FIRM INNOVATION IN DEVELOPING COUNTRIES, EVIDENCE FROM GHANA

ANTHONY KOFI KRAKAH

Institute for
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Anthony Kofi Krakah

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Summary: English Version

Incremental innovation in developing countries is inimical to firm survival (Cefis & Marsili, 2005) and growth (Arrow, 1962), while the extant research on the drivers of innovation is tainted with overgeneralization of outcomes due to the paucity of firm-level data in developing countries (Zanello et al., 2016), others are subject of ambiguities. Following Mashall's (1890) proposition on the effect of knowledge spillovers, for instance, the ambiguities (Beaudry & Schiffauerova, 2009) in the literature on which agglomeration, Marshall (localization) or Jacobs (urbanization) is most effective suggest the need for additional contributions to the literature. Besides, we know little about the mechanisms and firm-level processes underlying these differences. Thus, the thesis contributes to the innovation determinants literature, examining the role of the market, location, and capabilities. We test our hypothesis using the microdata of 5,400 manufacturing firms alongside the population of 638,000 firms in Ghana.

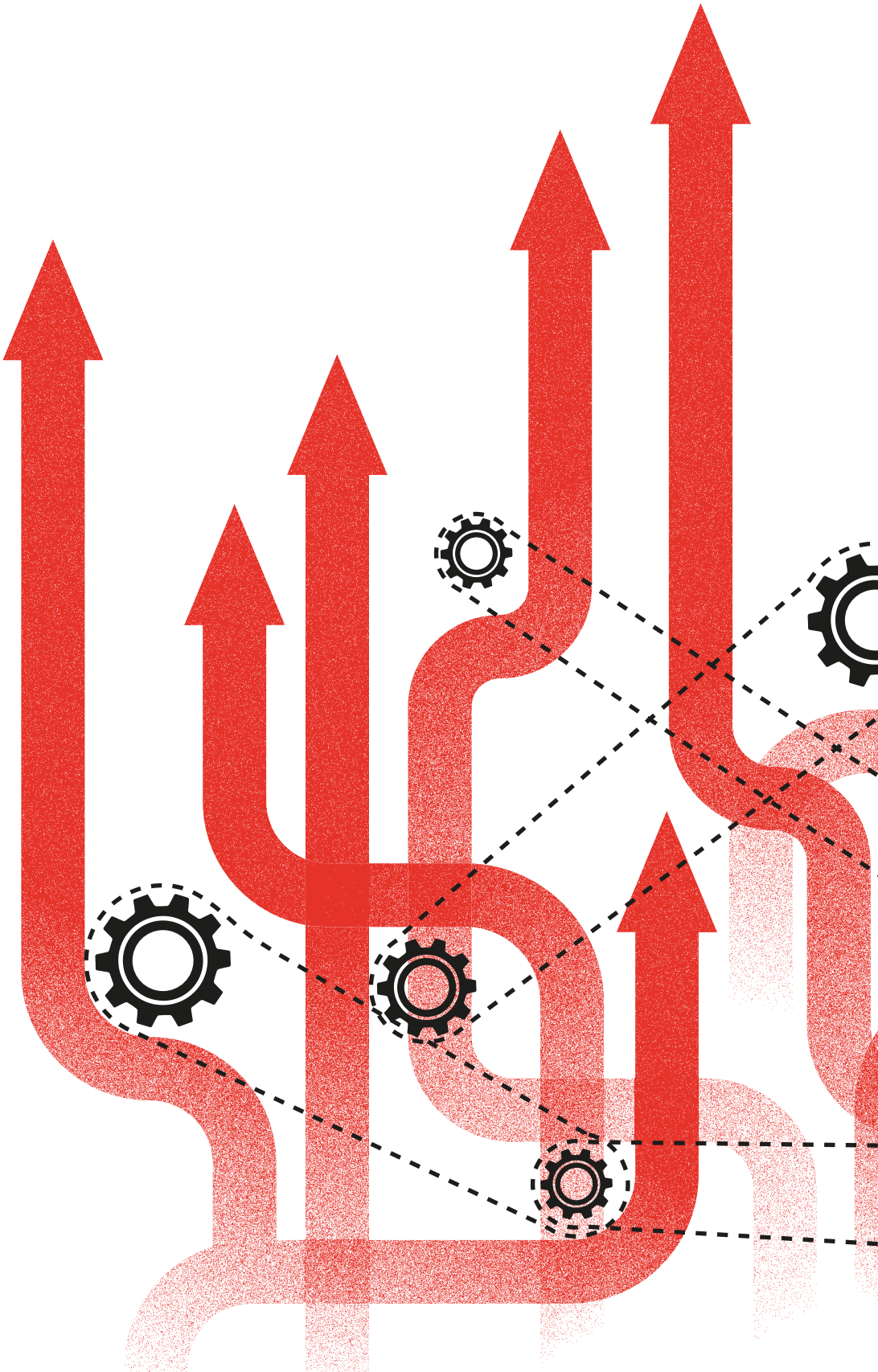
We postulate that sales by domestic firms to Multinational Companies as an indirect internationalization mode facilitate process innovation significantly but not product innovation. Export as a direct internationalization mode has a null effect on these innovation dimensions. Contributing to settling the ambiguity on the most effective agglomeration, we posit that when firms colocate within 25 to 60 kilometers in developing countries, externalities in an urbanization agglomeration significantly drive innovation, but localization externalities have adverse effects. Since firms are not affected equally (Knoben et al., 2016; Shaver & Flyer, 2000), apriori, we argue that openness, market, and absorptive capabilities will leverage the externalities by moderating their effectiveness on innovation, informing who are the externality beneficiaries. Astonishingly, our data does not support our hypotheses that these capabilities moderate the effects of externalities on innovation. Although, firm-size, resource constraints, and institutional weakness that culminate in firm mistrust and the unattractiveness of firms as knowledge partners are likely factors for the astonishing outcomes, further investigation into the barriers to the moderating prowess of the capabilities will provide in-depth insight.

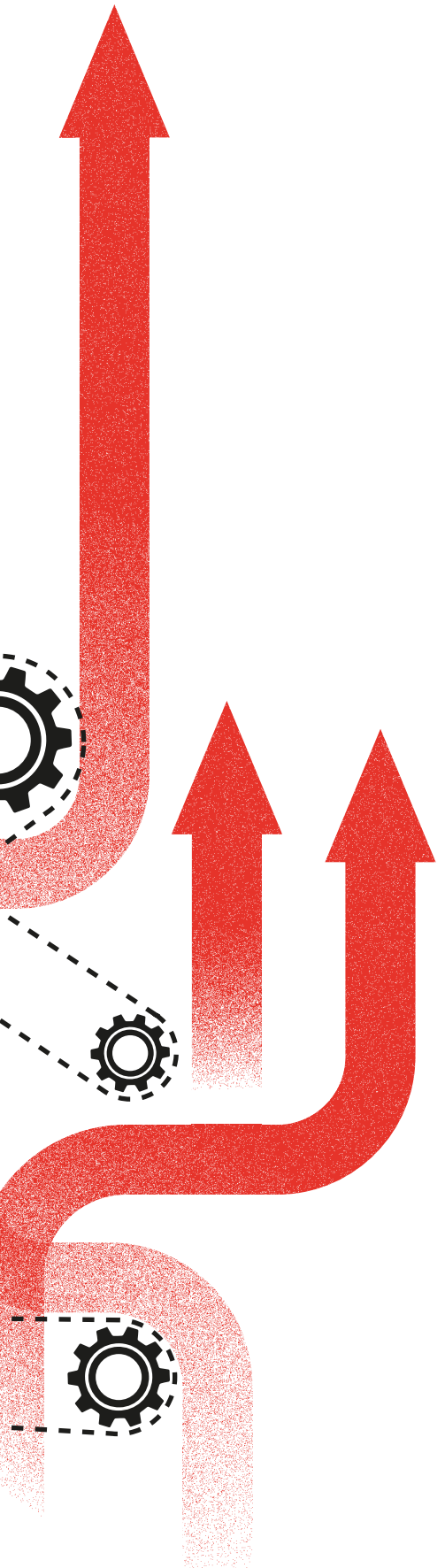
Summary: Dutch Version

Incrementele innovatie in ontwikkelingslanden is noodzakelijk voor het voortbestaan (Cefis & Marsili, 2005) en groei van bedrijven (Arrow, 1962). Het bestaande onderzoek naar de drijfveren van innovatie kenmerkt zich door een gebrek aan gegevens op bedrijfsniveau in ontwikkelingslanden en is daardoor beperkt generaliseerbaar (Zanello et al., 2016). Daarnaast bestaat er binnen het bestaande onderzoek al grote ambiguïteit over het effect van kennis-externaliteiten (Marshall, 1890) op innovatie. Zo laten Beaudry & Schiffauerova (2009) zien dat er grote onenigheid bestaat over de vraag welk type agglomeratie, Marshall (lokalisatie) of Jacobs (verstedelijking), het meest effectief is voor het stimuleren van innovatie. Specifiek weten we weinig over de mechanismen en processen op het niveau van het bedrijf die aan deze verschillen ten grondslag liggen.

