, IT and financial infrastructure (OECD 2010; Sivak, Caplanova, and Hudson 2011). It has been shown that access to public infrastructure is critical for innovation (OECD 2010; Sivak, Caplanova, and Hudson 2011). In line with this view, we hypothesize that the lack of electricity access can be an essential obstacle to firm innovation, both in the form of the introduction of new products or processes.

2.2. Role of other external obstacles

Although the focus of this study is on the role of political instability and infrastructure (i.e. access to electricity) as external obstacles for firm innovation, we account for other external factors such as the lack of skilled manpower, financial constraints, incompatibility with existing technology, and informal competition in our analysis and this session explores the extent to firm such factors can be an obstacle to firm innovation.

The recognition of the lack of skilled manpower as an obstacle to firm innovation has long been recognized in the literature. Schumpeter (1939, 1962) in his formulation of the theory of innovation emphasized the centrality of individual entrepreneurs who discover new, commercially untried ideas and introduce them to the market. Although Schumpeter's argument focused on radical innovations, the relevance of skilled manpower for firms involved in incremental innovation is still recognized. Skilled manpower is important in addressing several internal changes in a firm, and this includes managerial, organizational, and technical practices. Some studies have argued that skilled manpower is important in knowledge creation and in undertaking a firm's R&D activities (D'Este, Rentocchini, and Vega-Jurado 2014, 2016). Several studies have also found the lack of skilled labour to hamper firm innovation, some of which include Amara et al. (2016)

for Canada, D'Este, Amara, and Olmos-Peñuela (2016) for Spain, D'Este, Rentocchini, and Vega-Jurado (2014) for the UK and Galia and Legros (2004) for France. Consistent with these findings, we hypothesize that the lack of skilled manpower can be detrimental to firm innovation, be it incremental or radical. Although a few studies have sought to assess the role of skilled labour based on various firm characteristics, we envisage the phenomenon to be more precarious for smaller firms, newer firms (or younger firms) and manufacturing firms. The reason being that small and newer firms may not have the capacity to attract and maintain highly skilled labour, and in manufacturing firms, the level of sophistication in adopted technologies implies less skilled labour may be needed.

Again, financial constraints are one of the most researched innovation obstacles given that it also influences a firm's acquisition of a variety of other resources, including capital and R&D activities, required for innovation. Mancusi and Vezzulli (2010) identified financial constraints to be a negative factor affecting firm R&D decisions in Italy. Tiwari et al. (2008) relied on data from Denmark to show that the presence of financial constraints presents key obstacles to firm innovations. Savignac (2008) finds similar evidence in France. Hall (2002) established that financial difficulties are severe for innovative projects because their specific features increase the risk and the informational problems that a firm may have with external investors. We hypothesize that financial constraints are barriers for innovation and for process innovation which tends to be capital intensive.

Although incompatibility with existing technology can be a constraint to firm innovation, the literature on it is quite scarce. While Keller (1996) describes it mostly from the perspective of skills compatibility (i.e. technology is only implementable as the labour force has built up the corresponding skills), Nieto and Quevedo (2005) defined it from an organizational perspective to include the lack of managerial capacity. This notwithstanding, we define incompatibility with existing technology as desirable innovations that firms wish to adopt, but the existing organizational structures and processes do not make it feasible. Typically, incompatibility with existing technology can truncate a firm's learning curve, thereby discouraging additional investments in R&D or other related activities that can increase a firm's innovation propensity. It may also not allow firms to maintain their competitiveness as they are likely to pursue low-valued innovations and not the radical types that can be key to the sustainability of their business operations. Based on this, we hypothesize that incompatibility with existing technology can be detrimental for firm innovation as it constrains firms from moving beyond their current technological frontiers.

Finally, while informal firms can be important sources of information for innovation (Prahalad 2005; Bhattacharyya et al. 2010; Radjou, Prabhu, and Ahuja 2012) or important innovation collaborators (von Hippel 2005; George, McGahan, and Prabhu 2012), informal competition may deter firm innovation. Informal competition may distort the process of skills accumulation since informal firms require low skills (Mendi and Costamagna 2017). It can also discourage the introduction of new or significantly improved products since the entry cost for informal firms may be lower, and they are less affected by regulatory requirements (Djankov et al. 2002; McKenzie and Seynabou Sakho 2010). Emphasizing the positive spillover effects, Mendi and Costamagna (2017) argued that informal competition can force firms to differentiate further and to escape

the competition effect by being more innovative. While studies such as Galdon-Sanchez and Schmitz (2002), Symeonidis (2002) and Blundell, Griffith, and van Reenen (1999) find that informal competition has a positive effect on innovation, others including Avenyo, Konte and Mohnen (2021), Spulber (2013), Grossman and Helpman (1991) and Aghion and Howitt (1992) find a negative effect. In this study, we hypothesize that informal competition could likely deter firm innovation within the context of Kenya, because of the role it has in distorting skills accumulation. This is because the type of innovative activities in many African countries tends to be incremental.

3. Data and estimation strategy

3.1. Data

As indicated earlier, we relied on the 2018 World Bank Enterprise Survey for Kenya for the analysis. The Kenyan Enterprise Surveys collected several firm-level information across the following: primary information about firms, infrastructure and services, sales and supplies, degree of competition, capacity, land and permits, finance, mobile money use, labour, business environment and performance. Unlike the surveys for many other developing economies, the Kenyan dataset had some unique questions on various obstacles to innovation as well as the general business environment. We relied mostly on these innovation obstacles in our analysis. Table 1 presents the distribution of firms in our analytical sample by firm size,[1] sector (manufacturing or services), the newness of firms (i.e. whether start-up or an incumbent firm[2]) and the type of innovative activities (product/process).

Table 1. Distribution of firms in our sample.

	Frequency	Percent
Firm Size		
Micro	13	1.34
Small	422	43.42
Medium	357	36.73
Large	180	18.52
Region		
Mombasa	93	9.57
Kilifi	69	7.10
Machakos	59	6.07
Kirinyaga	75	7.72
Kiambu	96	9.88
Trans Nzoia	39	4.01
Uasin Gishu	68	7.00
Nakuru	99	10.19
Kisumu	71	7.30
Nairobi	303	31.17
Sector		
Services	536	55.14
Manufacturing	436	44.86
Newness		
Start-up Firm	340	34.98
Incumbent Firm (small)	230	23.66
Incumbent Firm (large)	402	41.36
Innovation		
Product Innovation	258	26.54
Process Innovation	451	46.40

Based on firm size, we observe that about one percent of the firms in our analytical sample are micro firms, 43 percent are small-sized firms, 38 percent are medium-sized firms, and 19 percent are large-sized firms. Geographically, most of the firms are situated in the capital Nairobi (31%), and the least number of firms are in largely agrarian Trans Nzoia County (4%). In terms of the economic sector, while about 55 percent are services firms, 45 percent are manufacturing firms. Based on the age of firms and membership of an enterprise group, we observe that about 35 percent of the firms are start-ups (i.e. aged 5 years or less), 24 percent are small-sized incumbent firms and 41 percent are large-sized incumbent firms. Finally, regarding the type of innovation undertaken, about 27 percent were classified as product innovators, while 46 percent were classified as process innovators.

In the survey, firms were asked to identify the extent to which certain factors were regarded as obstacles either for innovation or for doing business more generally (on a Likert scale of 0–4).[3] Based on the data, we identified the following to be amongst the pool of external obstacles that are likely to hamper firm innovation (i.e. the introduction of new or significantly improved products or services as well as the techniques of production): (1) political instability, (2) electricity, (3) lack of skilled manpower, (4) financial constraints, (5) incompatibility with existing technology, and (6) informal competition. We present in Tables 2 and 3 the firm's perceptions of these obstacles by relying on a severity index.[4] This index describes the relative importance of the above factors in affecting the innovativeness of the sampled firms. The results are presented based on the economic sector of operation and firm size (Table 2) and then based on newness and type of innovator (Table 3).

