

Product innovations and informal market competition in sub-Saharan Africa: Firm-level evidence

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Elvis Korku Avenyo ^{*a}

^aUNU-MERIT/University of Johannesburg

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Abstract

Competitive interaction between formal and informal businesses in product markets continue to grow in developing countries. Firm-level evidence however reveal the product market competitive behaviour of informal enterprises as 'unhealthy' and one of the top three obstacles formal businesses face in sub-Saharan Africa. With scant empirical evidence available, this paper fills the gap in the literature by investigating the relationship between informal product market competition and sales from innovative products introduced by formal firms. Using pooled data from the World Bank's Enterprise Survey and the newly available Innovation Follow-up Survey for five sub-Saharan African countries, our result shows a robust 'Schumpeterian effect' (monotonically negative effect) of informal competition on the market performance of product innovations. Results from sectoral, ownership type and size of firm analyses also show similar 'Schumpeterian effects'. However, extension to industry-level informal competition indicates an 'escape-competition effect' of informal competitive activities on the performance of product innovations. We also found through indirect mechanisms that firms with larger market share tend to have 'escape-competition effects'. We argue that informal competition matters for the performance of product innovations but only for formal firms that lack strategic collaborative 'footholds' in the informal economy.

Keywords: Informality, market competition, product innovations, sub-Saharan Africa.

JEL Codes: D22, L21, L25, O17, O31.

*avenyo@merit.unu.edu

1 Introduction

The informal economy has defied the expectations of traditional development literature by not only persisting over time but have also grown and expanded over the years. The growing evidence of the 'permanent' feature of informality in developing countries have led to increasing academic and policy interests in recent years. Typically, development literature considers informality and the activities of informal enterprises as largely negative on the economy. Evidence from firm-level data from developing countries also reveal the market competitive behaviour of informal enterprises as one of the top three obstacles formal businesses face in product markets (see Mendi and Costamagna, 2017; Friesen and Wacker, 2013; Lamanna and Gonzalez, 2007). Despite the growth of the literature on informality, the economic implications of informal enterprise activities remain under researched (Mendi and Costamagna, 2017; Friesen and Wacker, 2013; Bruton et al., 2012) with very scant empirical studies investigating the effect of informal product market competition (hereafter informal competition) on the innovation strategies of formal firms. This study fills this gap by examining the effect of informal competition on the performance of product innovations in sub-Saharan Africa (SSA).¹

In developing countries, the informal economy is increasingly being seen as a critical socio-economic pillar (Gërkhani, 2004) and a source of livelihood (La Porta and Shleifer, 2008) with highly heterogeneous enterprises (Bargain and Kwenda, 2011). The informal economy is most prevalent in SSA (Schneider et al., 2010) where it dominates economic activities both in terms of output and employment (Heintz and Pollin, 2008). For instance, the sector constitutes 80 percent of the labour force and accounts for nearly 55 per cent of GDP for many SSA countries (International Labour Office (ILO), 2013; African Development Bank, 2013). In Ghana for example, employment is found to be predominantly informal employing 86.1% of the working force (Ghana Statistical Service, 2012) with the production structure made up of Small-Medium Enterprises (SMEs). Informal SMEs are also found to be strong drivers of economic transformation (Haug, 2014).

In addition to serving as a source of livelihood in many developing countries, informal enterprises also pose as a source of informal competition (Mendi and Costamagna, 2017; Lamanna and Gonzalez, 2007) through prices at the 'local-level' at least where the competitive interaction is found to occur in product markets for the same consumers (Ali and Najman, 2015; Lamanna and Gonzalez, 2007). While market competition between firms is recognised widely as the driver of efficiency and growth, empirical evidence and firm-level data from developing countries (mostly from the World Bank Enterprise Surveys) often cite competitive behaviour of informal enterprises as unhealthy and as one of the top three obstacles to formal firms. The characterisation of informal competition as unhealthy may be as noted by Mendi and Costamagna (2017), a result of the wide market acceptance of informal enterprises in local markets particularly markets serving those in the bottom of the pyramid.

¹ A growing related literature is the informal competition and formal firms productivity literature (see La Porta and Shleifer, 2008; Ali and Najaman, 2015).

In the face of informal competition, formal firms may employ vertical product differentiation in order to stay competitive. In other words, formal firms may introduce product innovations. According to van Dijk and Sandee (2002); Gault (2010); OECD and Eurostat (2005), innovations particularly product innovations remain a primary driver of firm technological competitiveness (market performance) through improvements in product quality, offering of new products or opening up new markets or groups of customers thereby increasing the firm's market share. However, imitation and the increasing complementary interaction between formal and informal businesses coupled with the dynamic behaviours of informal enterprises may be blurring vertical product differences particularly in service and retail sectors. Consequently, the competitive advantage formal firms enjoy with vertical product differentiation may be fuzzy in the face of informal competition.

The relationship between innovation and competition in SSA is of particular interest as a result of the growing size of the informal economy as well as the peculiar nature of competition presented by the dualistic economic structure. This paper therefore investigates the effect of informal market competition on the performance of innovative products of registered firms in SSA and to provide a better understanding of the mechanisms through which these occur.

This paper contributes to the literature in several ways. The paper provides to our knowledge the first empirical evidence assessing the effect of informal competition on the sales of innovative products.² This study departs from the mainstream literature by analysing informal competition and from similar studies by going beyond the analysis of formal firms' incentives to innovate. What may be relevant for firms is not whether to introduce product innovation or otherwise but how the innovative products perform on the market in the face of dual competition. Analysing the effect of informal competition on product innovation using a binary dependent variable (whether the firm introduces product innovation or not) only determines the incentives to innovate or otherwise. This paper therefore goes beyond establishing a relationship between informal competition and the probability of the firm to introduce product innovation to assessing the effect of informal competition intensity on the performance of product innovation in SSA.

This paper also contributes to the literature by resolving possible econometric issues of bi-directional causality and the use of subjective responses that may bias our estimates. Using already existing econometric procedures developed by Guiso et al. (2004), Ali and Najman (2015) found informal competition varies across regions within the same country. This study follows Ali and Najman (2015) to construct an innovative regional competitive intensity measure that 'localises' competition thereby reducing the possible bi-directional causality between informal competition and sales of innovative products as well as controlling for possible bias due to the subjective nature of the data. We also employed the same procedure to construct industry-level informal competition indicator across industries in each country. These approaches allow us to control and introduce non-linear effects into our model that could help explain more rigorously the relationship between informal competition and formal firms technological innovativeness (see

² A recent contribution by Mendi and Costamagna (2017) focuses on the implications of informal competition on the incentives of formal firms' to introduce product and/or process innovations. This paper however departs by relating the degree of product innovative sales to informal competition.

Ali and Najaman, 2015; Aghion et al., 2005; Scherer, 1967). This paper also follows available econometric methods to control for selection bias associated with innovation where we allow the error terms of both equations to be freely correlated.

In addition, this study contributes to the literature by employing data from the Innovation Follow-up Survey (IFS) pooled with the Enterprise Survey (ES) from the World Bank. While similar studies also employ the ES (see Mendi and Costamagna, 2017; Ali and Najman, 2015; Friesen and Wacker, 2013; Lamanna and Gonzalez, 2007), this study departs by pooling data from both ES and the IFS thereby exploiting a larger number of variables in order to uniquely introduce controls that are uncommon in the literature.

Using data for 5 SSA countries namely: Democratic Republic of Congo (DRC), Ghana, Tanzania, Uganda, Zambia and employing two econometric approaches that localise informal competition in the product market at the first-level of estimation and controls for self-selection and sample selection biases at the second level of estimation, we have shown that local informal competition matters for the performance of product innovations. Specifically, our results indicate the presence of 'Schumpeterian effect' where informal competition is found to be detrimental to the performance of product innovations. Our conclusion is also found to be valid when we decompose formal firms into sectors, ownership type and size. However, extension to industry-level informal competition indicates an 'escape-competition effect' of informal competitive activities on the performance of product innovation. Our results also show through indirect mechanism that firms with larger market share tend to have 'escape-competition effect'.