Het onderzoek in dit proefschrift draagt bij aan de literatuur over de determinanten van innovatie, waarbij de rol van de markt, locatie en bedrijfscapaciteiten worden onderzocht. We maken hierbij gebruik van microdata van 5.400 bedrijven uit Ghana. We vinden, onder andere, dat verkopen door binnenlandse bedrijven aan multinationale bedrijven als een indirecte internationaliseringsvorm procesinnovatie aanzienlijk bevorderen, maar geen effect hebben op productinnovatie. Export als directe internationaliseringsvorm heeft echter geen effect op deze vormen van innovatie.

Met betrekking tot kennis-externaliteiten vinden we dat verstedelijking binnen een straal van 25 tot 60 innovatie significant stimuleert, maar dat lokaliserings-effecten juist nadelige effecten hebben. Aangezien bedrijven niet gelijk worden beïnvloed (Knoben et al., 2016; Shaver & Flyer, 2000), hadden we op basis van eerder onderzoek verwacht dat openheid, markt-, en absorptievermogen van bedrijven de mate waarin ze profiteren van kennis-externaliteiten zouden versterken. Verbazingwekkend genoeg ondersteunen onze gegevens deze verwachtingen niet. Mogelijk zijn verschillen in bedrijfsgrootte, resourcebeperkingen en instituties een verklaring voor deze verrassende resultaten. Verder onderzoek naar de vraag wat voor bedrijven wel of niet profiteren van kennis-externaliteiten in de context van zich ontwikkelende landen is noodzakelijk om hier uitsluitsel over te geven.





Background

CHAPTER 1

Innovation is a multilevel phenomenon (Srholec, 2011) in which firms explore internal and external resources, particularly locational, industrial, and market resources, to produce new or improved products or processes (OECD, 2005) for economic growth (Schumpeter, 1934; Solow, 1956). Understanding the effects of these forces on firm innovation within the context of internationalization, agglomeration, and capabilities provides a holistic view of the determinants of innovation, particularly from the developing-country perspective. We predominantly explore comprehensive and rich self-reported innovation data from over 5,400 manufacturing firms, with a survey design reflecting the industrial structure and firmographics that permits empirical insights into how internationalization, agglomeration, and capabilities shape firm innovation in developing countries. The thesis contributes to the literature on innovation determinants from the perspective of the market, business density, and firm capabilities while providing policy to guide firms and state actors to foster firm innovation performance.

Section 1.1 What Prevails in Developing Countries?

Relative to developed countries, firms' innovation in developing countries has been incremental (Duranton, 2015), typically at the firm level, leaving radical and original innovation as a developed country phenomenon since it is costly, risky, and path-dependent (Zanello et al., 2016). In remote cases, the incidence of radical innovation in developing countries has foreign sources such as globalization, Foreign Direct Investment (FDI), migration, and licensing (Fagerberg et al. 2010) as the key channels. Despite the abundance of these channels, weak educational systems, political instability, fragile legal systems protecting property rights, scarce financial resources, poor physical infrastructure, and cultural and linguistic distances limit the diffusion of innovations (Zanello et al., 2016), even if firms are open to allow these channels to transmit knowledge. Particularly, weak, inefficient, and rigidities in their institutional and regulatory frameworks are a bane to R&D investment that discourages further investment in R&D, depriving developing countries of new technologies and leaving them predominantly as imitators (Lorenczik & Newiak, 2012).

Consequently, in the face of globalization and competition, firm survival and growth (Cefis & Marsili, 2005) are affected, leaving most firms in developing countries as young firms, with most dying before their sixth birthday (McKenzie and Paffhausen, 2019). Apart from contributing to rendering domestic firms in

developing countries as Micro, Small, and Medium-sized (SMEs), it potentially contributes to leaving them as lower-technology firms, with foreigners owning the few high-technology firms, sometimes under the Multinational Companies (MNCs) arrangements.

Due to size and resource constraints (Edeh & Acedo, 2021; Bartels et al., 2014), significant informal sector (Charmes et al., 2016), and low state involvement in the development of R&D (Mani, 2004), firms in developing countries have significantly fewer networks with academic institutions in the vertical innovation networks (Ecuru et al., 2014; Bartels et al., 2012 & 2014), leaving customer feedback as the vital source of innovation knowledge. Then, in the horizontal networks, informal relationships between workers of competing firms (Bartels et al., 2012) and re-engineering or imitation (Zanello et al., 2016; Lorenczik & Newiak, 2012) provide some valuable sources of innovation. While many industrial nations deliberately developed industrial parks to guide industrial growth and development, typically, apart from encouraging firms to locate in free zone enclaves to export, the evidence (Todes, 2008) suggests minimum strategic efforts in spatial planning to create industrial parks for industrialization.

In the global market, the low capacity of firms in developing countries (Aryeetay et al., 2000; Wunsch-Vincent & Kraemer-Mbula, 2016) renders them mostly uncompetitive since they cannot produce the standards required to export directly, so some resort to trading with MNCs (Gorodnichenko et al., 2010; Javorcik, 2004), while others export traditional unprocessed products as inputs, typically, for low returns. The absorptive capability, a function of infrastructure, globalization, and human capital (Castellacci & Natera, 2013), which are deficient in developing countries, potentially contributes to the ineffectiveness of knowledge transfer and competition in enhancing innovation, with a likelihood of perpetuating a vicious cycle. Consequentially, many firms in developing countries cannot produce with the required standards for the global market, leading to low levels of internationalization and little innovation novelty at the firm, even with the numerous international trade protocols that seek to curtail deliberate trade barriers.

Section 1.2 Why this Study?

Epitomizing Sub-Saharan African and developing countries, Ghana's economy, over the last 4-decades, witnessed aggressive structural and liberalized trade reforms to boost industry sector-led growth but did not yield the expected outcome (Aryeetay et al., 2000). Within the period, the relative contribution of the manufacturing sub-sector to GDP has been dwindling, even though the number of small and micro-sized firms quadrupled (GSS, 2015). Rather than boosting industry-led growth, many large manufacturing firms died, partly due to low capacity and capability (Aryeetay et al., 2000), within a competitive global market, questioning the firm's innovativeness since innovation is crucial for firm survival (Cefis and Marsili, 2005) and a critical catalyst for growth (Schumpeter, 1934; Solow, 1956).

Before the 1990s, innovation studies depended on patenting and R&D expenditures, limiting the scope (Palangkaraya et al., 2016). Subsequently, extant literature relies on self-reported firm-level data. However, both approaches predominantly dwell on data from developed countries due to the paucity of comprehensive firm innovation data in developing countries, indicating a gap in the completeness of the innovation literature. Concerning the determinants of innovation from the perspectives of location and capabilities, for instance, studies show that agglomeration effects seem to have different effects in the developing (Knoben et al., 2023; Sanfilippo & Seric, 2016; Howard et al., 2014) vis-a-vis developed (Speldekamp et al., 2020; Knoben et al., 2016; Arikan & Knoben, 2014) countries, with little about the mechanisms and firm-level processes underlying these differences. Similarly, from the market perspective, extant literature argues differently for the role of internationalization in the developed (Zimmermann, 1987 & Bertschek, 1995) and the developing (Barasa et al., 2017; Javorcik, 2004) countries.

The distinct variations between developed and developing countries require in-depth studies of firm innovation in both economies to critically unravel the drivers of innovation in completeness to accomplish comprehensiveness of the innovation literature and the corresponding enhancement of effective policies in their entirety for firm survival and growth across all economies. Otherwise, the innovation literature remains inundated with overgeneralized policy inferences and ineffective consequences. Even more worrying are the studies focusing only on a segment of the industries, such as high-technology or medium to large firms in developed countries, with unrelated characterization in developing

countries since most firms in these economies are low-technology, informal, micro, and small-sized.

Consequently, we contribute to the literature on innovation drivers from the perspective of market, location, and capabilities, focusing on developing countries to minimize the gap in the comprehensiveness of the literature to facilitate innovation performance and related policy effectiveness, firm survival, and growth.