More generally, we observe in Tables 2 and 3 that political instability ranked highest as the most severe obstacle. This is consistent irrespective of firm size, sector, newness, and innovator type. The second most severe obstacle is financial constraints, across all definitions of firms, except for services firms and large firms. For these two types of firms, informal competition and electricity ranked second. The obstacle of least importance is incompatibility with existing technology for almost all firm types except medium-sized firms, small incumbent firms and product innovators.

3.2. Estimation strategy

In deciding on the most appropriate estimation strategy for the estimations, we explored various binary choice models because of the nature of our measures of innovation in the survey data. We relied on product and process innovation. Product innovation, in the

Table 2. Obstacle severity index (full sample, sector and firm size).

		Economic sector		Firm size		
Constraint	Full sample	Services	Manufacturing	Small	Medium	Large
Political instability	2.129 (1)	2.198(1)	2.044 (1)	2.090 (1)	2.151 (1)	2.178 (1)
Financial constraints	1.830 (2)	1.800 (3)	1.867 (2)	1.890 (2)	1.852 (2)	1.644 (3)
Informal competition	1.776 (3)	1.851 (2)	1.683 (4)	1.860 (3)	1.824 (3)	1.478 (4)
Lack of skilled manpower	1.167 (5)	1.146 (5)	1.193 (5)	1.103 (5)	1.190 (4)	1.272 (5)
Electricity	1.620 (4)	1.509 (4)	1.757 (3)	1.593 (4)	0.000 (6)	1.783 (2)
Incompatibility with existing technology	1.035 (6)	1.007 (6)	1.069 (6)	1.099 (6)	1.000 (5)	0.950 (6)

Note: Rank in parenthesis.

Table 3. Obstacle severity index (newness and innovators).

	Firm age			Innovator type		
Obstacles	Start-ups	Incumbent (Small)	Incumbent (Large)	Product Innovators	Process Innovators	All Innovators
Political Instability	2.2 (1)	2.0 (1)	2.1 (1)	2.3 (1)	2.1 (1)	2.2 (1)
Financial Constraints	1.9 (2)	1.9 (2)	1.7 (2)	2.0 (2)	1.9 (2)	1.9 (2)
Informal Competition	1.9 (2)	1.9 (2)	1.6 (3)	1.8 (3)	1.7 (3)	1.8 (3)
Lack of Skilled Manpower	1.3 (4)	1.0 (5)	1.2 (5)	1.4 (4)	1.3 (5)	1.3 (5)
Electricity	1.6 (3)	1.4 (3)	1.5 (4)	1.8 (3)	1.6 (4)	1.7 (4)
Incompatibility with existing Technology	1.1 (5)	1.1 (4)	1.0 (6)	1.1 (5)	1.1 (6)	1.1 (6)

Note: Rank in parenthesis.

survey, was measured by asking firms if they had introduced any innovative product or service. The response to this question was binary (1 = Yes, 2 = No). For process innovation, the firms were asked if they had introduced any innovative methods of manufacturing products or offering services. The response to this question was also binary (1 = Yes, 2 = No). We thus relied on the Probit estimator[5] to identify the constraint factors, which we specify is as follows:

$$Y_i = \beta_1 skilled\_man_i + \beta_2 finan\_const_i + \beta_3 incompatibility_i + \beta_4 informal\_comp_i + \beta_5 political\_insta_i + \beta_6 electricity_i + \beta_7 control_i + \beta_7 region_i + \varepsilon_i$$

where Y_i ($j = 1, 2$) represents the innovation measures (i.e. product, process) by the *ith* firm, $skilled\_man_i$ is a dummy for the lack of skilled manpower, $finan\_const_i$ is a dummy for financial constraints, $incompatibility_i$ is a dummy for incompatibility with existing technology, $informal\_comp_i$ is a dummy for informal competition, $political\_insta_i$ is a dummy for political instability, and $electricity_i$ is a dummy for electricity. As a robustness check, we apply a complementary technique (the bivariate Probit estimator) since product and process innovation can be complementary.

In our estimations, we include other controls such as the firm's use of research and development (R&D), appropriability instruments, the firm being a member of an enterprise group, foreign ownership, female ownership, exporting, training, the experience of a top manager, firm size, firms age, innovation cooperation, information sources of innovation, location and sector.[6] The choice of these controls is based on theory.

For instance, Becheikh, Landry, and Amara (2006), de Jong and Vermeulen (2006), Acs and Audretsch (2003), Acs and Audretsch (1988) discussed the importance of R&D in a firm's knowledge production function in resolving production problems as well as in building upon the firm's previous knowledge in the use of various techniques. Also, a firm is more likely to benefit from the innovations of other firms that it is in the same enterprise group (Amsden and Hikino 1994; Chang, Chung, and Mahmood 2006). Again, foreign ownership can enhance firm innovation through the transfer of R&D, skilled personnel and other inputs or the 'cherry-picking' of the most productive firms (Love, Roper, and Du 2009; Choi, Lee, and Williams 2011; Guadalupe, Kuzmina, and Thomas 2012); conversely, foreign ownership can mar firm innovation, if local firms do not have the capacity to absorb the superior foreign technologies (Malecki 1980; Howells 1984; Kleinknecht and Poot 1992; Love, Roper, and Du 2009). Furthermore, Dessler (2001) and Bagshaw (2004) noted the importance of women in the innovation

process as they improve the management skills of teams as well as their decision-making. Moreover, Caldera (2010) discussed the importance of exporting for innovating firms based on the characteristics of the exporting market (requires high-quality goods). Additionally, innovation-related training serves as an important complement in building human capital specific for innovative activity. Moreso, the experience of a top manager, is an important human capital that has been found to be critical for innovation (Daellenbach, McCarthy, and Schoenecker 1999).

With respect to firm size and firm age, Schumpeter (1942) argued that larger/older firms have some monopoly powers that they can exploit for their innovations. More recent literature has also argued that large firms can afford the high fixed cost of innovating due to their high economies of scale and their ability to manage associated risks (Acs and Audretsch 2003). A competing view is that smaller firms can be more innovative because they skirt the bureaucratic organizational structure of large firms (Pavitt, Robson, and Townsend 1987). The same applies to younger firms. Innovation cooperation has been extensively discussed in the strategic alliance literature and has been shown to be a complementary asset to technological know-how as well as access to various resources for firm innovation (Bougrain and Haudeville 2002; McGill and Santoro 2009). Similarly, various information sources of innovation have been acknowledged in the literature. Information sources for innovation are important since innovations are not entirely outputs of discrete events, but also from the problem-solving initiatives of firms that can emerge from customers, suppliers and business associations (Dosi 1982; Foray 2000).

4. Descriptive statistics

We present in Table 4, descriptive statistics of the variables used for the estimations. In addition to the earlier discussion about the distribution of the innovation obstacles in Section 3.1, we observed that 19 percent of the firms had undertaken research and development (R&D), 8 percent belonged to an enterprise group, 14 percent had foreign ownership and 45 percent had a female owner. We again observed that 30 percent of the firms are exporting firms, and about 47 percent have undertaken some form of innovation-related training. The average years of experience of a top manager is 3, while the average firm size and firm age are 73 and 16 respectively. The most dominant source of innovation cooperation is through collaborations/co-development (14%), while the most dominant information source is from customers (29%) (see Table 4).

When comparing the descriptive statistics between product and process innovators, we did not observe very major differences between product and process innovating firms, as both firms had a fairly equal proportion of all variables. This notwithstanding, product innovators, had a slightly higher proportion for the following variables: lack of skilled manpower, enterprise group, foreign ownership, and all information sources of innovation (customers, suppliers and business associations). We again observe that a fair amount of the firms undertook both product and process innovation.