The rest of the paper is organised as follows. Section 2 presents the review of relevant literature on the relationship between innovation and product market competition. In Section 3 the model and sources of data are presented. Section 4 presents the results from the empirical estimation in line with the objectives of the paper, the discussion of the results as well as the appropriate robustness checks to validate our results. Section 5 presents the conclusion of the paper.

2 Related Literature

The economic development literature establishing firm-level relationship between competition and innovation is relatively developed but remains central in both academic and policy spheres (Blundell et al., 1999; Peroni and Ferreira, 2011) as empirical evidence remain inconclusive (Aghion et al., 2005) and subtle (Aghion et al., 2013). This section situates our paper into this broad strand of literature.³

The literature mainly follow from the seminal contribution by Schumpeter (1942) with theoretical formalisation by Aghion and Howitt (1992). The Schumpeterian perspective of the literature essentially considers vertical innovations as creative destructions of the product mar-

³ See Gilbert (2006) for a recent survey of the literature.

ket and the source of long-run growth. Competition is considered a bane on innovations as it is considered to destroy the underlying incentives of firms to undertake innovation activities through the prospects of lower rents (Schumpeter, 1942; Aghion and Howitt, 1992; Aghion et al., 2001; Hashmi, 2013). This is referred to as the 'Schumpeterian effect'. Using panel data from the United States of America (USA) and the United Kingdom (UK) and one minus the average Lerner index of firms industry, citation-weighted patents for competition and innovation respectively, Hashmi (2013) found evidence of a 'Schumpeterian effect' in USA industries.

Contrary to the Schumpeterian perspective is the 'escape-competition effect' where increases in competition serve as an incentive to escape market rivalry by stimulating innovation activities and innovations particularly in industries with low technological gap (see Blundell et al., 1999; Aghion et al., 2001). For instance, Blundell et al. (1999) studied the market share, market value and innovation in a panel of British manufacturing firms by using innovation counts. The authors found 'escape-competition effect' where "increased product market competition in the industry tended to stimulate innovative activity" with innovative, large market share firms enjoying higher gains on the stock market. Boldrin and Levine (2008) developed a competitive model of innovation where the authors examined post-innovation rents under perfect competition. Presenting both theoretical and practical situations, the authors also found positive effects of competition on innovation.

A growing part of the literature also identify a non-linear relationship in the form of an inverted-U where lower and higher levels of product market competition influence firm-level innovations differently. Lower levels of market competition are found to promote innovation while higher levels of competition inhibit innovation. In other words, this strand finds both the 'Schumpeterian effect' and the 'escape-competition effect' (see Mendi and Costamagna, 2017; Aghion, et al., 2005; Scherer, 1967). An earlier study by Scherer (1967) analysed the effect of market concentration on innovative efforts using data for 56 industries in the USA. Measuring innovative efforts as employment of scientists and technical engineers and market concentration as industry average concentration ratios weighted by shipment values, the author found that lower industry concentrations tend to promote innovative efforts while higher concentrations beyond a threshold tend to inhibit innovative efforts. Similar inverted-U relationship has been recently identified by Aghion et al. (2005). In a UK panel data investigation where innovation and competition are measured as average weighted patents and the Lerner index respectively, Aghion et al. (2005) found an inverted-U relationship between product market competition and innovation. The authors argue that industries with low technological gaps tend to have firms that are neck-to-neck and competition in these industries tend to lead to lower pre-innovation rents. As a result, incumbent firms try to escape-competition by increasing the technological gap and post-innovation rents through innovations. Reversely, leader-laggard firms dominate industries with higher technological gaps. Higher product market competition in these industries with leader-laggard firms tend to reduce post-innovation rents of leaders resulting in the dominance of the 'Schumpeterian effect' (Aghion et al., 2005, p. 702).

One major criticism of the literature reviewed above remains that majority of the studies concen-

trate on developed countries where competition is essentially non-dualistic. This study departs from this literature by analysing a different type of competition, that is, informal competition. Most of the available literature also measure competition only at the industry-level. We argue that informal competition is also local.

As noted, this paper departs by analysing competition from a dualistic perspective where we considered informal competition. There is a growing body of literature understandably from Latin America and Africa on informal competition and the effect of informal competition on the performance of formal firms. Employing mainly cross-sectional data from the World Bank’s Enterprise Survey, some of these empirical works find informal competition and the activities of informal enterprises detrimental to the performance of formal firms and the economy as a whole (Lamanna and Gonzalez, 2007; La Porta and Shleifer, 2008; Friesen and Wacker, 2013). Informal competition is found to most adversely affect formal firms that are: small (Lamanna and Gonzalez, 2007, Ali and Najman, 2015); financially constrained (Friesen and Wacker, 2013); tax constrained and in industries with high entry cost, low capital and higher regulations (Lamanna and Gonzalez, 2007; Friesen and Wacker, 2013). On the contrary, Ali and Najman (2015) found informal competition has productivity enhancing effects. Using the ES for 33 sub-Saharan African countries, the authors found that formal firms with higher informal competition tend to increase their productivity with these effects increasing for large firms. In a cross-country analysis of Latin and African countries using average regional measure for informal competition, Mendi and Costamagna (2017)⁴ found an inverted-U relationship where informal competition has decreasing and increasing effects on the probability of introducing innovations at higher and lower intensities of competition respectively. While these studies provide some level of evidence of the effect of informal competition on the performance of formal firms, the evidence remain mixed. Evidence relating the effect of industry-level perception of informal competitive behaviour on the performance of product innovations also remain missing in the literature. Mendi and Costamagna (2017) considered the effect of informal competition on the probability of introducing product and process innovations. Our analysis go further by considering the performance of product innovations as well as using rigorous econometric approaches to provide a much deeper insight into the relationship.

3 Methodology

3.1 Data

The main data sets used for the empirical investigation in this paper come from the Enterprise Survey (ES) and the Innovation Follow-Up Survey (IFS) of the World Bank. The ES follows a standard methodology to collect representative enterprise data in 122 countries allowing for cross-country comparisons. The methodology randomly stratifies firms by sector, size and

⁴ The only known empirical evidence studying informal competition and innovation.

location thus making the sample in each country representative. The IFS is a representative firm-level data on innovation and innovation activities of firms interviewed during the ES. The IFS is therefore a follow-up survey to and covered 19 countries between 2011-2014 out of which 15 of the countries covered are in Africa. In this paper we employ data for 5 SSA countries namely: Democratic Republic of Congo (DRC), Ghana (GH), Tanzania (TZ), Uganda (UG) and Zambia (ZAM). ⁵ In total, data for 5 SSA countries totaling 2,466 firms were attained.

The descriptive statistics from our data are shown in Table 1. Out of 2,466 firms in the data, 2,456 responded to introducing product innovation or otherwise. A total of 955 firms constituting about 38.9% introduced product innovation while 1,501 firms making up about 61.1% did not introduce any product innovation. The average percentage sales from all product innovation across all countries under consideration is about 34.97% with Zambia having the least average percentage sales from all product innovation of about 25.97%. Out of 2,378 responding firms, 39.11% consider competition from informal enterprises as a major constraint. Country specific descriptive however show varying perceptions with about 47.44% and 27.43% of Zambian and Ghanaian firms respectively identifying informal competition as a major constraint to their businesses. Table 1 also shows the sectoral and size distributions of our data. Majority of firms (65%) in our data are classified as small with total number of workers between 5 and 19. Sectoral distributions show almost equal proportions of about 49% and 51% for manufacturing and service sector firms respectively.