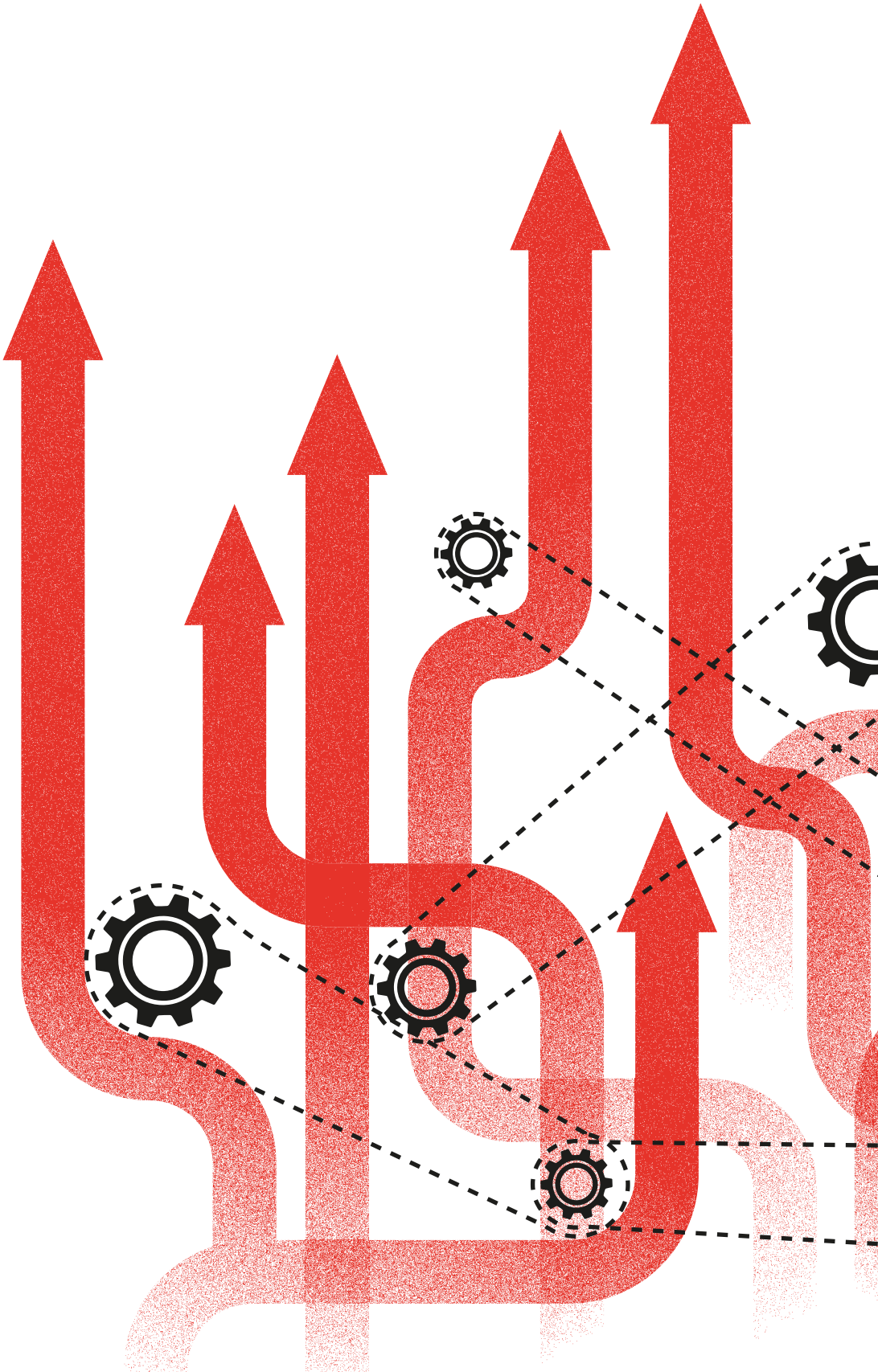
Section 1.3 The Results

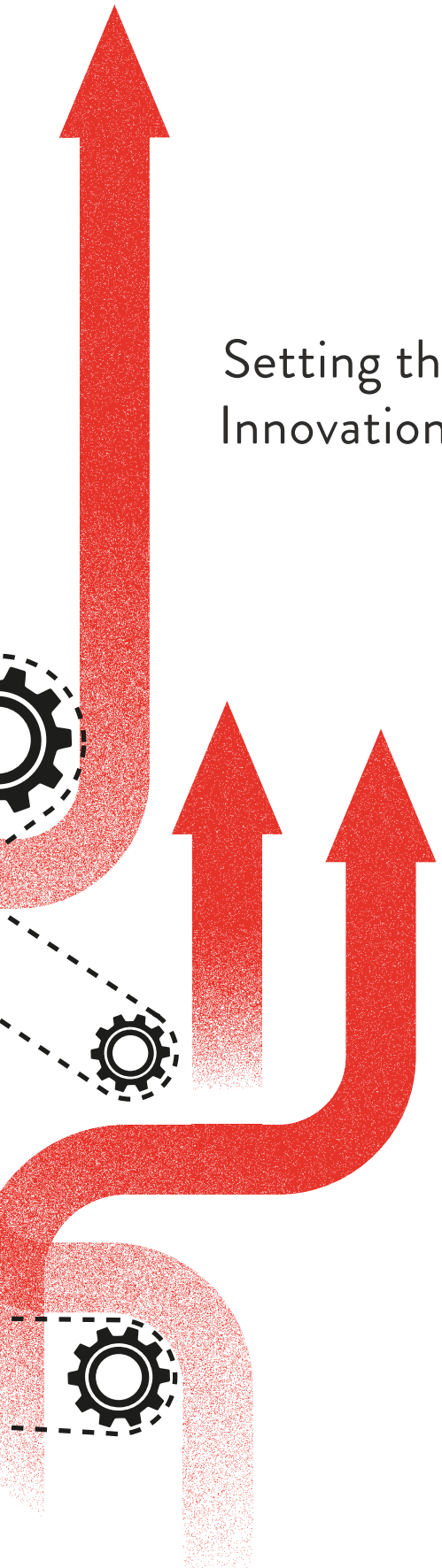
Structuring the thesis into six Chapters, Chapter 2 sets the stage for empirical studies in subsequent chapters. It also presents a comprehensive description of firm innovation, in which we note that firm innovation in a developing country like Ghana is incremental, varying across the type of novelty and taking note of the corresponding innovation barriers. Chapter 3 provides insight into the effects of the market, particularly the various modes of internationalization on dimensions of firm innovation, positing that selling to MNCs as an indirect internationalization mode drives process innovation significantly.

Contributing to settle the ambiguity between the most effective externality, localization (ala Mashall) or urbanization (ala Jacobs), Chapter 4 analyzes the effects of spatial concentration of economic activity on firm innovation and postulates that urbanization clusters have a strong positive effect on firm innovation, with localization having adverse effects. Recognizing that, even for similar clusters, not all firms will have the same effects, we delve into their capabilities to explore how openness, absorptive, and market capabilities moderate the effects of cluster externalities for innovation performance in Chapter 5. While we expect that firms with these capabilities will play a role in moderating the positive urbanization externality effects on innovation, astonishingly, the data suggests otherwise, and we conclude that each has a null effect in moderating the positive urbanization effects. Analogously, the absorptive and market capabilities do not moderate positively to offset the adverse localization effects on innovation. Also, while we expect that openness will moderate and contribute to the adverse localization externalities effects on innovation, surprisingly, we conclude that it has a null moderation effect.

For developing countries to escape the firm innovation incremental curse, state actors in developing countries should deliberately implement policies that will eliminate or minimize resource droughts, as well as institutional inefficiency and rigidities that adversely affect firms from knowledge acquisition and sharing or the extent to which firms can fully internalize investment in R&D so that returns on investment in knowledge acquisition are guaranteed. The predominant small-size firms in developing countries, which typically trade off internal knowledge for external resources (Speldekamp et al., 2020), can invest in internal knowledge acquisition to moderately enhance the internalization of external resources that arise from cluster externalities, competition, or knowledge transfer during internationalization.

1





Setting the Stage: Evidence of Firm Innovation in Developing Countries, the Case of Ghana

This chapter describes the state of firm innovation in Ghana, setting the stage for empirical analysis in subsequent chapters by providing descriptive insight into the role of firmographics while investigating what, why, and how of firm innovation in developing countries like Ghana to facilitate effective policy intervention that stimulates innovativeness since we do not know what works well due to the absence of data. The chapter also briefly describes the survey data for the thesis.

CHAPTER 2

Section 2.1 The Survey Data

The primary survey data for this study is from the regionally represented survey by the Ghana Statistical Service of Firms, which deploys a stratifying sampling design with region, size, and industry. We categorize industries using International Standard Industrial Classifications revision four to classify the principal activities, persons engaged define the size, and regions are administrative regions. The design allocated more than five percent (6,800) of about 100,000 manufacturing in Ghana for the survey, of which 5,400 provided data. The design selects establishments engaging 50 or more persons with certainty and a 5% sample of those engaging less than 50 persons across regions and the 22 industry groups. Using Nayman's optimum allocation, the design was mindful of sample sizes that would provide high precision and effective power, aggregating any stratum with more than a 5% coefficient of variations, particularly size groupings.

We examine the sample data from the perspectives of the firmographics to ascertain the descriptive overview before delving more into the empirical analyses in subsequent chapters. We limit our examination to six firmographics: size, age, legal status, owners' nationality, industry, and firm location. The chapter uses firmographics primarily because other studies (Ayyagari, 2012; Barasa et al., 2016) identified them as correlating with firm innovation. Concerning the firm attributes, Ayyagari et al., 2012, for instance, posits that large firms are more innovative than smaller firms, though others (Palangkaraya et al., 2016) have indicated otherwise. Several authors (Abdelmoula & Etienne, 2010; Becheikh, 2006; Ayyagari et al., 2012) have posited some association between firm age and innovation. Concerning firm ownership, Görg et al. (2004) demonstrate the importance of firm ownership in the innovation discourse while arguing for the significance of foreign ownership of firms.