We calculated the correlation between product and process innovating firms, and this was around 0.3, suggesting a fairly weak positive correlation. The correlations of the rest of the variables are presented in Appendix 3. The intention is to show: (1) the extent of association between the variables being used in the analysis; (2) to check and control for

Table 4. Descriptive statistics of variables

	Full sample		Product innovation		Process innovation		
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	*F*-Value
Innovation type							
Process innovation	0.265	0.442	0.399	0.490	1.000	0.000	–
Product innovation	0.464	0.499	1.000	0.000	0.698	0.460	–
Constraints							
Lack of Skilled Manpower	0.642	0.480	0.707	0.455	0.698	0.460	4.23***
Financial Constraints	0.825	0.380	0.845	0.363	0.849	0.359	1.00
Incompatibility with existing Technology	0.614	0.487	0.643	0.480	0.643	0.480	0.24
Informal Competition	0.777	0.417	0.785	0.411	0.779	0.416	2.08
Political Instability	0.842	0.365	0.851	0.356	0.864	0.343	3.17**
Electricity	0.824	0.381	0.856	0.352	0.860	0.347	1.05
Research and Development	0.193	0.395	0.297	0.457	0.372	0.484	6.70***
Innovation cooperation							
Strategic Alliance	0.117	0.322	0.211	0.408	0.256	0.437	13.17***
Collaboration/Co-development	0.140	0.347	0.253	0.435	0.341	0.475	17.57***
Acquisition	0.042	0.201	0.073	0.261	0.109	0.312	5.80***
Information source for innovation							
Customers	0.287	0.453	0.257	0.438	0.252	0.435	1.42
Suppliers	0.122	0.328	0.129	0.335	0.112	0.316	1.14
Business Associations	0.111	0.314	0.102	0.303	0.097	0.296	1.46
Other firm characteristics							
Enterprise group	0.088	0.284	0.106	0.309	0.085	0.280	0.66
Foreign Ownership	0.140	0.347	0.153	0.360	0.132	0.339	2.79*
Female Dummy	0.452	0.498	0.503	0.501	0.543	0.499	1.32
Exporting Firms	0.303	0.460	0.353	0.478	0.395	0.490	1.12
Innovation-related Training	0.474	0.500	0.621	0.486	0.686	0.465	8.29***
Experience of Top Manager	2.511	0.818	2.591	0.801	2.591	0.807	2.20***
Log of Firm Size	3.155	1.334	3.371	1.375	3.371	1.502	1.50***
Log of Firm Age	2.076	1.375	2.169	1.340	2.222	1.339	1.56***

Note: F-Value is a Pearson two-way test of homogeneity between product and process innovators.

possible multicollinearity amongst the variables. We find that most of our main explanatory variables are positively correlated with product and process innovation. In addition, none of the correlation coefficients is above the suggested threshold of 0.7, which would have indicated the possible presence of multicollinearity. We further provide tolerance statistics to show that there is no problem with multicollinearity between the explanatory variables.

5. Estimation results

We present in Tables 5 and 6, the main results of the Probit estimator. In Table 5, where the results for the propensity that a firm introduces product innovation are presented, we observe that access to electricity remains a major constraint to product innovation. This finding is consistent for services firms, small-sized firms, start-ups and incumbent firms that are small-sized. Electricity is not an obstacle for product innovation amongst manufacturing and large-sized firms, although we lose precision on the significance. These findings, however, underscore the point that electricity remains a key obstacle to innovation activities. Given that firms in developing countries are heavily dependent on publicly provided electricity and their production process may be very sensitive to electricity access, there are some implications of this finding for policy. Although, it is difficult to find studies explicitly exploring the role of electricity as an obstacle to innovation,

Table 5. Marginal effects for product innovation and obstacles.

		Economic sector		Firm size			Firm age		
Variables	Full sample	Services firms	Manufacturing firms	Small-sized firms	Medium-sized firms	Large-size firms	Start-ups	Incumbent (small)	Incumbent (large)
Obstacles									
Political Instability	0.067	0.075	−0.058	0.082	−0.055	−0.042	−0.000	0.165***	−0.154**
	(0.060)	(0.069)	(0.061)	(0.066)	(0.083)	(0.078)	(0.094)	(0.044)	(0.063)
Electricity	−0.086	−0.132**	0.128*	−0.209***	−0.047	0.123*	−0.133*	−0.165***	0.023
	(0.055)	(0.058)	(0.066)	(0.065)	(0.074)	(0.072)	(0.073)	(0.058)	(0.061)
Lack of Skilled Manpower	0.112**	0.129***	−0.051	0.154***	−0.078	−0.288***	0.128**	0.205***	−0.097*
	(0.044)	(0.048)	(0.063)	(0.048)	(0.062)	(0.069)	(0.062)	(0.042)	(0.055)
Financial Constraints	0.011	0.033	0.030	−0.015	0.069	0.036	0.044	−0.089	−0.002
	(0.063)	(0.067)	(0.059)	(0.077)	(0.073)	(0.068)	(0.095)	(0.055)	(0.059)
Incompatibility with existing Tech.	0.056	0.101**	0.029	0.075	0.197***	0.231***	0.096	0.061	0.112**
	(0.044)	(0.049)	(0.055)	(0.051)	(0.058)	(0.062)	(0.059)	(0.046)	(0.050)
Informal Competition	−0.081	−0.125*	0.026	−0.042	−0.065	0.012	0.068	−0.120*	−0.038
	(0.059)	(0.068)	(0.057)	(0.068)	(0.059)	(0.070)	(0.073)	(0.064)	(0.051)
Innovation cooperation									
Strategic Alliance	0.233***	0.360***	0.016	0.368***	0.130	0.096	0.323***	0.203**	0.111
	(0.070)	(0.101)	(0.085)	(0.096)	(0.101)	(0.117)	(0.107)	(0.080)	(0.080)
Collaboration/Co-development	0.264***	0.342***	0.151*	0.430***	0.306***	−0.012	0.201**	0.332***	0.236***
	(0.065)	(0.094)	(0.086)	(0.109)	(0.077)	(0.111)	(0.101)	(0.121)	(0.059)
Acquisition of other Companies	0.223**	0.191*	0.313***	0.031	0.252**	–	0.386***	−0.427**	0.327***
	(0.092)	(0.114)	(0.103)	(0.137)	(0.126)		(0.128)	(0.163)	(0.101)
Information sources									
Customers	0.038	0.037	0.042	0.072	0.031	0.101	−0.067	0.123***	0.003
	(0.050)	(0.053)	(0.057)	(0.055)	(0.070)	(0.063)	(0.068)	(0.042)	(0.056)
Suppliers	0.118*	0.149**	−0.142*	0.151*	0.153*	0.061	0.138	0.010	0.291***
	(0.067)	(0.072)	(0.085)	(0.080)	(0.080)	(0.111)	(0.100)	(0.054)	(0.076)
Business Association	0.100*	0.106*	−0.022	0.138**	0.080	0.004	0.051	0.100	0.054
	(0.054)	(0.064)	(0.064)	(0.063)	(0.092)	(0.072)	(0.107)	(0.073)	(0.057)
Other control variables									
Research and Development	0.100*	0.079	0.087	0.109	0.246***	0.263***	0.116	0.121**	0.169***
	(0.055)	(0.064)	(0.061)	(0.067)	(0.066)	(0.073)	(0.078)	(0.048)	(0.060)
Enterprise Group	−0.038	−0.053	−0.006	0.000	0.099	−0.087	−0.039	0.023	0.185**
	(0.072)	(0.075)	(0.071)	(0.083)	(0.077)	(0.121)	(0.088)	(0.057)	(0.075)
Foreign Ownership	0.029	0.014	0.061	−0.191	−0.056	0.141**	0.049	−0.422***	−0.018
	(0.065)	(0.073)	(0.055)	(0.117)	(0.067)	(0.057)	(0.091)	(0.116)	(0.058)
Female Ownership	0.082**	0.099**	0.009	0.133***	0.010	−0.074	0.130**	−0.063	−0.015
	(0.039)	(0.044)	(0.043)	(0.045)	(0.057)	(0.059)	(0.055)	(0.041)	(0.046)