Table 1: Descriptive statistics of data by country

	ALL	DRC	GH	TZ	UGA	ZAM
No. of firms in data	2,466	385	549	543	449	540
Product innovations						
No. of all firms	2456	383	544	541	448	540
Innovators	955	147	154	89	238	327
Non-innovators	1501	236	390	452	210	213
Sales, all product innovations (Mean%)	34.97	44.95	36.65	43.5	37.64	25.97
Informal competition						
No of all firms	2378	364	523	519	445	527
Major obstacle (%)	39.11	37.36	27.34	44.89	37.75	47.44
No. obstacle (%)	60.89	62.64	72.66	55.11	62.25	52.56
Size of firm						
Small (%)	65.17	70.65	68.85	55.43	67.04	65.74
Medium (%)	26.64	23.38	25.87	29.83	25.84	27.22
Large (%)	8.19	5.97	5.28	14.73	7.13	7.04
Sector of firm						
Manufacturing (%)	49.31	47.79	51.73	50.09	46.33	49.63
Services and retail (%)	50.69	52.21	48.27	49.91	53.67	50.37

Source: Enterprise and Innovation Follow-Up Surveys.

⁵ We excluded other countries due to missing observations of variables of interest.

3.2 Empirical analysis

The ES methodology as noted randomly stratifies firms by sector, size and location which are assumed to be exhaustive and non-overlapping. However, the number of firms sampled in each stratum (sector, size and location) and across these strata are non-random resulting in non-random total sample size (Wooldridge, 2002). In addition, a firm’s decision to introduce product innovations onto the market is not random but often influenced by plethora of confounders. As a result of the non-random nature of the decision to introduce product innovations and the sampling design used in the ES, employing OLS may give inconsistent estimates due to the likely selection bias (see Heckman, 1979; Wooldridge, 2002). The empirical literature also recognises bi-directional causality between innovation and competition and the need to resolve the possible endogeneity bias (see Aghion et al., 2005). The ES firm-level data regarding the product market competitive behaviour of informal enterprises are mainly perception data and have been found to be highly subjective and may bias estimates (see Mendi and Costamagna, 2017; Ali and Najman, 2015; Friesen and Wacker, 2013; Lamanna and Gonzalez, 2007) as bad performing formal firms are more likely to exaggerate the competitive behaviour of informal enterprises more than good performing firms.

This section addresses the above possible biases by employing two main econometric approaches to estimate the effect of informal competition on the percentage sales from all innovative products of formal firms. At the first level of estimation, we employ a two-step methodology developed by Guiso et al. (2004) and updated by Ali and Najman (2015) to construct ‘local’ and industry-level (in extension) informal competition indicators to address the possible endogeneity and subjectivity in the data. At the second level of estimation, we employ Type II Tobit model (Amemiya, 1985) to estimate the effect of our informal indicators (normalised marginal probabilities) on percentage sales from all innovative products and other relevant covariates controlling for self-selection and sample selection biases.

3.2.1 Model specifications

First-level estimation: ‘Local’ informal competition indicator construction

To construct our ‘local’ informal competition indicator, we employ the two-step econometric procedure developed by Guiso et al. (2004) and updated by Ali and Najman (2015). As noted, the standardised ES collects firm-level perception data on the product market competitive behaviour of informal enterprises. These perception responses from formal firms have been found to be highly subjective (Ali and Najman, 2015; Friesen and Wacker, 2013). As a result, using local (regional) averaged responses where firms operating in the same locality (region) have the same informal competition indicator allows for variations across regions within the same country. This has been found to mitigate the subjective bias and measurement errors

in the data as well as reduce the bi-directional relationship between informal competition and innovation (see Ali and Najman, 2015; Friesen and Wacker, 2013).

Following Lamanna and Gonzalez (2007) and Ali and Najman (2015), we assume informal competition is at first only 'local' with informal enterprises competing only in their immediate vicinities. That is enterprises operate in their immediate product markets with no or very little competitive interaction in national and/or global product markets. Several questions in the standardised ES seek to find out how formal firms perceive the competitive behaviours of both formal and informal businesses. In the construction of our 'local' informal competition indicator, we employ data on the question: Do you think the practices of competitors in the informal sector present:

- a) No obstacle
- b) Minor obstacle
- c) Moderate obstacle
- d) Major obstacle
- e) Very severe obstacle

to the current operations of your establishment?

In the ES data set, this question is further summarised into: *Percentage (%) of firms identifying competitors in the informal sector as a major constraint*. This later question presents a binary classification that takes the value 1 if the firm considers the competitive practices of informal enterprises as a major and a very severe obstacle and the value 0 if the firm considers the competitive practices of informal enterprises as no, minor and moderate obstacles respectively. Following Ali and Najman (2015), we use the binary classification to formalise a non-linear regression equation as:

$$Informal_competition_{iqj} = \gamma_0 + \gamma_{qj}Region_{qj} + \gamma_2X_{iqj} + \gamma_I + \gamma_y + \gamma_c + \epsilon_{ij} \quad (1.1)$$

where $Informal_competition_{iqj}$ is a binary variable taking the value 1 if firm i in country j considers the competitive practices of informal enterprises as a major obstacle and value 0 if firm i in country j considers the competitive practices of informal enterprises as no obstacle. $Region_{qj}$ is our 'local' informal competition variable which is a list of regional dummies in country j . X_{ij} , γ_I , γ_y and γ_c are defined as vector of all firm-specific, industry, year and country-specific variables that respectively explain firms perception of informal market competitive behaviour.⁶

The marginal coefficients from the first-level probit regression of equation (1.1) are shown in Appendix 2. The results indicate that foreign owned firms are less likely to identify the com-

⁶ See Appendix 1 for definition of all terms and variables.

petitive practices of informal enterprises as a major constraint as compared to domestic firms all other factors held constant. The probability that formal firms identify the competitive activities of informal enterprises as a major constraint increases if other obstacles to business such as corruption and crime are present. Firms located in the capital city consider the informal competition less a major constraint as compared to firms located elsewhere. Firms with higher percentage increase in total sales from the previous fiscal year are less probable to perceive informal competition as a major constraint.

In the second stage, we predict the marginal probabilities of $Region_{qj}$ from the estimation of equation (1.1) with firms operating in the same vicinity having the same informal competition intensity (marginal probabilities).⁷ The marginal probabilities in region q located in country j is then normalised to values between 0 and 1 with firms having the least informal competition intensity assigned the value 0 while the region with the highest informal competition intensity assigned the value 1. This is done formally by following Ali and Najman (2015) as:

$$IPMC_{qj} = [\hat{\gamma}_{qj} - \min(\hat{\gamma}_{qj})] / [\max(\hat{\gamma}_{qj}) - \min(\hat{\gamma}_{qj})] \quad (2.1)$$

where $IPMC_{qj}$ is 'local' informal competition indicator of region q in country j . $\hat{\gamma}_{qj}$ are the marginal probabilities of region q in country j . $\max(\hat{\gamma}_{qj})$ and $\min(\hat{\gamma}_{qj})$ refer to the maximum and minimum marginal probabilities respectively. Equation (2.1) normalises our 'local' informal competition indicator into a range between 0 and 1 where values close to 1 indicate intense informal competition and values close to 0 indicating less informal competition in the vicinity.

Description of our regional variable, country of location and their respective local informal competition indicators in percentages are presented in Table 2. A look on Table 2 shows varying intensities of our 'local' informal competition indicator across different regions of the same country. Lira in Uganda has the least intensity of 'local' informal competition while Lusaka is found to have the highest intensity of 'local' informal competition. In Tanzania for example, Arusha has the least intensity of informal competition of about 3.1% while Zanzibar has the highest intensity of informal competition of about 53%. These regional disparities across all countries validate our use of the local indicator rather than a national proxy for informal competition as we see varying levels of informal competition across regions located in the same country.