Similarly, Ayyagari et al., 2012 argue that the legal status of firms is a significant attribute that affects firm innovation. Apart from the firm attributes, industrial groupings and location are significant factors affecting firm innovation, particularly in the agglomeration literature (Beaudry & Schiffauerova, 2009; Glaeser et al., 1992). Understanding this essential firmographics in the sample data contributes to enriching the deductions and conclusions that relate to them in this study.

2.1.1 The Size and Age of the Sample of Firms in the Survey

The number of persons engaged defines the firm's size, including employees and unpaid workers. The three size categories are small (firms engaging up to 30 persons), medium (firms engaging between 31 and 100 persons), and large (firms engaging more than 100 persons). A significant proportion of firms are small, micro, and medium-sized, such that 90.1 percent are small-sized firms, with only three percent being large (Figure 2.1).

By the survey design, the age attribute of the sample data mimics the structure of business in the country. The age attribute of firms is defined based on the commencement year of the firms relative to the year 2014. More than half of the firms in the sample are relatively younger (less than ten years old), with only six percent aged 30 years and above. Figure 2.2 presents a feature where the number of firms decreases with age, typical of firms in developing countries. Thus, the firms are predominantly small or micro, and the majority are start-ups or younger firms, indicating a high attrition rate among firms in developing countries and an increase in the number of births or start-ups.

Figure 2.1: Size Distribution

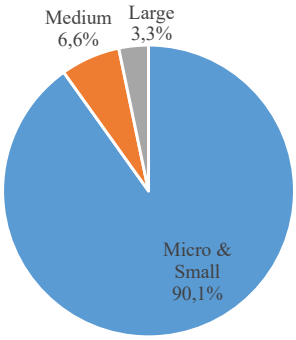
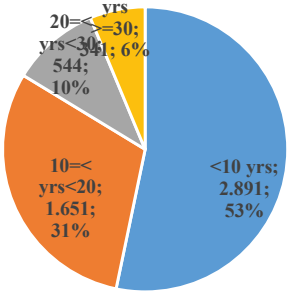


Figure 2.2: Age Distribution



2.1.2 Legal and Foreign Ownership Status of the Sample Data

The study defines the legal status by the Registration of Companies Act in which corporate firms legally register with the mandate to conduct businesses as limited liability firms or partnerships. On the contrary, unincorporated firms include sole proprietorships, associations, and those not registered. Figure 2.3 indicates that nearly eight of ten firms are unincorporated, while only one-fifth are incorporated. Most firms are owned by Ghanaians, with only four percent of

the 5,419 firms in the sample owned by foreign nationals (Figure 2.4). Typical of a developing country, these unincorporated firms are predominantly micro or small, while most incorporated firms are large and medium-scale.

Figure 2.3: Legal Status of Sampled Firms

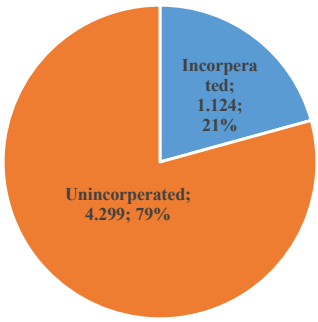
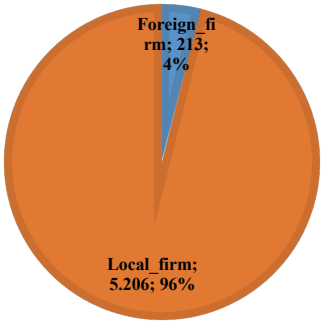


Figure 2.4: Ownership of Sampled Firms



2.1.3 Industrial Distribution of Sample Data

The survey was regionally and nationally represented and provided the basis for industrial-level analysis at the regional level. Table 2.1 presents the industrial distribution of manufacturing firms by size, mimicking the universe of manufacturing firms in Ghana. It shows the vast spread in the number of firms across industries, such that 1,156 firms (one-fifth) are in the food and beverage industry and only six in the petroleum industry. While the distribution shows that most firms across industries are small, it also indicates that firms in the high technology industries, such as those in the chemical and pharmaceutical, rubber and plastics, and basic-metals industries, relatively dominate the large-size firms within industries. On the contrary, the food and beverage industries, which constitute one-fifth of firms in the sample, have barely five percent of firms as large-size firms, even though ten percent of firms in this industry are medium-sized. Generally, the sample has far more low to medium-technology-based firms than high-technology firms, a feature that mimics the structure of firms in Ghana.

Typically, high-technology industries have high concentrations of workers in science, technology, engineering, and mathematics. This study identifies the high-technology industries as the petroleum, chemical and pharmaceutical,

rubber and plastic, basic metals, electronics and computers, machinery and equipment, transport, and motor vehicle industries.

Table 2.1: Industrial and Size Distribution of the Sample Data

Industry	Large		Medium		Small		N
	Number	%	Number	%	Number	%	
Food and beverages	58	5.0	125	10.8	973	84.2	1,156
Textiles and wearing apparel	7	0.7	33	3.4	930	95.9	970
Leather	1	0.3	3	1.0	289	98.6	293
Wood	24	8.2	38	13.0	231	78.8	293
Paper and paper products	6	8.5	11	15.5	54	76.1	71
Publishing and printing	6	2.5	13	5.5	219	92.0	238
Refined petroleum	1	16.7	2	33.3	3	50.0	6
Chemicals and pharmaceuticals	26	12.2	39	18.3	148	69.5	213
Rubber and plastics	18	20.0	18	20.0	54	60.0	90
Nonmetallic	5	2.0	17	6.7	233	91.4	255
Basic metals	9	13.0	4	5.8	56	81.2	69
Fabricated metals	6	0.9	26	3.8	657	95.4	689
Electronics and computers	3	3.5	3	3.5	79	92.9	85
Machinery and equip	0	-	4	3.7	104	96.3	108
Transport and motor vehicles	1	1.1	0	-	88	98.9	89
Furniture	3	0.5	16	2.6	607	97.0	626
Other manufacturing	4	2.3	6	3.4	166	94.3	176
Total	178	3.3	358	6.6	4,891	90.1	5,427

2.1.4 Spatial Distribution of Sample Data

The survey reports ten administrative regions in Ghana: Western, Central, Greater Accra, Vota, Easter, Ashanti, Brong Ahafo, Northern, Upper East, and Upper West. Regionally, the distribution exhibits a similar skewed spread as that in the industry (Figure 2.5). While 18% (973) of the sampled firms are in the national capital, Greater Accra, barely three percent, is in the Upper West region. Aside from the Greater Accra region, where the proportion of the large-

size is barely more than ten percent (11%), few large-size firms are in the other nine regions. This phenomenon is similar in the medium-sized firm category, where apart from the Greater Accra region, the proportion of medium-size firms in the other nine regions is less than seven percent. This is an indication that the location of large firms is an administrative capital phenomenon in Ghana, probably because of access to the main seaport and airport, other infrastructure, strategic state industrial development programs, and bureaucracies.

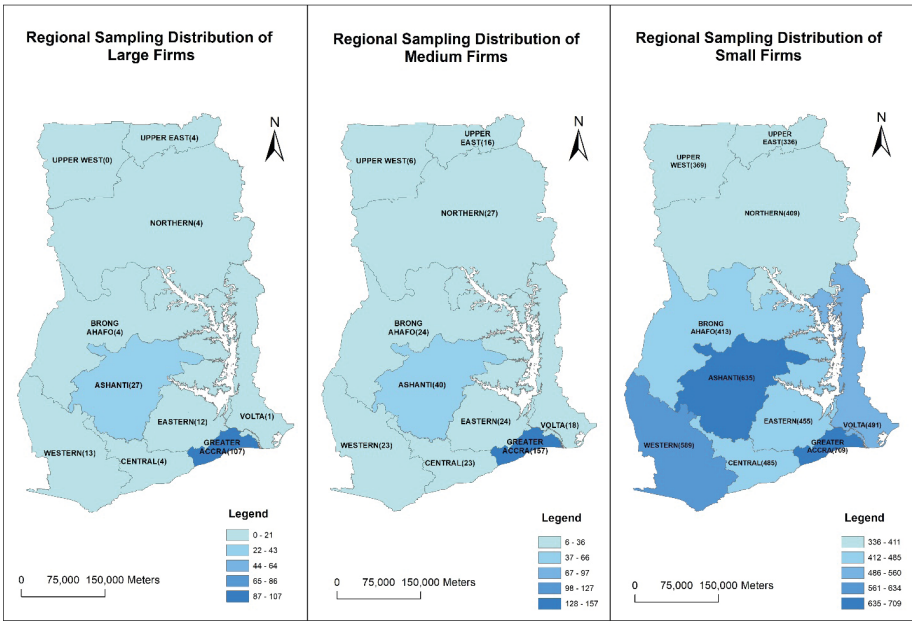


Figure 2.5: Sampling Distribution of Firms by the Size of Firms and Region.