Exporting Firms	−0.086*	−0.075	−0.132**	−0.155**	−0.048	0.063	−0.133	−0.043	0.035
	(0.051)	(0.059)	(0.056)	(0.066)	(0.055)	(0.057)	(0.081)	(0.051)	(0.049)
Innovation-related Training	0.172***	0.194***	0.115**	0.173***	0.123**	0.051	0.134*	0.135***	0.176***
	(0.042)	(0.044)	(0.047)	(0.048)	(0.054)	(0.058)	(0.071)	(0.044)	(0.043)
Experience of Top Manager	0.067**	0.073**	0.007	0.108***	−0.002	−0.036	0.112***	0.038	−0.011
	(0.029)	(0.033)	(0.039)	(0.029)	(0.043)	(0.031)	(0.039)	(0.029)	(0.034)
Log of Firm Size	0.045**	0.036	0.083***	0.057	−0.020	−0.028	0.065*	0.042	0.023
	(0.021)	(0.026)	(0.018)	(0.043)	(0.044)	(0.029)	(0.035)	(0.045)	(0.027)
Log of Age	0.007	−0.004	0.031	−0.008	−0.023	0.021	−0.055	0.034	−0.068**
	(0.017)	(0.020)	(0.023)	(0.018)	(0.025)	(0.021)	(0.051)	(0.023)	(0.031)
Location	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	972	536	436	435	357	180	340	230	402

Standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 6. Marginal effects for process innovation and obstacles.

		Economic Sector		Firm Size			Firm age		
Variables	Full Sample	Services Firms	Manufacturing Firms	Small-sized Firms	Medium-sized Firms	Large-Size Firms	Start-ups	Incumbent (Small)	Incumbent (Large)
Obstacles									
Political Instability	0.157***	0.194***	0.039	0.261***	0.010	−0.001	0.137	0.347***	0.056
	(0.053)	(0.070)	(0.048)	(0.074)	(0.042)	(0.058)	(0.086)	(0.087)	(0.040)
Electricity	−0.020	−0.020	0.038	−0.094	0.031	0.003	−0.104	−0.061	0.031
	(0.064)	(0.071)	(0.057)	(0.076)	(0.054)	(0.056)	(0.087)	(0.063)	(0.042)
Lack of Skilled Manpower	0.037	0.056	−0.042	0.030	−0.023	0.074	−0.002	0.135**	−0.076*
	(0.054)	(0.060)	(0.054)	(0.063)	(0.054)	(0.049)	(0.068)	(0.060)	(0.043)
Financial Constraints	−0.014	−0.007	−0.069	0.048	0.161***	−0.004	0.115	0.009	0.031
	(0.057)	(0.069)	(0.060)	(0.083)	(0.053)	(0.058)	(0.090)	(0.071)	(0.039)
Incompatibility with existing Tech.	−0.007	−0.009	−0.001	−0.005	−0.024	0.106**	−0.025	0.018	−0.019
	(0.048)	(0.057)	(0.046)	(0.060)	(0.044)	(0.049)	(0.069)	(0.054)	(0.037)
Informal Competition	0.049	0.032	0.114**	0.127	0.053	−0.041	0.089	0.064	0.000
	(0.060)	(0.070)	(0.052)	(0.077)	(0.052)	(0.060)	(0.095)	(0.069)	(0.037)
Innovation cooperation									
Strategic Alliance	0.160**	0.192**	0.031	0.127	−0.014	0.051	−0.145	−0.043	0.060
	(0.076)	(0.085)	(0.077)	(0.100)	(0.068)	(0.081)	(0.101)	(0.122)	(0.050)
Collaboration/Co-development	0.047	0.004	0.330***	0.036	0.136**	0.147*	0.401***	0.307***	0.167***
	(0.073)	(0.082)	(0.071)	(0.110)	(0.068)	(0.082)	(0.130)	(0.092)	(0.043)
Acquisition of other Companies	0.379***	0.414***	−0.055	1.157***	0.004	0.241***	–	0.163	0.034
	(0.099)	(0.110)	(0.115)	(0.258)	(0.070)	(0.088)		(0.118)	(0.051)
Information sources									
Customers	−0.006	−0.015	0.015	−0.038	−0.076*	0.120*	0.036	−0.036	−0.060
	(0.051)	(0.058)	(0.052)	(0.067)	(0.042)	(0.063)	(0.057)	(0.066)	(0.041)
Suppliers	0.023	0.004	0.082	0.023	0.040	−0.018	0.009	0.027	0.015
	(0.071)	(0.079)	(0.060)	(0.089)	(0.054)	(0.081)	(0.091)	(0.077)	(0.041)
Business Association	0.100	0.106	−0.049	0.177*	−0.144**	0.067	0.034	0.278***	0.010
	(0.076)	(0.086)	(0.054)	(0.090)	(0.068)	(0.062)	(0.116)	(0.078)	(0.048)
Other control variables									
Research and Development	0.108*	0.088	0.169***	0.060	0.134***	0.048	0.019	0.453***	0.042
	(0.065)	(0.073)	(0.047)	(0.095)	(0.043)	(0.054)	(0.083)	(0.113)	(0.042)
Enterprise Group	−0.091	−0.091	−0.092	−0.028	−0.106*	−0.104	−0.167	0.160	−0.115**
	(0.094)	(0.108)	(0.081)	(0.127)	(0.061)	(0.124)	(0.136)	(0.100)	(0.055)
Foreign Ownership	−0.144**	−0.229**	0.082	−0.156	−0.098	0.035	−0.072	−0.205*	−0.101*
	(0.067)	(0.096)	(0.053)	(0.140)	(0.070)	(0.051)	(0.090)	(0.111)	(0.054)
Female Ownership	0.024	0.008	0.085**	0.070	−0.014	−0.031	−0.002	0.003	0.080**
	(0.042)	(0.049)	(0.041)	(0.058)	(0.043)	(0.048)	(0.054)	(0.057)	(0.035)

Exporting Firms	−0.078	−0.075	−0.148***	−0.084	−0.115***	−0.053	−0.231***	0.051	−0.048
	(0.053)	(0.065)	(0.046)	(0.077)	(0.043)	(0.049)	(0.076)	(0.068)	(0.034)
Innovation-related Training	0.072	0.080	0.039	0.022	0.122***	0.038	0.081	−0.046	0.043
	(0.054)	(0.062)	(0.040)	(0.067)	(0.036)	(0.052)	(0.071)	(0.063)	(0.033)
Experience of Top Manager	−0.014	−0.028	0.053*	0.025	−0.049**	0.106***	−0.037	0.184***	−0.049**
	(0.033)	(0.038)	(0.030)	(0.040)	(0.024)	(0.034)	(0.037)	(0.052)	(0.023)
Log of Firm Size	−0.002	−0.009	0.024	0.043	0.093***	0.099***	0.139***	−0.091*	0.042**
	(0.020)	(0.026)	(0.016)	(0.046)	(0.034)	(0.024)	(0.027)	(0.052)	(0.017)
Log of Age	−0.001	0.004	−0.028	0.009	−0.025	−0.032	−0.114*	−0.049	−0.006
	(0.019)	(0.022)	(0.019)	(0.023)	(0.017)	(0.022)	(0.060)	(0.034)	(0.021)
Location	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	972	536	436	435	357	180	340	230	402

Standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0$.

Sivak, Caplanova, and Hudson (2011) showed the extent to which public infrastructure remains critical for innovation and entrepreneurship and how its absence or lack of access can be a deterring factor, even though their emphasis was mostly on transport, IT and financial infrastructure.