There exist disparities across countries as well as across product innovators and non-product innovators. On the average Tanzania has the lowest intensity of informal competition of about 29% while Zambia has the highest of about 85%. On the average, innovators experienced a higher intensity of informal competition of about 57% as compared to the 44% of intensity experienced by non-product innovators. Cross-country comparison indicates on the average that both product and non-product innovators in Zambia experienced the highest intensity of local informal competition of about 86% and 83% respectively (see Table 3).

⁷ Accra was used automatically as the base outcome.

Table 2: Description of regions and indicator by country

Country	Region	Number of firms	Local informal competition (IPMC) (%)
Congo, D.R.	Central	51	29.827
	East	95	16.170
	South	47	21.193
	West	192	63.265
Ghana	Accra	275	43.485
	North	106	16.484
	Takoradi	54	32.496
	Tema	114	13.187
Tanzania	Arusha	92	3.140
	Dar Es Salaam	268	32.810
	Mwanza	53	24.490
	Zanzibar	74	52.590
Uganda	Jinja	79	73.626
	Kampala	165	87.912
	Lira	37	0
	Mbale	48	2.512
	Mbarara	54	9.419
	Wakiso	66	57.614
Zambia	Kitwe	74	70.330
	Livingstone	73	67.033
	Lusaka	288	100
	Ndola	105	64.835
TOTAL	22	2410	

Table 3: Description of local informal competition indicator by country

	ALL	DRC	GH	TZ	UGA	ZAM
Local informal competition (IPMC)						
All firms (Mean %)	48.919	42.079	30.899	29.305	55.131	84.640
Innovators (Mean%)	56.706	41.839	31.531	32.091	50.495	85.862
Non-innovators (Mean%)	43.914	42.248	30.614	28.729	60.296	82.763

Second level estimation- Type II Tobit model

To estimate the effect of our 'local' informal competition indicator on sales from all innovative products, we formulate a Type II Tobit model (Amemiya, 1985) procedure as:

Regression equation:

$$Sales_{Product_Innovationsij} = Y_{ij} = \alpha_0 + \alpha_1 IPMC_{qj} + \alpha_2 Z_i + \delta_I + \delta_y + \delta_c + \epsilon_{ij}, \text{ if } w_i^* > 0 \quad (3.1)$$

Selection equation:

$$Introduce_{Product_Innovationsij}^* = w_i^* = \beta_0 + \beta_1 M_i + v_{ij}, \text{ if } w_i^* > 0 \text{ and } w_i = \text{otherwise} \quad (3.2)$$

where $Sales_{Product_Innovationsij}$ is the percentage sales from all innovative products of firm i in country j , $IPMC_{qj}$ is our 'local' informal competition indicator in region q of country j . Z_i is the set of control covariates. γ_I, γ_c and γ_y are industry-specific, country specific and year specific covariates that may affect the percentage sales from all innovative products. $Introduce_{Product_Innovationsij}^*$ is a latent dummy which takes value 1 if firm i in country j introduced product innovations over the last three (3) fiscal years and 0 if otherwise. M_i is a set of control covariates that might affect firm i in country j to introduce product innovations and vice versa. ϵ_{ij} and v_{ij} are both multivariate normally distributed error terms.

3.2.2 Estimation

To estimate the Type II Tobit models, we employed the 'flexible' conditional mixed process (*cmp*) Stata command which performs a limited-information maximum likelihood estimation by assuming the errors from both the regression and selection equations can be correlated and are multivariate normally distributed (see Roodman, 2011). The parameters obtained from the simultaneous estimation of both the regression and selection equations have been found to be 'generally more efficient' due to the use of the full covariance structure in both equations (Roodman, 2011). All variance-covariance matrices are clustered at the region.

4 Empirical results

4.1 Main results and discussion

The empirical results from regressing our 'local' informal competition indicator on percentage sales due to all product innovations are reported in panel A of Table 4. Panel B of the same table shows estimation results from our selection equation where we regressed 'local' informal competition indicator on the decision to introduce product innovations. All results for both basic and extended specifications are heteroskedasticity-robust standard errors.

Our main result from panel A (1) of Table 4 shows informal competition in product markets have a significantly negative effect on the performance of product innovations. That is, increase in the concentration of informal activities in the immediate vicinity of formal firms reduce the percentage of sales from all newly introduced product innovations. This result is in line with the empirical findings of Hashmi (2013) but partly contrary to the inverted-U relationship found recently by Mendi and Costamagna (2017). One explanation for this 'Schumpeterian effect' may be due to the increasing capability of informal enterprises to imitate new technological products introduced by formal firms. This result may also be explained by the increase in the non-competitive interactions between few formal firms and informal enterprises mainly through collaborations and outsourcing of economic activities. These non-competitive interactions may be enabling few registered firms to expand their market size through informal enterprises by taking strategic advantage of the dynamic behaviours as well as the 'local' market acceptance of these unregistered enterprises. As a result, formal firms without these non-competitive interactions may face intensive competition from informal enterprises who happen to be most active and visible competitors in product markets with similar 'imitated' products. These market behaviours may be eroding the competitive advantage formal firms without non-competitive interactions enjoy with vertical product differentiation resulting in lower sales of product innovations. This result may also partially explain the recent persistence of growth and economic relevance of the informal sector in SSA. In panel B(1), our results also show insignificant effect of informal competition suggesting informality of the product market is irrelevant in deciding whether to introduce product innovations or otherwise by firms. This result is contrary to Mendi and Costamagna (2017) who found inverted-U relationship between informal competition and firms' incentives to introduce innovations. Our result however justifies our claim that firms are more concerned with how product innovations perform in the face of informal competition rather than on the decision to introduce innovations.

To understand the main transmission mechanisms through which 'local' informal competition affect the performance of product innovations, we interacted our informal competition indicator with log of total sales lagged. Our results show growth in total sales tend to have positive effect on the performance of product innovations with increases in informal competition. This may be due to the growing strategic collaboration between large formal firms and informal enterprises with informal enterprises working to boost sales of new innovative products introduced by collaborators in the formal economy particularly in the retail sector. As a result of this strategic

Table 4: Effect of informal competition on all product innovations

Estimation method	Limited-information maximum likelihood (LIML)			
	A		B	
	(1)	(2)	(1)	(2)
	% sales, product innovations		Introduce product innovations	
Local competition (IPMC)(%)	-0.189*** (0.055)	-0.587*** (0.126)	-0.001 (0.003)	-0.001 (0.003)
Log of sales lagged 3 (USD)	-0.913 (0.902)	-2.518** (0.997)	-0.022 (0.024)	-0.021 (0.024)
IPMC*Log of sales lagged 3		3.533*** (1.012)		
Tax	-2.712 (3.966)	-1.483 (3.779)	0.044 (0.174)	0.042 (0.174)
Corruption	-6.493*** (2.094)	-6.698*** (2.250)	-0.152 (0.102)	-0.151 (0.102)
Licensing	4.419** (1.862)	4.579** (1.881)	0.171* (0.100)	0.171* (0.100)
Crime	-1.923 (2.902)	-2.605 (2.971)	0.075 (0.103)	0.075 (0.103)
Log of labour cost per worker (USD)	-0.506 (0.910)	-0.673 (0.915)	0.022 (0.034)	0.022 (0.034)
Log of total employment lagged 3	0.435 (1.810)	0.208 (1.650)	0.118** (0.047)	0.118** (0.046)
Ownership	3.572 (3.352)	3.262 (3.436)	-0.087 (0.079)	-0.087 (0.078)
Log of experience	-4.330** (1.930)	-4.391** (1.792)	0.046 (0.115)	0.048 (0.115)
Support	8.171 (5.236)	8.912* (4.729)	0.039 (0.334)	0.042 (0.331)
Log of age	14.951 (9.329)	15.444* (8.669)	0.650** (0.305)	0.648** (0.304)
Log of age square	-2.789* (1.681)	-2.989* (1.527)	-0.114* (0.067)	-0.114* (0.066)
Marketing	6.495* (3.404)	5.023 (3.384)	0.546*** (0.104)	0.534*** (0.105)
R&D			0.554*** (0.079)	0.559*** (0.080)
Country fixed effect	Yes	Yes	Yes	Yes
sig_1	20.703*** (1.088)	20.366*** (1.079)		
rho_12	-0.377*** (0.123)	-0.357*** (0.108)		
N	969	969		
Wald chi ²	1150.92	1154.14		
Prob χ^2	0.000	0.000		

Notes: Robust standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Used *cmp* Stata package for LIML estimation. All standard errors are adjusted for 22 clusters in Region.