Section 2.2 Descriptive Analysis of Firm Innovation in Ghana

This section examines firm innovation by analyzing the proportion of innovating manufacturing firms and their innovation novelty to unravel the degree, scope, and target. Also, we descriptively unravel why manufacturing firms innovate and analyze the source of firm innovation knowledge to understand firms' different innovation activities. Further, we relate how the acquisition of innovation knowledge plausibly culminates in implementing innovation activities. We also

analyze the self-reported barriers to innovation, bringing to the fore the forces that could plausibly contribute to the current levels of innovation in developing countries like Ghana while addressing the why questions. The section intriguingly addresses the "what, for whom, how, and why " firm innovation questions to provide an impetus and perspective for analyzing the drivers of innovation in subsequent chapters, even distinctively for the various innovation dimensions.

Section 2.2.1 Innovation Prevalence

The proportion of innovating firms relative to the overall firms defines the prevalence of firm innovation in Ghana, measuring how firms transmit knowledge into developing new and improved products and processes. Introducing new or significantly improved products or services, such as improved user-friendliness, components, software, or sub-systems, defines product innovation. In contrast, process innovation involves using a new or significantly improved method or process to produce or supply goods and services. The paper focuses on these two dimensions of innovation, which must be new to the firm but not necessarily new to the industry or market. The study excludes purely organizational innovation in process innovation, such as changes in firm structure or management practice. Overall, firm innovation could be product or process innovation, irrespective of whether the product or process innovation is new to the firm, industry, or the World.

On average, 10 percent of manufacturing firms in Ghana implement either product or process innovation (Figure 2.6). Also, eight percent of firms implement product innovation, while five percent implement process innovation, indicating that only a few firms implement the two dimensions of innovation. According to the African Innovation Outlook (2014), these levels are relatively low compared to countries within the Sub-Saharan African region. However, it is evident from the survey design that variability in size, sector, industrial groupings, and firm location have been accounted for in the survey, making it one of the rich firm surveys, thereby enhancing the precision level of the results.

2.2.1.1 Firmographics and Innovation Prevalence

Size, age, legal status, and ownership of firms contribute to firm innovation from various perspectives (Ayyagari, 2012) and are plausible drivers of firm innovation. It is indicative from Table 2.2 that innovation among micro and small category firms is relatively low even though most firms in Ghana belong to this category. The considerable variability between innovation prevalence by large and small firms among the innovation dimensions points to the relevance of large firms or size in innovation prevalence.

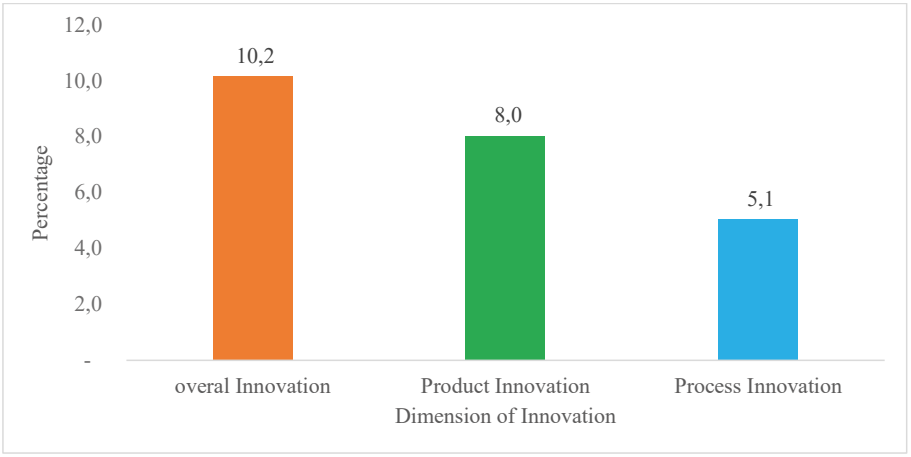


Figure 2.6: Firm Innovation Prevalence by the Various Dimensions.

Concerning the legal status of firms, innovation among incorporated firms is higher than in unincorporated firms, pointing to the relevance of formal firms in innovation. The exposure of foreign firms to best practices and access to foreign funds, either from parent firms or foreign funding agencies, could influence the innovation level among firms since foreign-owned firms are inclined to innovate more than local or domestic firms. Ironically, the substantial variation in the level of innovation prevalence across the various firm attributes is not the same as the firm's age, pointing to the plausibility of an unlikely significant effect of age on overall firm innovation. Nonetheless, since product innovation can trigger process innovation (Kraft, 1990), it suggests that firms usually initiate product innovation and follow up with process innovation, which can render a different proposition when examining innovation from various dimensions. The apparent spread between product and process innovation among younger firms (less than 30 years) is extensive. For instance, between the ages of 20 and 29, 5.7 percent of firms implement process innovation, and 11.0 percent implement product innovation, indicating a spread of close to 100 percent. This scenario presents the plausibility of the dominance of younger firms contributing to the low level of overall innovation activity since the majority will still be in the early stages of innovation.

Table 2.2: Attributes of Firms and Dimensions of Innovation

Feature of Firm	Innovation	Product innovation	Process Innovation	N
Size				
large	20.8	16.9	14.6	178
medium	14.5	9.8	9.8	358
small	9.5	7.6	4.4	4,891
Age				
yrs<10	9.2	7.0	4.9	2,891
10=<yrs<20	10.7	8.8	4.7	1,651
20=<yrs<29	13.4	11.0	5.7	544
yrs>=30	10.6	8.2	7.0	341
Legal Status				
Incorporated	13.9	10.4	8.7	1,124
Unincorporated	9.2	7.4	4.1	4,299
Ownership				
Foreign firm	13.6	9.9	8.9	213
Local firm	10.0	8.0	4.9	5,206

Across industries, innovation is primarily product innovation, though, in nine industries, less than ten percent of firms within these industries implemented product innovation. The industries with a low proportion of product innovation prevalence are the food and beverage and textile industries. These two industries account for 40 percent of the total firms in the sample, and the small and micro-sized firms in these two industries alone account for 35 percent of the total firms in the sample, where innovation levels are predominantly deficient. Consequently, a lower proportion of product innovation prevalence in these industries with a significant sample share could imply lower overall product innovation prevalence.

In the basic metal industry, the proportion of firms implementing process innovation is higher than product innovation for all other industries. Across industries, the proportion of firms implementing process innovation ranges from zero percent in the petroleum industry to 9.4 percent in the electronics and computer industry, even though in the electronic and computer industry, the proportion of firms implementing product innovation is higher (12.4%) than the 9.4 percent of process innovation (Table 2.3).

Table 2.3: Prevalence of Innovation Dimension within Industries

Industry	Innovation		Product Innovation		Process Innovation		N
	No.	%	No.	%	No.	%	
Food and beverages	74	6.4	43	3.7	39	3.4	1,156
Textiles and wearing apparel	95	9.8	76	7.8	41	4.2	970
Leather	54	18.4	46	15.7	20	6.8	293
Wood	21	7.2	19	6.5	10	3.4	293
Paper and paper products	8	11.3	8	11.3	2	2.8	71
Publishing and printing	22	9.2	14	5.9	11	4.6	238
Refined petroleum	1	16.7	1	16.7	0	-	6
Chemicals and pharmaceuticals	23	10.8	17	8.0	16	7.5	213
Rubber and plastics	10	11.1	9	10.0	8	8.9	90
Nonmetallic	25	9.8	18	7.1	14	5.5	255
Basic metals	3	4.3	1	1.4	3	4.3	69
Fabricated metals	70	10.2	60	8.7	35	5.1	689
Electronics and computers	12	14.1	11	12.9	8	9.4	85
Machinery and equip	16	14.8	14	13.0	9	8.3	108
Transport and motor vehicles	9	10.1	8	9.0	3	3.4	89
Furniture	85	13.6	71	11.3	40	6.4	626
Other manufacturing	24	13.6	20	11.4	15	8.5	176

2.2.1.3 Firm Location and Prevalence of Firm Innovation

Across the regions, innovation is highest (15.4%) for firms in the Greater Accra Region, followed by firms in Brong Ahafo (13.8%), Upper East (12.9%), and the Ashanti Regions (10.5%), even though there are far more manufacturing firms in the Ashanti region than ether Brong Ahafo or Upper Region. Incidentally, unlike the Greater Accra Region, which is the administrative capital of Ghana, we expect the Ashanti region, which is the second-largest region and closer to the sea and airports than the Brong Ahafo and Upper East regions, apriori should have a large proportion of innovating firms, but it turns out otherwise. The highest proportion of firms innovating in the Greater Accra Region plausibly suggests the effect of Marshallian externalities on firm innovation.