Our finding of the effect of political instability is mixed. Depending on the age of the firm, we found for the case of small incumbent firms that political instability enables product innovation, but for large incumbent firms, Political instability acts as a barrier. Díaz-Díaz, López-Iturriaga, and Santana-Martín (2021), argued that political instability may not be associated with corporate investments into new products and services, even for politically connected firms due to the inefficiencies with political decisions and other constraints. For the case of Kenya, it is possible that incumbent firms, that are large-sized, may not be investing in the introduction of new products because of their knowledge of the inefficiencies of political decisions and the fear of losing out on their investments. For small firms, the results seem to confirm the findings of Díaz-Díaz, López-Iturriaga, and Santana-Martín (2021) that political instability may indeed lend a 'helping hand' for product innovation. Such firms through their political connectedness may exploit access to networks of political decision-makers to their exclusive advantage and where possible, to the disadvantage of larger firms. Moreover, the large-sized firms in our analytical sample are largely concentrated in the food, chemical as well as plastics and rubber sectors with a sizeable proportion having some form of foreign ownership. It is therefore not difficult to see why political instability can be an obstacle for such businesses in introducing new or significantly improved products.

Again, we observe that the lack of skilled manpower is mostly an obstacle to product innovation amongst large-sized firms. Given the important role skilled manpower play in firms through knowledge creation and R&D activities (D'Este, Rentocchini, and Vega-Jurado 2014; D'Este, Amara, and Olmos-Peñuela 2016), it is fairly easy to comprehend why the lack thereof will affect large firms disproportionately. In a different spectrum, informal competition is observed to be an obstacle for product innovation amongst services firms and small incumbent firms although the effect is not very strong. The finding is, however, consistent with Avenyo, Konte and Mohnen (2021), which finds that that the competitive behaviour of informal sector enterprises in the product market is one of the main barriers to innovations in formal sector enterprises.

Also, incompatibility with existing technology does not appear to be an obstacle for product innovation amongst services firms, as well as medium and incumbent large-sized firms. We did not find evidence to suggest that financial constraints affect the propensity to undertake product innovation. While R&D was observed to be important for innovation in medium-sized and large-sized firms, foreign ownership was found to be important for large-sized firms. Female ownership was essential for the full sample, services firms, small-sized firms and start-ups. Exporting does not seem to enhance product innovation. Training, the experience of a top manager, firm size, all innovation cooperation measures and information from suppliers and business associations were important for product innovation at varying degrees and across different firm categories. Most of these findings are consistent with those in the extant literature. Given that in most developing countries, innovation is at best described as marginal or incremental, the mixed evidence on the effect of these external obstacles on the propensity to undertake product innovation is not surprising.

With regards to process innovation (in Table 6), we did not find evidence of either political instability or electricity access acting as obstacles. The results suggest that political instability is an enabler of process innovation in the full sample, as well as for services firms, small-sized firms and incumbent firms that are small-sized. It is important to indicate that this result is quite unexpected and surprising. This finding on small-sized firms regarding process innovation is consistent with our observations for small firms regarding product innovation. Also, most of the services firms in our analytical sample are into retail services, hotels and restaurants. The relative ease with which services firms can alter their production techniques relative to non-services firms may explain why political instability does not appear to be an obstacle to process innovation.

With regards to the other external obstacles, we find that the lack of skilled manpower hampered process innovation in incumbent firms that are large-sized, even though the effect was not very strong while in incumbent firms that are small, the lack of skilled manpower was not a constraint. The other factors such as financial constraints, incompatibility with existing technology and informal competition were found to increase the propensity to undertake process innovation. In particular, while financial constraints was not an obstacle for undertaking process innovation by medium-sized firms, incompatibility with existing technology was not an obstacle for process innovation for large-sized firms. Also, informal competition was not an obstacle for undertaking process innovation for manufacturing firms.

While these latter results do not align with what can mostly be found in the literature, it is appropriate that the issue of context is discussed. For instance, studies such as Mancusi and Vezzulli (2010) and Hall (2002) found financial constraints to be obstacles to R&D and innovation. Our finding of a positive effect could hint of medium-sized firms relying on other sources (e.g. foreign partnerships) to enhance process innovation apart from the fact that innovation is undertaken in developing economies may be more of the incremental kind and not radical thereby requiring substantial funding. The firms are, therefore, less likely to be constrained by finance.

Again, the finding that incompatibility with existing technology increases the propensity for a firm to undertake process innovation could be because such innovations are at best incremental and not radical. It is also important to note that a substantial proportion of firms in many developing countries are gradually gravitating towards the services sector where most innovations tend to depend on the customer, and incompatibility with existing technology may not entirely be an obstacle to such firms undertaking matured process innovations.

Mendi and Costamagna (2017) find informal competition to hinder innovation among firms in Kenya. While this contradicts our finding for manufacturing firms, it is again crucial to note that Galdon-Sanchez and Schmitz (2002), Symeonidis (2002) and Blundell, Griffith, and van Reenen (1999) find that informal competition has a positive effect on innovation and rely on the escape competition effect to explain their result – the fact that informal competition induces firms to further differentiate to escape competitive pressure. We foresee a similar effect in the case of manufacturing firms in Kenya based on our findings.

For most of the remaining control variables, their signs and significance were consistent with earlier results for the propensity to undertake product innovation. The only exceptions were foreign ownership which does not enhance process innovation in the

full sample and for services firms, and the experience of a top manager, which is also not a factor that enhances process innovation in medium-sized firms. Lastly, business associations and customers are not important sources of information for process innovation in medium-sized firms.

6. Robustness check

The analysis was carried out again relying on the biprobit estimator (See Appendix 4 and 5). The use of the biprobit estimator is based on evidence that process and product innovation may complement each other. The results from the probit estimator were generally similar to those found in Tables 5 and 6. The results reinforce our argument about the critical role of political instability and access to electricity for innovation in Kenya. Most of the other variables maintained their signs and significance.

7. Discussion and conclusion

The main aim of this paper was to identify the factors that hamper firm innovation in Kenya. While the overwhelming emphasis of the innovation literature has been to identify the factors that drive firm innovation, studies that assess the factors that potentially hamper firm innovation, particularly in developing economies, remain limited in the literature. This study sought to provide some evidence on the barriers to firm innovation from the perspective of a developing African economy, which potentially holds important lessons for policy on factors that can undermine efforts aimed at encouraging innovation among firms in developing economies. Of particular interest was the effect of political instability and infrastructure in the form of access to electricity. These obstacles are fairly common to many developing economies. The study relied on data from the World Bank's Enterprise Survey on Kenya, which in several ways reflects the developmental aspirations and challenges of a typical developing country context.

By defining firm innovation as product and process innovations and estimating a Probit model, we find that political instability and access to electricity act as both enablers and barriers to innovation activities depending on the characteristics of firms. On the one hand, while political instability was found to enable product innovation in mature firms which are small, it acts as an obstacle for mature firms which are large. Regarding process innovation, on the other hand, political instability was observed as an enabler in the full sample, small firms, matured firms that are small and services firms. These findings share some similarities with the extant literature, largely agreeing with those identifying innovation obstacles.

Furthermore, we find strong evidence suggesting that challenges with electricity access act as a barrier to product innovation among services firms, small-sized firms and matured firms that are small. We, however, find no evidence to suggest that electricity access acts as a barrier or enabler to process innovation among firms in Kenya. The results on product innovation align with findings in studies that show the role of the provision of public infrastructure for firm innovation (Sivak, Caplanova, and Hudson 2011).

Regarding the other external obstacles, we explored heterogeneities in the results when we conducted the analysis for the different categorisations of firms and find the lack of skilled manpower, incompatibility with existing technology, informal competition, and

electricity to be additional factors that hamper product innovation for different firm types. We also found the lack of skilled manpower, financial constraints, incompatibility with existing technology and informal competition to be additional factors that hamper process innovation for different firm types.

Some of these findings were supported in the literature. For instance, the finding of the lack of skilled manpower hampers innovation is consistent with the studies of Amara et al. (2016) for Canada, D'Este, Amara, and Olmos-Peñuela (2016) for Spain, D'Este, Rentocchini, and Vega-Jurado (2014) for the UK and Galia and Legros (2004) for France. The finding of financial constraint also being an obstacle to firm innovation is consistent with the studies of Savignac (2008) for France, Mohnen and Röller (2005) for some European countries and Mohnen and Rosa (2001) for Canada. Mendi and Mudida (2018) find in the case of Kenya that informality is a constraint to firm innovation. Incompatibility with existing technology shares some characteristics with studies that relied on the absence of technology-related knowledge factors in undermining innovation (D'Este et al. 2012) and organizational inertia variables (Baldwin and Lin 2002).