All regressions include size, year, size of locality, sector and 23 industry dummies.

interactions, the introduction of new vertically differentiated products perform better in sales even with increased informal competition holding all other variables constant. As noted by Blundell et al. (1999), some firms introduce and sell more of innovative products because they have 'marketing advantages' as compared with other firms. We verified this assertion by introducing a marketing dummy that captures whether a firm used services of marketing firm or consumer research firm or an advertising firm. Our results show firms that employed marketing services actually perform better with sales of innovative products (only in panel A1) and are more likely to introduce product innovations.

4.2 Extensions to sector, size and ownership

We extend our analysis to examine the effect of 'local' informal competition between: manufacturing versus service sector firms; domestically owned firms and; small versus medium-sized firms. The empirical results are reported in Tables 5, 6 and 7.

The standardised results showing the effect of informal competition on the percentage sales due to all product innovations of manufacturing and service sector firms are presented in Table 5. Results show that informal competition in product markets affect negatively the performance of product innovations introduced by formal firms both in the manufacturing and service sectors. One explanation for this result may be that majority of formal enterprises in both sectors operate at low levels of technology. As a result, informal firms are capable of imitating new products introduced onto the product market resulting in higher competition and hence weak performance of new products. We however found the negative effect of 'local' informal competition to be greater on service and retail sector firms as compared to manufacturing sector firms. An explanation for the differences in the effect on manufacturing and service firms may be due to the differences in the level of technologies used. The service sector generally employs low levels of technology and requires less know-how and hence easy to imitate. Manufacturing sector however requires a higher level of technology and technical know-how and as a result may be experiencing lower levels of imitations coupled with higher levels of collaboration with the informal economy. This may be leading to the better performance of product innovation from the manufacturing sector as compared with the service and retail sectors. These results are robust across all specifications.

Our results also show manufacturing firms that experienced higher percentage sales from three fiscal years ago and do not perceive corruption as an obstacle tend to sell more of all newly introduced product innovations with increases in the intensity of informal competition holding other factors constant than otherwise. This result means that market size is relevant for the performance of product innovations. The results also show manufacturing firms that perceive and identify corruption as a major obstacle to their business tend to sell less of all newly introduced product innovations with increases in the intensity of informal competition even with gains in market share holding other factors constant. We find similar indirect mechanisms

of sales for service sector firms as well. However, we find the indirect sales mechanism to be much effective in the service sector than in the manufacturing sector. That is, service sector firms that experienced higher percentage sales from three fiscal years ago tend to sell more of all newly introduced product innovations with increases in the intensity of informal competition holding other factors constant than compared with manufacturing firms.⁸ In other words, service sector firms with larger market power tend to perform better with new product innovations with increases in informal competition as compared to manufacturing firms. This may also be due to the differences in non-competitive interactions with the informal economy. We find the indirect growth in sales mechanism to be most active in service sector as compared to manufacturing firms in the face of informal competition.

Table 6 presents the regression results showing the effect of informal competition on domestic owned firms. Results reveal negative effect of informal competition on the performance of all product innovations introduced by firms owned locally. We failed to find any indirect mechanisms.

Regression results from our size of firm analysis are presented in Table 7 with panels A and B showing the basic and extended results for small-sized and medium-sized firms respectively. We find statistically negative effect of informal competition on both small and medium-sized firms. We also find similar indirect mechanisms where medium-sized firms that experienced higher percentage sales from three fiscal years ago tend to sell more of all product innovation with increases in the intensity of informal competition holding other factors constant than otherwise. We however failed to find any evidence of similar indirect mechanisms for small-sized firms.

⁸ See Table 5 for results on the sectoral analysis.

Table 5: Sectoral analysis of the effect of informal competition on % sales, all product innovations

Estimation method	Limited-information maximum likelihood (LIML)				
	Manufacturing			Services and retail	
	(1)	(2)	(3)	(4)	(5)
Percentage sales due to all product innovations					
Local informal competition (%)	-0.181*** (0.049)	-0.107 (0.069)	-0.382** (0.149)	-0.274*** (0.084)	-0.885*** (0.163)
Log of sales lagged 3 (USD)		-1.347* (0.811)	-2.661** (1.220)	-0.530 (1.135)	-2.623** (1.246)
Tax		-5.561 (6.617)	-4.769 (6.733)	1.378 (6.217)	1.933 (5.126)
Corruption		-5.820** (2.901)	-5.519* (3.017)	-5.437** (2.535)	-6.027** (2.939)
Licensing		2.934 (2.040)	2.843 (1.990)	6.994 (5.124)	7.673 (5.035)
Crime		2.238 (3.419)	1.364 (3.455)	-9.408*** (3.469)	-9.840*** (3.350)
IPMC* Corruption			-12.47** (6.043)		1.339 (8.510)
IPMC*Log of sales lagged (USD)			2.586* (1.328)		5.468*** (1.432)
Log of labour cost per worker		0.712 (1.062)	0.820 (1.078)	-1.785 (1.216)	-2.481** (1.015)
Log of total employment lagged		3.280 (2.490)	3.415 (2.419)	-2.112 (2.132)	-3.013 (1.855)
Ownership		3.143 (4.282)	3.212 (4.273)	3.146 (5.442)	2.221 (5.242)
Log of Experience		-5.475 (4.716)	-5.239 (4.654)	-4.481 (3.147)	-4.843 (3.111)
Support		-1.802 (7.673)	-1.795 (6.716)	13.098 (8.353)	13.902* (7.121)
Log of Age		34.05*** (12.88)	35.42*** (11.75)	19.11* (10.91)	18.46* (10.64)
Log of Age Squared		-5.725*** (2.187)	-6.151*** (2.076)	-4.271** (1.884)	-4.174** (1.783)
Country fixed effect	No	Yes	Yes	Yes	Yes
N	833	629	629	621	621
Wald chi ²	1733.49	2428.55	72276.12	1145.92	1141.14
Prob χ^2	0.000	0.000	0.000	0.000	0.000

Notes: Robust standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Used *cmp* Stata package for LIML estimation. All standard errors are adjusted for 22 clusters in Region.

All standard errors are robust to heteroskedasticity.

All regressions include size, year, sector, locality and 23 industry dummies.