Consequently, in addition to urbanization, the relatively high number of large-size firms (11%) in the Greater Accra region could be a plausible trigger for the relatively high levels of innovation in the region since the evidence suggests that product or process innovation is typically a large-size firm phenomenon. Regionally, the variation in the proportion of firms undertaking product or process innovation is apparent, ranging from 5 to 12 percent and 3 to 9 percent, respectively (Figure 2.7). Thus, across regions, the evidence points to product innovation activities driving the levels of firm innovation and the likelihood of regional variations in the effects of Marshallian externalities on innovation.

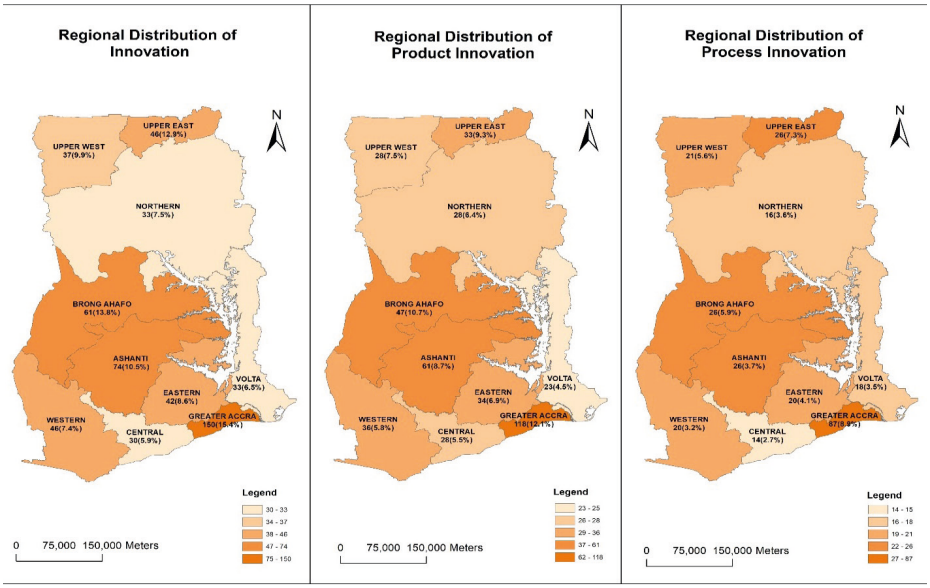


Figure 2.7: Innovation Prevalence and Dimensions by Region.

Section 2.3 Innovation Novelty

The study examines firm innovation novelty in line with novelty at the firm, industry, and international markets and can infer the degree of radical innovation. Novelty to firms refers to those that indicate that the innovation is only new to the establishment, and those for industry refers to firms whose innovation is only new to their industry, while new to the World refers to the novelty of innovation in the international market.

Among innovating firms, Figure 2.8 suggests that the degree of novelty in innovation is at the firm level. However, a few (10%) innovate for the international markets, suggesting a deficient degree of radical innovation (1%) among all the manufacturing firms, given that overall innovation is only 10%, affirming the literature (Zanello et al., 2016) that radical innovation is a developed countries phenomenon. Regarding product innovation, the proportion of firms implementing process innovation is higher by 13 percentage points. Apart from this, firms also reported a similar proportion for the industry and international markets. The relatively low level of innovation for the international market could relate to the relatively low level of exports (2.3%) among the firms in Ghana (Table A.3). Nonetheless, the subsequent examination of the firmographics provides some basis to understand whether these firmographics could plausibly contribute to the levels in the innovation novelty.

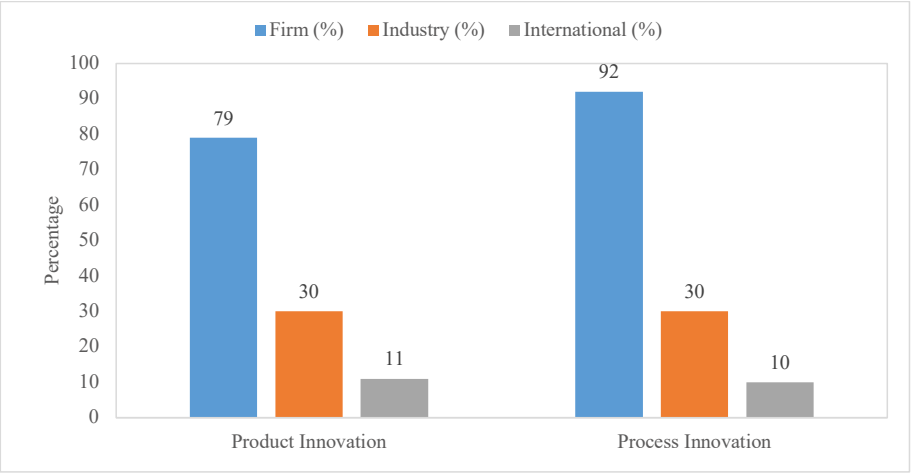


Figure 2.8: Targets for Dimensions of Innovation Novelty.

2.3.1 Firmographics and Innovation Novelty

Analyses of the firmographics indicate that older firms are more inclined to innovate for the international markets than younger firms. Relatively, as much as one-fifth (19.4%) of the innovating firms aged 30 years and above innovate for the international market. Across all age groups, six out of every ten innovating firms innovate for the firm. Concerning the size of innovating firms, large and medium-sized firms are more prone to innovating for the international market than small firms. Also, relative to small-size firms, where only one-fifth of innovating firms innovate for the industry they belong to, more than one-third

of large-size and medium-size firms are inclined to innovate for the industry. The firmographics point to the novelty of innovation by incorporated firms for industry and international markets to be relatively higher than unincorporated firms. The pattern is similar for the nationality of the owners in which foreign-owned innovating firms innovate far more than domestic firms for the international market or the industry (Table 2.4).

The firmographics and innovation novelty patterns suggest more challenges for firms in developing countries to innovate as the degree of innovation expands. This phenomenon could primarily be due to competition and the low capacity of firms with corresponding high standard requirements in globalization, which could be inimical to small, younger, unincorporated, and domestic firms. Consequently, apart from the low level of exports, the relatively low level of firms innovating for the industry and international market could be unintendedly driven by the distribution of the firmographics. However, examining the firms' innovativeness is necessary to understand the dynamics associated with the levels of innovation novelty.

Table 2.4: Targets for Innovation Novelty by Attributes of Firm

	New the firm (%)	New to Industry (5)	New to World (%)	Overall Innovation
Age				
yrs<10	60.7	21.7	7.1	267
10=<yrs<20	66.5	24.4	9.7	176
20=<yrs<29	57.5	28.8	4.1	73
yrs>=30	63.9	27.8	19.4	36
Size				
small	62.9	21.8	6.3	463
medium	78.4	35.1	21.6	37
large	46.2	34.6	17.3	52
Legal Status				
unincorporated	65.4	21.5	7.1	396
incorporated	54.5	30.1	11.5	156
Nationality of Owners				
Domestic firm	62.5	23.5	7.8	523
Foreign firm	58.6	31.0	17.2	29

Section 2.4 Innovation Objectives

Understanding the reasons for firm innovation complements the innovation prevalence levels, novelty, and activities for a descriptive examination of the incremental level of innovation. The survey collected data on the objectives for innovation differently for the various dimensions. The multiple questions seek the critical reasons motivating firms to implement specific innovation dimensions.

Replacement of a product or service, the extension of the range of products or services, an increase in domestic market share, exporting to a new foreign market, or an increase in foreign market share, a decrease in the cost of production or services, producing products or services offered by a competitor, complying with regulations or standards, as well as dealing with a decrease in the demand are the questions posed to elucidate the objective for product innovation. However, concerning process innovation, the objective questions include an increase in the number of products or services, an increase in the total production or amount of services offered, an increase in the flexibility of production or offering service, an increase in the speed of production or offering service, increase the speed of delivery to the customer, decrease the cost of production or offering service. While a Yes response is assigned a dummy value of one and provides the basis to indicate that the option is one of the objectives for a particular innovation dimension, with a response of No or do not know, the study treats the response otherwise.

In Figure 2.9, the product and process innovation objectives are not very distinct, except for a few ones, such as an increase in the flexibility of production. Incidentally, more than half of firms do product innovation to extend the range of products or services (70%) and their market share (54%). On average, seven of ten firms implementing process innovation did so because they wanted to increase production (70%). Fewer firms reported cost minimization as a critical objective for both types of innovation, raising the question of whether firms can vary production processes to minimize production costs.

Also, fewer (13%) innovative firms implement product innovation because of export, affirming the low level of innovation for the international market. Similarly, many firms innovate to increase market share and extend the range of products, pointing to the seemingly high proportion of firms innovating domestically for the firm or industry. Generally, these reasons for innovating

could plausibly be responsible for the relative incremental levels of innovation among firms. Also, barely one-third (33%) of innovating firms implement product innovation to be competitive. So the question is, have the ills of globalization, such as foreign trade barriers (Ma and Lu, 2011), impoverished firms in developing countries and rendered them unmotivated to innovate? Competition arising from globalization, which should be driving higher innovation, has plausibly become inimical to firm innovation, resulting in many firms becoming inward-looking.