Two main conclusions can be drawn from our study. First, the impact of political instability on innovation, product or process, depends largely on the characteristics of firms. Secondly, challenges associated with access to key public infrastructure (electricity access) remains deleterious to innovation activity, irrespective of the characteristics of firms. Both findings are intuitive and provide compelling reasons for policy measures to attenuate their effects on innovation within the context of a developing economy. Also, given that the factors that hamper innovation may be varied and, in some cases, not limited to the two factors emphasized in this study, policymakers need to account for firm categorisations in tailoring policy interventions for encouraging firm innovation. This is because in some cases, a factor that is an obstacle to firm innovation for a particular type of firm may promote innovation in another. This suggests that not only is a diversified set of policies needed to attenuate the deleterious impact of various innovation obstacles, but an attempt must be made to minimize the 'over-flow' effects on firms that may be adversely impacted by a particular initiative or event.

It is important to indicate that our results may be considered preliminary since they are based on cross-sectional data. We are unable to address issues of endogeneity in the obstacles as well as complementarities. Particularly for the latter, it implies that a policy measure that seeks to address a particular factor can also improve another. For now, we only find some strong correlations between political instability and infrastructure.

Notes

1. In the World Bank Enterprise Survey, Firm size is defined using the number of employees as follows: Micro = 0–4, Small = 5–19, Medium = 20–99, Large> = 100
2. Startups and incumbent firms were defined based on firm age and evidence of the firm being a subsidiary or not. Startups are firms below five years and are not subsidiaries of any form. Incumbent firms are those above five years.
3. The definition of the Likert Scale was as follows: 0 = No Obstacle, 1 = Minor Obstacle, 2 = Moderate Obstacle, 3 = Major obstacle, 4 = Severe obstacle.
4. We followed Biggs and Srivastava (1996) to compute the severity indexes using the formulae as follows $SI = \{sum\ [(class\,frequency \times score\ \ of\ rating)]\}/(total\,sample)$.

5. The Probit estimator provided more intuitive results. The definitions of the variables used in the model are provided in Appendix 2.
6. The definitions of the variables are provided in the Appendix.

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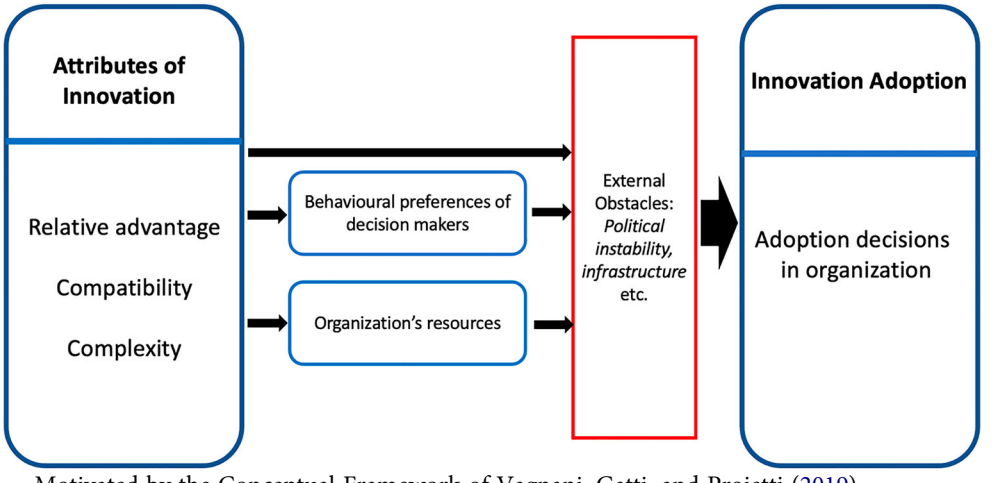
Appendices

Appendix 1. Conceptual framework



Motivated by the Conceptual Framework of Vagnani, Gatti, and Proietti (2019)

This conceptual framework is motivated by the innovation adoption decision framework of Vagnani, Gatti, and Proietti (2019) that views the entire process to be an organizational choice influenced by various sources including the attributes of the innovation (relative advantage, compatibility, and complexity), behavioural preferences of decision-makers (managers) and the sufficiency of organizational resources. We argue that for the firm to make a positive decision about innovation, the firm needs to overcome some external obstacles (which includes the political climate, availability of the needed infrastructure etc.). We also argue that how a firm goes about making such decisions depend on its economic sector, size and age.

Appendix 2. Definition of variables

Variables	Definition
Outcome variables	
Product Innovation	1, if the firm introduced a new or significantly improved product, 0 otherwise
Process Innovation	1, if the firm introduced any innovative methods of manufacturing products or offering services, 0 otherwise
Obstacles	
Lack of Skilled Manpower	1, if the lack of skilled manpower is an obstacle to undertaking an innovation, 0 otherwise
Financial Constraints	1, if financial constraint is an obstacle to undertaking an innovation, 0 otherwise
Incompatibility with existing Technology	1, if incompatibility with existing technology is an obstacle to undertaking an innovation, 0 otherwise
Informal Competition	1, if informal competition is an obstacle to doing business, 0 otherwise
Political Instability	1, if political instability is an obstacle to doing business, 0 otherwise
Electricity	1, if electricity is an obstacle to doing business, 0 otherwise
Control variables	
Research and Development	1, if the firm conducted internal or external Research and Development, 0 otherwise
Enterprise Group	1, if the firm is part of an enterprise group, 0 otherwise
Foreign Ownership	1, if the firm is foreign-owned, 0 otherwise
Female Ownership	1, if there is a female amongst the owners of the firm, 0 otherwise
Exporting Firms	1, if the firm is an exporting firm, 0 otherwise
Innovation-related Training	

(*Continued*)

Continued.

Variables	Definition
	1, if the firm provided formal training to any of its employees specifically for the development and/or introduction of innovative products or services and processes, 0 otherwise
Experience of Top Manager	Number of Years of experience of the top manager
Log of Firm Size	The total number of full-time employees
Log of Age	The age of the firm
Innovation cooperation	
Strategic Alliance	1, if the firm has introduced a product/process innovation through strategic alliance, 0 otherwise
Collaboration/Co-development	1, if the firm has introduced a product/process innovation through collaboration/co-development, 0 otherwise
Acquisition of other companies	1, if the firm has introduced a product/process innovation through acquisition of other companies, 0 otherwise
Information sources for innovation	
Customers	1, if the main source of innovation for the firm is through customers, 0 otherwise
Suppliers	1, if the main source of innovation for the firm is through suppliers, 0 otherwise
Business Association	1, if the main source of innovation for the firm is through business associations, 0 otherwise
Firm type	
Services Firms	Categorical variable for the different Services firms
Manufacturing Firms	Categorical variable for the different Manufacturing firms
Small-sized firms	0–19 (Number of Employees)
Medium-sized firms	20–99 (Number of Employees)
Large-Sized firms	>=100 (Number of Employees)
Start-ups	Firms less than five years
Small Incumbent firms	Firms younger than five years and employ between 0 and 19
Large incumbent firms	Firms older than five years and employ between above 20