Table 6: Effect of informal competition on % sales, all product innovations: Domestic

Estimation method	Limited-information maximum likelihood (LIML)		
	(1)	(2)	(3)
	Percentage sales due to all product innovations		
Local informal competition (%)	-0.212*** (0.067)	-0.196*** (0.055)	-0.426*** (0.149)
Log of sales lagged 3 (USD)		-1.553* (0.825)	-2.421** (0.953)
Tax		1.693 (4.910)	1.952 (4.685)
Corruption		-6.129*** (1.897)	-6.367*** (1.947)
Licensing		4.226** (1.832)	4.091** (1.831)
Crime		-1.447 (2.899)	-1.831 (2.912)
Size of locality (250,000-1m)		-6.083** (2.688)	-4.767 (2.951)
Size of locality (50,000-250,000)		3.941 (6.469)	5.337 (6.577)
Size of locality (less than 50,000)		-9.406*** (3.309)	-9.549*** (3.427)
IPMC*Log of sales lagged 3 (USD)			0.019 (0.013)
Log of labour cost per worker		0.187 (0.930)	0.115 (0.942)
Log of total employment lagged		1.973 (1.666)	1.827 (1.655)
Log of Experience		-4.352 (3.710)	-4.445 (3.603)
Support		8.740 (6.089)	9.145 (5.780)
Log of Age		23.992** (11.490)	23.643** (11.380)
Log of Age Squared		-4.551** (2.093)	-4.553** (2.062)
Country fixed effect	No	Yes	Yes
N	1351	1032	1032
Wald chi ²	393.41	1934.54	1933.47
Prob χ^2	0.000	0.000	0.000

Notes: Robust standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Used *cmp* Stata package for LIML estimation. All standard errors are adjusted for 22 clusters in Region.

All standard errors are robust to heteroskedasticity.

All regressions include size, year, sector and 23 industry dummies.

Table 7: Effect of informal competition on % sales, all product innovations: Small vs. medium.

Estimation method	Limited-information maximum likelihood (LIML)				
	A-Small		B-Medium		
	(1)	(2)	(3)	(4)	(5)
Percentage sales due to all product innovations					
Local informal competition (%)	-0.171*** (0.065)	-0.201*** (0.071)	-0.246** (0.108)	-0.220* (0.127)	-1.213*** (0.222)
Log of sales lagged 3 (USD)		-0.834 (1.286)		-1.528 (1.260)	-5.085*** (1.115)
Tax		-7.440 (7.064)		3.858 (11.048)	6.907 (8.868)
Corruption		-7.105** (3.343)		-2.989 (4.303)	-1.784 (3.753)
Licensing		4.624 (3.251)		8.015 (5.577)	11.037** (5.198)
Crime		-2.425 (3.690)		1.652 (4.327)	-2.368 (4.635)
IPMC*Log of sales lagged (USD)					2.602*** (1.759)
Log of labour cost per worker		-0.601 (1.526)		-1.239 (1.882)	-1.646 (1.601)
Log of total employment lagged		-1.617 (1.761)		1.383 (2.971)	0.074 (2.731)
Ownership		7.532 (4.965)		-3.518 (3.918)	-1.554 (4.708)
Log of Experience		-4.421 (4.082)		-9.621** (4.158)	-8.394** (4.054)
Support		14.440** (6.442)		-3.675 (13.167)	5.244 (9.672)
Log of Age		18.520* (10.975)		30.740 (22.554)	33.585* (20.134)
Log of Age Squared		-3.245 (2.079)		-5.242 (3.887)	-5.985* (3.297)
Country fixed effect	No	Yes	No	Yes	Yes
N	1084	829	446	333	333
Wald chi ²	484.17	1536.97	178.16	651.49	644.28
Prob χ^2	0.000	0.000	0.000	0.000	0.000

Notes: Robust standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Used *cmp* Stata package for LIML estimation. All standard errors are adjusted for 22 clusters in Region.

All standard errors are robust to heteroskedasticity.

All regressions include size, locality, year, sector and 23 industry dummies.

Firm size classifications are: Small ≥ 5 ; ≤ 19 , Medium ≥ 20 and ≤ 99 and Large ≥ 100 .

4.3 Extensions to industry-level informal competition

In extending the analysis to the industry-level⁹, we followed the two-step econometric procedure presented above in equations (1.1) and (2.1) to construct industry-level informal competition indicator. The industry-level indicator is normalised between 0 and 1 with industries in a country having the least informal competition intensity assigned the value 0 while the industry with the highest informal competition intensity assigned the value 1. This enables us to capture the variations in the industry-level informal competition across different industries in the same country as well variations in similar industries across different countries.¹⁰

Table 8 presents the estimation results showing the effect of both our 'local' and industry-level informal competition indicators on the performance of product innovations. The sectoral analysis of the effect of 'local' and industry-level informal competition indicators are shown in Table 9. The results from both tables remain similar to the results obtained above with 'local' informal competition having significantly negative effect on the performance of product innovations in both manufacturing and service and retail firms. The results however indicate a significantly positive effect of industry-level informal competition across all specifications. This implies that industries with higher concentration of informal enterprises tend to perform better in product markets with new product innovations. Sectoral analysis shown in Table 9 also indicates manufacturing firms tend to perform better on product markets with increases in industry-level informal competition than service and retail sector firms. This result may also be explained by the differences in the technology gap and technical know-how between the manufacturing sector and informal manufacturing enterprises on one hand and between service and retail firms and informal service enterprises on the other hand. The service sector is relatively less capital intensive and requires less technical know-how compared with the manufacturing sector. As a result, informal enterprises are more likely to easily imitate and compete with new innovative services in an industry. The negative effect of industry-level competition is found in other empirical papers including Blundell, Griffith and Van Reenen (1999), Aghion et al., (2001), Boldrin and Levine (2008).

4.4 Robustness

To further test the robustness of our results to alternative empirical specifications, we followed Friesen and Wacker (2013) by employing our 'local' informal competition indicator as an instrument for informal competition. We also estimated this model on three variants of sales from product innovations namely: percentage sales due to all product innovations, total sales due to all product innovations in dollars and log of total sales due to all product innovations in dollars. The results of all variant specifications as reported in Appendix 5 are consistent across all specifications with our earlier results with informal competition significantly affecting

⁹ See Table 3 in appendix for list of industries and industry classifications.

¹⁰ See Table 4 in appendix for description of our industry-level informal competition indicator in percentages.

Table 8: Effect of 'local' and industry-level informal competition on all product innovations

Estimation method	Limited-information maximum likelihood (LIML)			
	A		B	
	(1)	(2)	(1)	(2)
	% sales, all product innovations		Introduce product innovation	
Local competition (%)	-0.193*** (0.062)	-0.525*** (0.139)	-0.001 (0.003)	-0.001 (0.003)
Industry competition (%)	0.294*** (0.073)	0.308*** (0.068)	0.004 (0.005)	0.004 (0.005)
Log of sales lagged 3 (USD)	-1.123 (0.816)	-2.488** (1.038)	-0.019 (0.024)	-0.019 (0.024)
IPMC*Log of sales lagged 3 (USD)		0.028** (0.011)		
Tax	-2.459 (4.026)	-1.324 (3.795)	0.033 (0.183)	0.032 (0.182)
Corruption	-5.302*** (1.903)	-5.510*** (2.024)	-0.169 (0.103)	-0.169 (0.103)
Licensing	4.618*** (1.744)	4.880*** (1.691)	0.186* (0.104)	0.186* (0.105)
Crime	-3.373 (3.169)	-3.751 (3.366)	0.082 (0.085)	0.083 (0.085)
Log of labour cost per worker (USD)	-0.569 (0.906)	-0.737 (0.878)	0.012 (0.033)	0.011 (0.033)
Log of total employment lagged 3	0.280 (1.842)	0.015 (1.696)	0.093** (0.041)	0.093** (0.041)
Ownership	3.188 (3.419)	3.091 (3.380)	-0.121 (0.080)	-0.121 (0.079)
Log of experience	-4.095** (1.869)	-4.010** (1.763)	0.023 (0.109)	0.023 (0.109)
Support	7.448 (4.797)	7.962* (4.369)	0.002 (0.295)	0.004 (0.294)
Marketing			0.522*** (0.100)	0.515*** (0.101)
R&D			0.567*** (0.077)	0.570*** (0.077)
Country fixed effect	Yes	Yes	Yes	Yes
sig_1	21.408*** (0.983)	21.143*** (0.993)		
rho_12	-0.351*** (0.095)	-0.332*** (0.093)		
N	966	966		
Wald chi ²	2259.80	2256.76		
Prob χ^2	0.000	0.000		

Notes: Robust standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Used *cmp* Stata package for LIML estimation. All standard errors are adjusted for 22 clusters in Region.