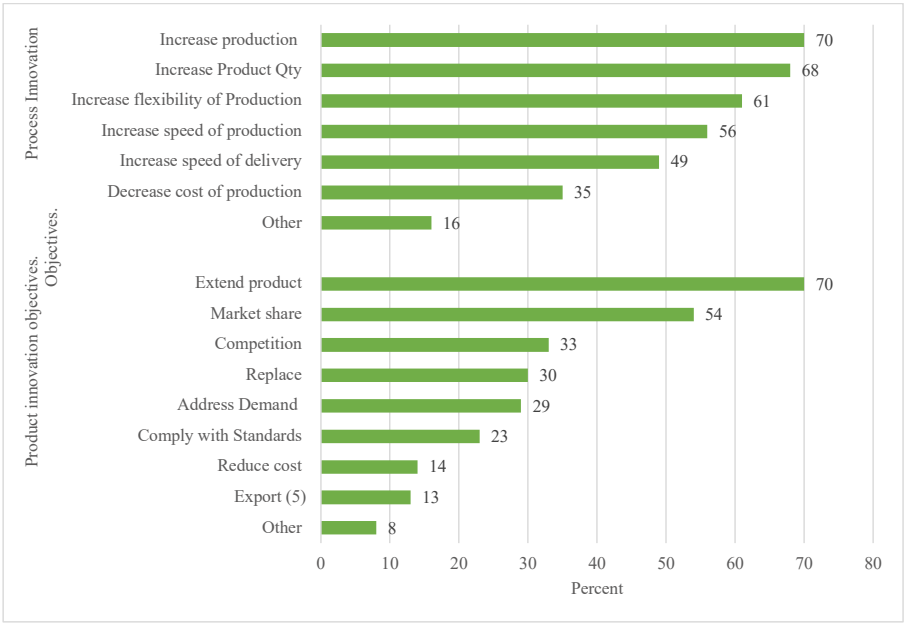


Figure 2.9: Objectives for Product and Process Innovation.

2.4.1 Industry-Specific Objectives for Implementing Innovation Dimensions

The industry's objectives for product innovation reveal very little difference between high and low-technology industries. Except for the firms in the paper and paper products where product replacement is an essential objective, most firms across industries implement product innovation to either expand the product base of the firm or increase the market share. Incidentally, the data suggests a deliberate effort by rubber and plastic industry firms to innovate for the international market since relatively many of these firms (44%) implement

product innovation to compete. Activities in some industries could plausibly not have resulted in a higher proportion of innovation for the international market since this industry is host to relatively few firms.

Typically, cost minimization is an essential factor in competition. Consequently, a further study is required to understand why, though a higher proportion (40%) of firms in the textiles and wearing apparel, refined petroleum, rubber and plastics, fabricated metals, transport, and motor vehicles industries self-reported that the objective for product innovation is for competition, however, cost minimization is not. This phenomenon further supports the need for a critical examination of the capability of firms in the innovation discourse. Even though addressing bottlenecks in demand could result in a higher market share, there is a need to examine these objectives further in contextualizing the levels of innovation (Table 2.5).

Unlike product innovation, in which firm objectives for innovation across industries could be distinctly differentiated, Table 2.6 shows that differentials in the proportion of process innovation objectives across industries are minimal. Nonetheless, most process innovating firms implemented process innovation across industries to increase product quantity, production, flexibility, or speed. These objectives directly complement the primary goals for product innovation, including product diversification or extension and the growing market share of firms across industries. Even though the proportions of firms by industry differ for each dimension, the pattern is similar.

The pattern could affirm that product innovation triggers process innovation (Kraft, 1990). Even though product and process innovation are conceptually different (Utterback and Abernathy, 1975), the results of the self-reported objectives for innovation indicate the need to complement each other (Oslo, 2005) for firms to achieve a higher return on overall innovation. Apart from the petroleum industry, where a few firms did not self-report any process innovation, the self-reported objectives are similar across high and low-technology industries.

Table 2.5: Industry Objectives for Implementing Product Innovation

Objectives for Product Innovation	Replace (%)	Extend product (%)	Market share (%)	Export (5)	Reduce cost (%)	Competition (%)	Comply with Standards (%)	Address Demand (%)	Other (%)	N
Industry										
Food and beverages	14	40	47	12	9	30	19	21	5	43
Textiles and wearing apparel	28	79	47	21	13	42	17	37	8	76
Leather	39	89	54	13	9	28	13	24	9	46
Wood	11	84	58	26	16	37	26	26	16	19
Paper and paper products	50	63	38	13	13	13	25	13	13	8
Publishing and printing	29	79	29	-	21	36	14	36	-	14
Refined petroleum	-	-	100	100	100	100	100	-	-	6
Chemicals and pharmaceuticals	29	47	41	18	6	18	41	29	-	17
Rubber and plastics	33	44	44	22	22	44	44	22	-	9
Nonmetallic	28	67	61	11	22	28	33	17	6	18
Basic metals	-	100	100	-	-	100	-	100	-	1
Fabricated metals	28	67	60	7	13	42	27	23	8	60
Electronics and computers	27	55	73	18	18	18	18	36	-	11
Machinery and equip	29	71	71	7	29	36	43	43	14	14
Transport and motor vehicles	38	75	50	-	13	50	25	38	13	8
Furniture	44	76	61	6	17	27	18	32	13	71
Other manufacturing	30	75	60	30	10	20	30	40	5	20
Overall	30	70	54	13	14	33	23	29	8	436

Table 2.6: Industry Objectives for Implementing Process Innovation

Objectives for Process Innovation	Increase Product Qty (%)	Increase production (%)	Increase the flexibility of production (%)	Increase the speed of production (%)	Increase the speed of delivery (%)	Decrease cost of production (%)	Other (%)	N
Industry								
Food and beverages	41	54	51	51	51	44	31	39
Textiles and wearing apparel	66	78	63	51	44	27	12	41
Leather	65	60	55	75	50	45	10	20
Wood	90	90	70	50	50	30	20	10
Paper and paper products	100	100	50	100	100	50	-	2
Publishing and printing	45	55	55	45	36	45	36	11
Refined petroleum								0
Chemicals and pharmaceuticals	69	63	69	56	63	50	13	16
Rubber and plastics	63	63	75	63	63	-	-	8
Nonmetallic	71	64	64	64	57	50	29	14
Basic metals	67	67	67	33	33	33	-	3
Fabricated metals	83	74	57	63	54	29	11	35
Electronics and computers	50	75	50	25	13	38	-	8
Machinery and equip	78	78	78	67	67	67	11	9
Transport and motor vehicles	67	100	67	33	33	33	-	3
Furniture	75	70	65	58	45	25	13	40
Other manufacturing	93	93	53	53	40	33	20	15
Overall	68	70	61	56	49	35	16	274

Section 2.5 Innovation Activities

Typically, firms actualize their innovation objectives by implementing innovation activities, which involve the deliberate and strategic implementation of productive activities geared towards profit maximization or higher output. Understanding the firmographics in the choice of innovation activities provides some basis to explain why firms' specific innovation activities dominate in developing countries, even though the extent to which a firm implements a particular innovation activity is subject to the innovation knowledge acquired. Understanding the role of firm attributes in the choice of innovation activities is essential since firmographics can contribute to explaining the acquisition of innovation knowledge.

This study classifies innovation activities as an interaction between the firm and five external agents. These are intramural or in-house research and experimental development (R&D); extramural or outsourced R&D; acquisition of machinery, equipment, and software; acquisition of other external knowledge; formal training; market introduction of innovations; and other activities. Under each of these activities, firms provided Yes, No, or do not know responses to several questions (see Appendix 2), and a Yes response is assigned a dummy value of one and zero for a No or do not know.

The multiple responses from firms on innovation activities presented in Figure 2.10 suggest that firms mostly implemented the acquisition of machinery, followed by formal training and intramural, with a marginal difference of one percentage point. Intuitively, these three activities relate since training could be required to use new equipment and undertake in-house (intramural) activities to re-align the setup to introduce new equipment. Invariably, formal training may be required to facilitate intramural activities. It also reveals that manufacturing firms do minimal external consultation, such as outsourcing innovation activities. Generally, many firms would develop and implement their ideas instead of informally learning from peers.

Typical of a developing country, firms acquire innovation knowledge from co-located firms to perform innovation activities since most firms are small and informal. Nonetheless, delving into the role of firmographics in the choice of innovation activities could provide some further understanding. It is also plausible that the low level of extramural innovation activities could be due to trust or other socio-cultural issues inherent in the population.