Appendix 3. Correlation matrix

	Tolerance Statistics	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. Process Innovation	–	1.00																						
2. Product innovation	–	0.28	1.00																					
3. Skilled Manpower	0.75	0.07	0.13	1.00																				
4. Financial Constraint	0.84	0.04	0.05	0.29	1.00																			
5. Incompatibility	0.77	0.04	0.06	0.42	0.26	1.00																		
6. Informal Competition	0.88	0.00	0.02	0.16	0.14	0.17	1.00																	
7. Political Instability	0.94	0.04	0.03	0.15	0.10	0.12	0.11	1.00																
8. Electricity	0.88	0.06	0.08	0.23	0.19	0.19	0.14	0.13	1.00															
9. R&D	0.81	0.27	0.24	0.07	0.09	0.00	−0.05	−0.01	0.08	1.00														
10. Enterprise Group	0.96	−0.01	0.06	0.02	0.02	−0.04	0.05	0.02	−0.02	0.11	1.00													
11. Foreign Ownership	0.91	−0.01	0.04	−0.01	−0.06	−0.06	−0.03	−0.06	0.01	0.04	0.05	1.00												
12. Female Dummy	0.93	0.11	0.10	0.07	0.10	0.06	−0.01	0.00	0.11	0.10	0.00	−0.10	1.00											
13. Export Status	0.77	0.12	0.10	0.04	−0.01	−0.01	−0.19	−0.06	0.06	0.22	0.02	0.18	0.13	1.00										
14. Training	0.82	0.25	0.27	0.11	0.04	0.06	−0.07	0.00	0.05	0.29	0.03	0.09	0.10	0.20	1.00									
15. Top Manager exp.	0.72	0.06	0.09	0.03	0.00	0.00	−0.04	0.00	0.05	0.05	0.00	0.05	0.02	0.17	0.08	1.00								
16. Log of Firm Size	0.76	0.10	0.15	−0.03	−0.10	−0.07	−0.07	0.02	0.02	0.14	0.01	0.21	−0.03	0.31	0.19	0.22	1.00							
17. Log of Age	0.63	0.06	0.06	−0.02	−0.07	−0.03	−0.15	−0.06	−0.06	0.05	0.05	0.07	0.04	0.27	0.16	0.51	0.36	1.00						
18. Strategic Alliance	0.58	0.26	0.27	0.07	0.08	0.01	0.00	0.01	0.03	0.24	0.07	0.04	0.09	0.12	0.22	0.09	0.09	0.06	1.00					
19. Collaboration	0.55	0.35	0.30	0.08	0.05	0.02	0.03	0.05	0.05	0.29	0.03	0.04	0.10	0.16	0.26	0.09	0.11	0.08	0.63	1.00				
20. Acquisition	0.88	0.20	0.14	0.00	0.00	0.00	−0.01	0.01	−0.02	0.07	0.04	−0.03	0.02	0.03	0.14	0.02	0.07	0.05	0.27	0.30	1.00			
21. Customers	0.83	−0.05	−0.06	−0.01	−0.04	−0.01	0.03	−0.04	−0.07	−0.05	0.00	−0.05	−0.06	−0.08	−0.10	−0.10	−0.10	−0.09	−0.05	−0.05	−0.02	1.00		
22. Suppliers	0.87	−0.02	0.02	0.02	0.02	0.01	0.03	0.02	−0.03	−0.08	−0.03	−0.06	−0.02	−0.10	−0.05	0.03	−0.07	0.02	0.00	−0.03	−0.03	−0.24	1.00	
23. Business Association	0.89	−0.03	−0.03	−0.06	0.04	−0.04	−0.01	−0.03	−0.05	−0.03	−0.01	0.05	−0.02	−0.01	0.03	0.00	0.06	0.02	−0.04	−0.05	−0.04	−0.22	−0.13	1.00

Appendix 4. Conditional probabilities of success for process innovation (Biprobit Model).

Variables	Full sample	Economic sector		Firm size			Firm age		
		Services firms	Manufacturing firms	Small-sized firms	Medium-sized firms	Large-sized firms	Start-ups	Incumbent (Small)	Incumbent (Large)
Obstacles									
Political Instability	0.177***	0.225**	0.073	0.333***	0.012	−0.002	0.178*	0.429***	0.079*
	(0.068)	(0.089)	(0.062)	(0.104)	(0.047)	(0.056)	(0.100)	(0.150)	(0.046)
Electricity	−0.002	0.017	−0.001	−0.055	0.030	−0.006	−0.065	−0.026	0.022
	(0.079)	(0.088)	(0.064)	(0.170)	(0.060)	(0.060)	(0.098)	(0.146)	(0.046)
Lack of Skilled Manpower	0.016	0.031	−0.034	−0.017	−0.026	0.110**	−0.050	0.091	−0.077
	(0.068)	(0.077)	(0.060)	(0.137)	(0.062)	(0.052)	(0.079)	(0.140)	(0.047)
Financial Constraints	−0.016	−0.008	−0.089	0.089	0.190***	0.011	0.106	0.080	0.050
	(0.077)	(0.093)	(0.071)	(0.112)	(0.057)	(0.062)	(0.090)	(0.108)	(0.044)
Incompatibility with existing Tech	−0.021	−0.038	−0.011	−0.032	−0.039	0.080	−0.076	−0.030	−0.030
	(0.061)	(0.073)	(0.052)	(0.097)	(0.049)	(0.050)	(0.079)	(0.085)	(0.042)
Informal Competition	0.070	0.062	0.126**	0.187*	0.056	−0.058	0.119	0.155	−0.007
	(0.075)	(0.089)	(0.059)	(0.104)	(0.058)	(0.060)	(0.106)	(0.104)	(0.041)
Information sources									
Strategic Alliance	0.132	0.134	0.021	0.023	−0.015	0.041	−0.322**	−0.092	0.059
	(0.095)	(0.114)	(0.095)	(0.260)	(0.073)	(0.082)	(0.143)	(0.196)	(0.053)
Collaboration/Co-development	0.002	−0.087	0.380***	−0.045	0.118	0.152*	0.475***	0.224	0.157***
	(0.091)	(0.106)	(0.091)	(0.252)	(0.075)	(0.081)	(0.147)	(0.248)	(0.048)
Acquisition of other Companies	0.425***	0.487***	−0.178	1.575***	−0.026	−0.102	2.810***	0.355	−0.013
	(0.128)	(0.146)	(0.135)	(0.362)	(0.087)	(0.177)	(0.288)	(0.252)	(0.060)
Information sources									
Customers	−0.012	−0.025	0.018	−0.070	−0.086*	0.106*	0.076	−0.103	−0.065
	(0.064)	(0.073)	(0.061)	(0.099)	(0.048)	(0.063)	(0.063)	(0.109)	(0.044)
Suppliers	−0.007	−0.057	0.136**	−0.033	0.031	−0.019	−0.013	0.028	−0.006
	(0.093)	(0.110)	(0.069)	(0.172)	(0.058)	(0.082)	(0.106)	(0.114)	(0.045)
Business Association	0.092	0.086	−0.053	0.172	−0.167**	0.062	0.017	0.357***	0.002
	(0.092)	(0.108)	(0.065)	(0.163)	(0.078)	(0.061)	(0.130)	(0.109)	(0.054)
Other control variables									
Research and Development	0.103	0.084	0.180***	0.048	0.131**	−0.002	−0.018	0.585***	0.017
	(0.081)	(0.093)	(0.054)	(0.147)	(0.051)	(0.063)	(0.096)	(0.174)	(0.046)
Enterprise Group	−0.112	−0.114	−0.123	−0.034	−0.143*	−0.107	−0.205	0.226*	−0.152**
	(0.116)	(0.132)	(0.104)	(0.162)	(0.075)	(0.128)	(0.165)	(0.131)	(0.068)
Foreign Ownership									

(*Continued*)

Continued.