All regressions include size, year, sector, size of locality, log of age and log of age squared.

Table 9: Sectoral analysis of local and industry-level competition on % sales, all product innovations

Estimation method	Limited-information maximum likelihood (LIML)			
	Manufacturing		Services and retail	
	(1)	(2)	(3)	(4)
Percentage sales due to all product innovations				
Local competition (%)	-0.112 (0.085)	-0.302* (0.169)	-0.276*** (0.086)	-0.934*** (0.152)
Industry competition (%)	0.355*** (0.115)	0.363*** (0.110)	0.275* (0.153)	0.256* (0.141)
Log of sales lagged 3 (USD)	-1.747** (0.790)	-2.674** (1.173)	-0.454 (1.117)	-2.714** (1.196)
IPMC*Log of sales lagged 3 (USD)		0.016 (0.014)		0.057*** (0.014)
Tax	-5.648 (6.159)	-5.033 (6.252)	1.304 (5.662)	1.801 (4.662)
Corruption	-4.815** (2.384)	-4.600* (2.380)	-5.929** (2.895)	-6.346* (3.280)
Licensing	3.446 (3.049)	3.537 (2.958)	7.198 (4.973)	8.140* (4.911)
Crime	-0.021 (4.321)	-0.472 (4.416)	-9.38*** (3.420)	-9.826*** (3.319)
Log of labour cost per worker	0.541 (1.123)	0.622 (1.084)	-1.625 (1.177)	-2.415** (1.020)
Log of total employment lagged	2.456 (2.577)	2.573 (2.553)	-1.941 (1.894)	-3.018* (1.587)
Ownership	2.165 (3.974)	2.271 (3.867)	3.889 (6.095)	2.403 (5.634)
Log of Experience	-4.241 (3.841)	-3.873 (3.867)	-3.600 (2.880)	-4.264 (2.606)
Support	-1.929 (7.918)	-1.820 (7.391)	12.087 (8.033)	12.597* (6.607)
Log of Age	34.263*** (12.694)	34.314*** (12.400)	16.903 (11.165)	15.423 (11.032)
Log of Age Squared	-6.156*** (2.223)	-6.243*** (2.172)	-3.924** (1.974)	-3.647* (1.885)
Country fixed effect	Yes	Yes	Yes	Yes
N	505	505	621	621
Wald chi ²	1188.23	1187.74	1148.99	1143.31
Prob χ^2	0.000	0.000	0.000	0.000

Notes: Robust standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Used *cmp* Stata package for LIML estimation. All standard errors are adjusted for 22 clusters in Region.

All standard errors are robust to heteroskedasticity.

All regressions include size, year, sector and size of locality.

performance of product innovation negatively. That is, an increase in informal competition reduces the market performance of product innovations.¹¹

5 Conclusion

Firm-level evidence reveal the competitive behaviour of informal enterprises as unhealthy and one of the top three obstacles formal businesses face in sub-Saharan Africa. The competitive interaction between formal and informal businesses however continue to grow with increasing recognition of the 'permanent feature' of the informal economy particularly in sub-Saharan Africa (SSA). With limited empirical evidence assessing the economic implications of informal competitive behaviour on formal firms' performance, this paper fills the gap and contributes to the scant literature by examining the effect of informal product market competition on sales from all innovative products introduced by formal firms in SSA.

The World Bank's Innovation Follow-Up Survey was merged with the Enterprise Survey (ES) for 5 SSA countries. Employing two econometric approaches that localise informal competition in the product market at the first-level of estimation and controls for self-selection and sample selection biases at the second level of estimation, we have shown that 'local' informal competition matters for the performance of product innovations. That is, informality of the market tends to be detrimental to the performance of product innovations. We however found through interactions that product innovations introduced by firms with larger market share tend to perform better with informality of the product market. That is, the main mechanism of increasing sales from product innovations is through the growth in market size. We argued that this indirect mechanism is driven mainly through the level of non-competitive interactions (collaborations and outsourcing of economic activities) between formal and informal businesses. The collaboration and outsourcing of economic activities we argued, enable registered firms to take strategic advantage of the 'local' market acceptance of informal enterprises to expand market size and perform better with product innovations. As a result, formal firms with less or without any competitive interaction face intensive competition from informal enterprises and hence lower sales of product innovations. In other words, formal firms with strategic footholds in the informal economy thrive with new products.

Our findings provide useful evidence that point to informal enterprises as critical actors in the National System of Innovation (NIS) in sub-Saharan Africa. We recommend further research and policy debate on the role of informal enterprises in innovation systems.

¹¹ We also tested the stability of our results by introducing industry-level informal competition indicator as a second instrument for informal competition. We however found similar results.

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Appendix 1

Definition of variables

Product innovation: A binary variable taking the value of 1 if the firm has introduced product innovation over the last 3 fiscal years and 0 if otherwise.

Percentage sales from all product innovations: A continuous variable indicating the percentage of total sales represented by sales from all innovative products or services. It assumes strict value between 0-100. Zero implies the firm has not introduced product innovation.

Informal competition: Binary classification that takes the value 1 if the firm considers the competitive practices of the informal sector as a major and a very severe obstacle and the value 0 otherwise.

Region: A categorical variable showing the twenty-two (22) country sampling regions.

Local informal competition indicator (IPMC): A continuous variable that indicates the local informal product market competition across regions of a country. It ranges between zero (0) and one (1) where values close to 1 indicate intense informal competition and values close to 0 indicating less informal competition in the vicinity.

Log of experience: The logarithm of the number of working years of the top manager.

Ownership: A dummy variable that takes value 1 if the firm is foreign owned and 0 if the firm is owned domestically.

Log of total employment (-3): The logarithm of total number of employees at end of 3 fiscal years ago.

Log of sales lagged (-3): The logarithm of total sales of output in last three (3) fiscal year converted to United States Dollars using exchange rate in corresponding fiscal year.

Log of labour cost per worker (USD): The logarithm of labour cost per worker in United States Dollars constructed as total cost of labour/total permanent employees+0.5(temporary employees) converted using exchange rate in last fiscal year.

Corruption: A dummy variable that assumes value 1 if the firm identifies corruption as a major constraint and 0 otherwise.

Tax: A dummy variable that assumes value 1 if the firm identifies tax rates as a major constraint and 0 otherwise.

Licensing: A dummy variable that assumes value 1 if the firm identifies the time to it takes to license as a major constraint and 0 otherwise.

Crime: A dummy variable that assumes value 1 if the firm identifies crime, theft and disorder as a major constraint and 0 otherwise.

Finance: A dummy variable that assumes value 1 if the firm identifies access/cost of finance as a major obstacle and 0 otherwise.

Labour regulations: A dummy variable that assumes value 1 if the firm identifies labour regulations as a major obstacle and 0 otherwise.

Locality: A categorical variable measuring the size of the locality with 0 if ($< 50,000$), 1 if ($\geq 50,000$ and $\leq 250,000$), 2 if ($\geq 250,000$ and ≤ 1 million) and 3 if large (1 million and over).

Marketing: A dummy variable that assumes value 1 if the firm used services of a marketing firm/ consumer research firm/ advertising firm and 0 otherwise.