Variables	Full sample	Economic sector		Firm size			Firm age		
		Services firms	Manufacturing firms	Small-sized firms	Medium-sized firms	Large-sized firms	Start-ups	Incumbent (Small)	Incumbent (Large)
	−0.197**	−0.308**	0.091	−0.167	−0.113	0.011	−0.114	−0.127	−0.118*
	(0.087)	(0.125)	(0.063)	(0.191)	(0.083)	(0.052)	(0.111)	(0.307)	(0.062)
Female Ownership	−0.000	−0.032	0.093*	0.036	−0.020	−0.018	−0.061	0.044	0.095**
	(0.054)	(0.062)	(0.048)	(0.122)	(0.048)	(0.047)	(0.057)	(0.092)	(0.039)
Exporting Firms	−0.079	−0.077	−0.154***	−0.071	−0.123**	−0.048	−0.247***	0.067	−0.053
	(0.064)	(0.082)	(0.053)	(0.124)	(0.048)	(0.050)	(0.078)	(0.096)	(0.038)
Innovation-related Training	0.046	0.041	0.011	−0.034	0.119***	0.029	0.027	−0.123	0.035
	(0.070)	(0.081)	(0.051)	(0.140)	(0.041)	(0.052)	(0.085)	(0.102)	(0.037)
Experience of Top Manager	−0.046	−0.076	0.064*	−0.009	−0.058**	0.118***	−0.064	0.241***	−0.053**
	(0.040)	(0.048)	(0.033)	(0.094)	(0.027)	(0.034)	(0.042)	(0.068)	(0.026)
Log of Firm Size	−0.016	−0.022	−0.000	0.048	0.112***	0.101***	0.147***	−0.139*	0.041**
	(0.026)	(0.034)	(0.020)	(0.071)	(0.038)	(0.024)	(0.028)	(0.075)	(0.019)
Log of Age	−0.005	0.005	−0.040*	0.010	−0.026	−0.039*	−0.111*	−0.080	0.005
	(0.024)	(0.028)	(0.021)	(0.031)	(0.019)	(0.022)	(0.065)	(0.058)	(0.024)
Location	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	972	536	436	422	357	180	340	230	402

Standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Appendix 5. Conditional probabilities of success for product innovation (Biprobit Model).

Variables	Full sample	Economic sectors		Firm size			Firm age		
		Services firms	Manufacturing firms	Small-sized firms	Medium-sized firms	Large-sized firms	Start-ups	Incumbent (small)	Incumbent (large)
Obstacles									
Political Instability	0.007	−0.003	−0.077	−0.034	−0.058	−0.037	−0.009	0.006	−0.144**
	(0.065)	(0.078)	(0.100)	(0.081)	(0.082)	(0.081)	(0.847)	(0.067)	(0.057)
Electricity	−0.084	−0.131**	0.140	−0.189***	−0.047	0.076	−0.142	−0.172**	0.014
	(0.056)	(0.060)	(0.094)	(0.069)	(0.074)	(0.093)	(0.568)	(0.071)	(0.053)
Lack of Skilled Manpower									

(*Continued*)

Continued.

		Economic sectors		Firm size			Firm age		
Variables	Full sample	Services firms	Manufacturing firms	Small-sized firms	Medium-sized firms	Large-sized firms	Start-ups	Incumbent (small)	Incumbent (large)
	0.103**	0.112**	−0.035	0.163***	−0.066	−0.151	0.149**	0.147**	−0.057
	(0.044)	(0.050)	(0.092)	(0.053)	(0.058)	(0.313)	(0.068)	(0.067)	(0.051)
Financial Constraints	0.015	0.032	0.020	−0.041	0.008	0.020	0.057	−0.080	−0.014
	(0.068)	(0.075)	(0.150)	(0.085)	(0.099)	(0.093)	(0.631)	(0.068)	(0.051)
Incompatibility with existing Tech	0.058	0.098**	0.029	0.082	0.204***	0.167	0.112	0.090	0.097**
	(0.044)	(0.049)	(0.058)	(0.051)	(0.056)	(0.606)	(0.200)	(0.058)	(0.042)
Informal Competition	−0.087	−0.121*	0.020	−0.078	−0.090	0.003	0.104	−0.167**	−0.033
	(0.059)	(0.070)	(0.219)	(0.070)	(0.063)	(0.279)	(0.745)	(0.072)	(0.044)
Innovation cooperation									
Strategic Alliance	0.171**	0.266**	0.022	0.313***	0.128	0.101	0.308	0.181	0.064
	(0.075)	(0.104)	(0.096)	(0.091)	(0.098)	(0.338)	(1.051)	(0.117)	(0.065)
Collaboration/Co-development	0.214***	0.295***	0.124	0.324***	0.232***	0.006	0.250	0.257	0.131*
	(0.073)	(0.104)	(0.677)	(0.115)	(0.089)	(0.725)	(2.730)	(0.170)	(0.078)
Acquisition of other Companies	0.084	0.039	0.345**	−0.366*	0.250*	1.401	0.600	−0.551***	0.270***
	(0.096)	(0.116)	(0.163)	(0.200)	(0.130)	(1.398)	(14.652)	(0.210)	(0.090)
Information sources									
Customers	0.036	0.040	0.045	0.081	0.054	0.085	−0.058	0.166***	0.017
	(0.048)	(0.052)	(0.081)	(0.054)	(0.073)	(0.618)	(0.280)	(0.049)	(0.049)
Suppliers	0.127*	0.176**	−0.155	0.171**	0.136*	0.035	0.134	0.045	0.240***
	(0.071)	(0.078)	(0.163)	(0.086)	(0.081)	(0.095)	(0.191)	(0.061)	(0.072)
Business Association	0.073	0.079	−0.015	0.102*	0.108	0.014	0.051	−0.002	0.042
	(0.051)	(0.061)	(0.109)	(0.062)	(0.104)	(0.326)	(0.228)	(0.078)	(0.051)
Other control variables									
Research and Development	0.066	0.046	0.091	0.094	0.192**	0.198	0.110	−0.061	0.132**
	(0.057)	(0.067)	(0.344)	(0.074)	(0.079)	(0.260)	(0.125)	(0.085)	(0.051)
Enterprise Group	−0.025	−0.045	−0.006	−0.053	0.147	−0.077	−0.046	−0.058	0.187**
	(0.069)	(0.070)	(0.210)	(0.069)	(0.093)	(0.616)	(1.070)	(0.052)	(0.073)
Foreign Ownership	0.098	0.129	0.066	−0.066	−0.025	0.107	0.049	−0.383***	0.015
	(0.069)	(0.081)	(0.180)	(0.121)	(0.073)	(0.205)	(0.477)	(0.125)	(0.061)
Female Ownership	0.078*	0.102**	0.007	0.120**	0.019	−0.047	0.134	−0.078	−0.035
	(0.041)	(0.045)	(0.158)	(0.050)	(0.055)	(0.151)	(0.082)	(0.058)	(0.049)
Exporting Firms	−0.049	−0.035	−0.138	−0.104	−0.008	0.026	−0.153	−0.044	0.042
	(0.049)	(0.061)	(0.318)	(0.074)	(0.071)	(0.199)	(1.468)	(0.058)	(0.044)
Innovation-related Training	0.141***	0.153***	0.117	0.159***	0.078	0.043	0.137	0.156**	0.130***
	(0.045)	(0.050)	(0.090)	(0.058)	(0.071)	(0.204)	(0.363)	(0.066)	(0.046)
Experience of Top Manager									

(*Continued*)

Continued.

		Economic sectors		Firm size			Firm age		
Variables	Full sample	Services firms	Manufacturing firms	Small-sized firms	Medium-sized firms	Large-sized firms	Start-ups	Incumbent (small)	Incumbent (large)
	0.082***	0.102***	0.007	0.120***	0.014	−0.002	0.119	−0.051	0.004
	(0.028)	(0.033)	(0.113)	(0.031)	(0.046)	(0.549)	(0.120)	(0.042)	(0.031)
Log of Firm Size	0.047**	0.039	0.090*	0.033	−0.047	0.011	0.090	0.086	0.010
	(0.022)	(0.028)	(0.046)	(0.045)	(0.056)	(0.490)	(0.869)	(0.055)	(0.025)
Log of Age	0.007	−0.007	0.033	−0.010	−0.015	0.006	−0.092	0.073**	−0.057**
	(0.018)	(0.021)	(0.055)	(0.020)	(0.027)	(0.182)	(0.702)	(0.031)	(0.027)
Location	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	972	536	436	422	357	180	340	230	402

Standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.