Capital city: A dummy variable that assumes value 1 if the firm is located in the capital city and 0 otherwise.

Age: The number of years the firm has being operating.

Age square: The square of the number of years the firm has being operating.

Industry: Sectors according to the group classification of ISIC Revision 3.1: group D, construction sector (group F), services sector (groups G and H), and transport, storage communications sector (group I) and IT (group K sub-sector 72).

Sector: A categorical variable that takes value 0 if the firm is engaged in manufacturing, 1 if firm is engaged in retail and 2 if firm is engaged in services.

Size of firm: A categorical variable that takes value 0 if the firm is micro (< 5), 1 if the firm small (≥ 5 and ≤ 19), 2 if the firm is medium (≥ 20 and ≤ 99) and 3 if large (100 and over).

Support: A dummy variable that takes value 1 if the firm receives government support and 0 if otherwise.

Year: Year of data collection.

Appendix 2

Table 10: Probit estimation of informal competition as a major constraint

	Informal competition as a major constraint
Ownership	-0.054** (0.023)
Finance	0.113*** (0.028)
Tax	0.055 (0.059)
Corruption	0.040 (0.029)
Licensing	0.081 (0.049)
Crime	0.114** (0.046)
Labour regulations	-0.115 (0.082)
Capital city	-0.265*** (0.071)
Log of labour cost per worker	0.016 (0.011)
Log of sales lagged 1 (USD)	-0.023** (0.010)
Log of Age	0.041 (0.116)
Log of Age Squared	-0.006 (0.026)
Log of Experience	0.004 (0.024)
Size of locality dummy	Yes
Year dummy	Yes
Industry fixed effects	Yes
Region fixed effects	Yes
Country fixed effects	Yes
N	1225
Wald chi ²	711.08
Prob > chi ²	0.000
Pseudo R ²	0.1326

Notes: Robust standard errors in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01.
All standard errors are robust to heteroskedasticity.

Appendix 3

Table 11: Industry ISIC Rev. 3

Industry of the firm	Frequency
Food	216
Textiles	67
Garments	121
Leather	10
Wood	72
Paper	7
Publishing, printing, and Recorded medi	96
Chemicals	67
Plastics & rubber	46
Non-metallic mineral products	72
Basic metals	25
Fabricated metal products	160
Machinery and equipment	22
Electronics (31 & 32)	19
Transport machines (34&35)	8
Furniture	202
Construction Section F	60
Services of motor vehicles	110
Wholesale	148
Retail	488
Hotel and restaurants: section H	345
Transport Section I: (60-64)	71
IT	24
Total	2,456

Appendix 4

Table 12: Computed industry-level informal competition by country

	DRC	GH	UGA	TZ	ZAM
Industry of the firm					
Food	59.202	59.202	59.202	59.202	59.202
Textiles	62.750	62.750	62.750	62.528	62.971
Garments	51.885	52.328	51.885	52.550	51.441
Leather	98.226	100	-	94.457	96.674
Wood	55.654	55.654	55.432	55.876	55.432
Paper	54.324	54.545	-	54.767	53.880
Publishing, printing, and Recorded medi	20.399	24.834	17.960	22.616	14.856
Chemicals	31.486	33.925	30.155	33.259	28.160
Plastics & rubber	52.106	52.550	52.106	52.772	51.663
Nonmetallic mineral products	44.789	45.676	44.346	45.676	43.459
Basic metals	52.106	52.328	51.885	52.550	51.441
Fabricated metal products	31.264	33.703	30.155	33.038	27.938
Machinery and equipment	8.647	-	4.656	11.086	0
Electronics (31 & 32)	-	83.370	82.262	80.931	82.927
Transport machines (34&35)	-	32.594	28.381	31.486	26.164
Furniture	56.984	56.984	56.984	56.984	56.763
Construction Section F	21.729	25.942	19.734	23.947	16.630
Services of motor vehicles	31.929	34.368	30.820	33.703	28.825
Wholesale	49.224	49.667	49.002	49.889	48.337
Retail	40.577	41.907	40.133	41.907	38.803
Hotel and restaurants: section H	27.273	30.377	25.721	29.268	23.282
Transport Section I: (60-64)	41.020	42.350	40.577	42.350	39.246
IT	50.111	50.554	49.889	50.776	49.446

Appendix 5

Table 13: Effect of informal competition on sales from all product innovations

Estimation method	Limited-information maximum likelihood (LIML)				
	(1)	(2)	(3)	(4)	(5)
	% sales		Total sales		Log sales
Informal competition [£]	-27.579** (13.817)	-25.138* (15.171)	-354.330*** (136.070)	-340.218** (146.955)	-0.304*** (0.114)
Log of sales lagged 3 (USD)	-1.344* (0.747)	-0.974 (0.932)	9.788 (10.594)	13.094 (12.896)	0.036 (0.036)
Tax	-2.327 (4.022)	-2.703 (4.147)	-18.499 (51.943)	-21.374 (53.582)	-0.129 (0.195)
Corruption	-7.574*** (2.341)	-7.471*** (2.352)	-104.999*** (35.676)	-103.582*** (35.996)	0.014 (0.172)
Licensing	6.319*** (1.916)	6.161*** (1.810)	87.996*** (23.453)	86.921*** (22.066)	0.177* (0.094)
Crime	-3.104 (2.983)	-2.975 (2.990)	-71.489* (41.850)	-71.481* (41.249)	-0.211 (0.142)
Size of locality (250,000-1m)	-2.625 (3.022)	-4.617 (3.172)	-30.961 (31.189)	-50.379 (34.987)	-0.107 (0.076)
Size of locality (50,000-250,000)	-3.150 (4.780)	-5.112 (4.832)	-114.371 (87.244)	-133.270 (92.815)	-0.078 (0.262)
Size of locality (less than 50,000)	-10.048*** (2.879)	-10.691*** (2.836)	-133.986*** (33.891)	-139.681*** (35.965)	-0.323 (0.794)
IPMC*Log of sales lagged (USD)		-0.006 (0.005)		-0.055 (0.082)	-0.012 (0.014)
Log of labour cost per worker	-0.704 (0.828)	-0.537 (0.886)	0.213 (9.747)	1.418 (10.647)	0.020 (0.025)
Log of total employment lagged	1.903 (1.803)	1.946 (1.786)	26.434 (24.598)	26.765 (24.263)	0.001 (0.070)
Ownership	4.810 (5.140)	5.031 (5.231)	93.956 (59.654)	96.719 (59.231)	0.249* (0.143)
Log of Experience	-0.704 (2.251)	-0.537 (2.137)	-56.636** (23.467)	-55.180** (21.755)	-0.082 (0.088)
Support	8.574* (5.140)	8.936* (5.231)	104.484* (57.083)	108.185* (58.224)	0.225 (0.161)
Log of Age	17.674* (10.201)	17.336* (10.060)	295.346** (125.738)	290.726** (124.475)	0.480 (0.346)
Log of Age Squared	-3.051* (1.810)	-2.985* (1.796)	-54.460** (23.613)	-53.628** (23.570)	-0.094 (0.070)
Country fixed effect	Yes	Yes	Yes	Yes	Yes
N	2367	2367	2367	2367	2367
Wald chi ²	3928.81	3928.04	4912.84	4912.48	2654.14
Prob χ^2	0.000	0.000	0.000	0.000	0.000

Notes: Robust standard errors in parentheses, * p < 0.10, ** p < 0.05, *** p < 0.01.

Used *cmp* Stata package for LIML estimation. All standard errors are adjusted for 22 clusters in Region.

All standard errors are robust to heteroskedasticity.

All regressions include size, year, sector and 23 industry dummies.

[£] All estimations used 'local' competition indicator (%) as instrument for informal competition.