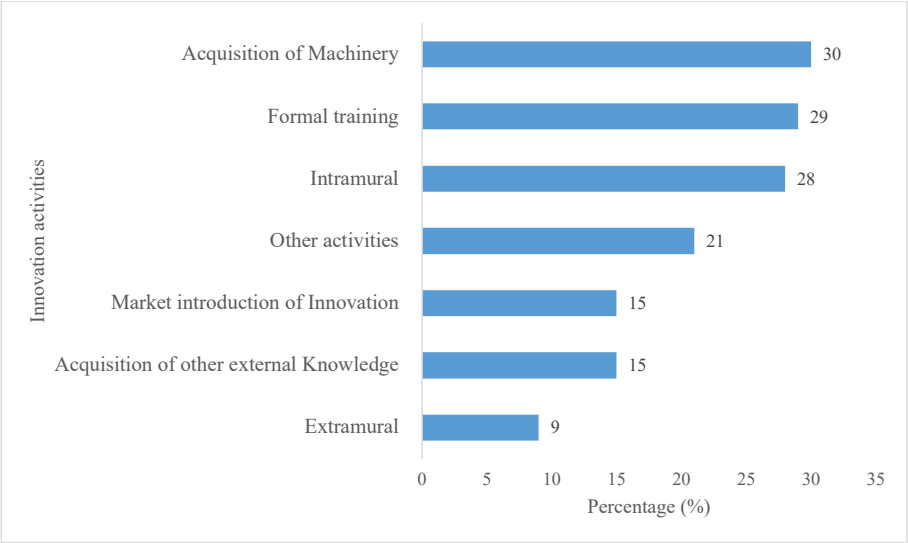


Figure 2.10: Innovation Activities by Innovating Firms (%).

2.5.1 Firmographics and Innovation Activities

The attributes of firms can influence the choice of innovation activities since past and present circumstances and default attributes of firms could plausibly dictate the firm's orientation on which innovation activities would not be inimical to the firm's innovation prospects. Table 7 presents the percentage distribution of the innovation activity of innovating firms for age groupings, size categories, legal status, and ownership status of the firm. Concerning the age of firms, more than half of the firms aged 30 years and above acquire machinery or provide formal training for staff during innovation activities. Relative to the other age groups, firms aged 30 years and above implement all the innovation activities more than the other age groups. Even though outsourcing innovation activities (extramural) is relatively uncommon among firms, it is far worse among firms under 30 years of age. This pattern could plausibly be due to trust issues emanating from several years of building a business relationship.

The data suggests a plausible relationship between size and innovation activities as relatively large-size firms implement all the innovation activities far more than medium-size or small-size firms. The variation is far more extensive with extramural or the marketing of innovation (market introduction of innovation), with more than two-thirds of large-size firms implementing

Table 2.7: Firm Attributes and Innovation Activities

Innovation Activities	Intramural (%)	Extramural (%)	Acquisition of Machinery (%)	Acquisition of other external Knowledge (%)	Formal training (%)	Market introduction of innovation (%)	Other activities (%)	N
Attributes								
				Age				
yrs<10	26.2	9.7	27.3	12.0	25.8	12.0	20.6	267
10=<yrs<20	27.8	9.1	29.5	16.5	28.4	14.2	22.2	176
20=<yrs<29	28.8	4.1	24.7	16.4	28.8	15.1	15.1	73
yrs>=30	44.4	19.4	66.7	30.6	55.6	41.7	36.1	36
				Size				
large	75.7	40.5	81.1	43.2	78.4	59.5	51.4	37
medium	40.4	11.5	46.2	21.2	53.8	30.8	25.0	52
small	23.1	6.7	24.4	12.3	22.2	9.7	18.6	463
				Legal Status				
Unincorporated	23.2	5.1	21.2	12.4	20.2	7.8	18.7	396
Incorporated	41.0	20.5	53.2	22.4	51.3	33.3	28.2	156
				Ownership of Firm				
Local Firm	27.2	8.4	27.9	14.5	26.8	13.4	20.1	523
Foreign Firm	48.3	27.6	72.4	27.6	69.0	41.4	44.8	29

intramural or acquisition of machinery. Typical of a developing country, apart from the cost constraints, small-size firms are primarily informal and do not have the infrastructure required for a sturdy financial muscle, limiting their scope of innovation activities. Consequently, these firms cannot engage the skilled personnel required to implement the extramural, acquire other external knowledge, or market innovation external to the firm. Similarly, compared to incorporated and foreign firms, unincorporated and domestic firms lack the capacity and resources just as small firms and exhibit a similar pattern.

Section 2.6 Source of Innovation Knowledge

Acquisition of innovation knowledge is a pre-condition for implementing innovation activities, shapes the objectives, and contributes to prevalence in the various markets. Firms acquire innovation knowledge from the industrial environment (Glaeser et al., 1992; Audretsch and Feldman, 1996), co-located firms (Rosenthal and Strange, 2003), and exposure to innovation from firms with higher technology during production, such as multinational firms (Javorcik, B., 2004), competitors (Beaudry & Schiffauerova, 2009), the formal-firms seeking of knowledge about product and technology, and internally building the capacity of firm staff to develop innovation knowledge. Consequently, this section examines knowledge from the parent organization, competitors, supplies, reverse engineering, consultancy, association, publication, government, internet, and customer feedback. The study collected responses from firms concerning using these sources of innovation knowledge by requesting the firms to indicate how they acquire innovation knowledge. Using options such as Yes paid for, Yes not paid for, No, and not applicable, a dummy value of one was assigned to a variable if the firm responded Yes paid for, or Yes not paid for, and zero otherwise.

Understanding these sources of firm innovation knowledge provides some basis to comprehensively appreciate the pattern in innovation prevalence, novelty, and activities. The data suggest that most (41%) firms acquire innovative ideas from customer feedback, followed by reverse engineering (Figure 2.11). This pattern reinforces our earlier result, suggesting that many firms undertake innovative activities internally rather than resorting to activities involving external agents. Intuitively, customer feedback, typically driven by time-variant dynamic tastes and preferences, invigorates the viewpoint that customer satisfaction should be paramount in firm decision-making. This source of innovation knowledge is

vital to firms' sustainability because it shapes the type of innovation activity that firms should strategically implement to survive.

Barely one in every ten firms obtains innovation knowledge from government or research sources. This phenomenon points to a shallow interaction in the vertical innovation systems, particularly between firms, research institutions, and the public sector. It indicates less public sector involvement in firm-level innovation activities in developing countries. Further analysis of the firmographics in understanding the diverse sources of innovation knowledge is essential since firms' disposition and capabilities could plausibly inform the choice of innovation knowledge.

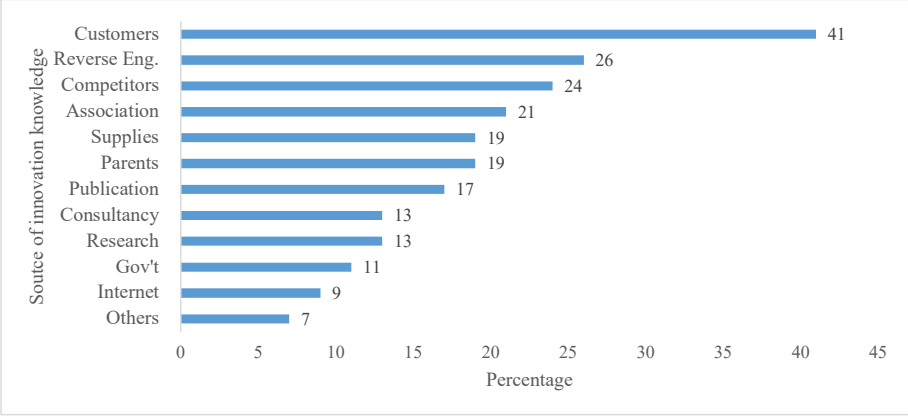


Figure 2.11: Source of Innovation Knowledge (%).

2.6.1 Firmographics and the Sources of Innovation Knowledge

The capability of firms to acquire knowledge can be a function of the resources available to the firms, the experience of the firms, which could be related to the age of firms, or the relationship of the firms to other firms exposed to innovation, which may be directly related to ownership or the legal status of firms. Table 8 suggests that most innovative firms, across all the age groups, reported that customers are the essential source of innovating knowledge, with higher figures (61%) for firms aged 30 years. This phenomenon is staggering since older firms should have more extensive and far-reaching business relationship networks beyond customers to include government, research, academia, competitors, and skilled and competent workers capable of using modern technologies such as the Internet.

Table 2.8: Source of Innovation Knowledge and Attribute of Firms

Innovation Knowledge	Parents (%)	Competitors (%)	Supplies (%)	Reverse Eng. (%)	Research (%)
Firm Attribute					
		Age			
yrs<10	16.5	19.5	18.0	25.5	10.9
10=<yrs<20	21.0	29.0	16.5	25.6	11.9
20=<yrs<29	15.1	20.5	17.8	19.2	16.4
yrs>=30	36.1	36.1	41.7	44.4	27.8
		Size			
large	62.2	48.6	45.9	67.6	48.6
medium	21.2	21.2	25.0	30.8	19.2
small	15.3	22.0	16.2	22.0	9.5
		Legal Status			
Unincorporated	13.6	21.5	14.1	20.2	8.8
Incorporated	32.7	29.5	31.4	40.4	23.7
		Ownership of Firm			
Local_firm	16.6	22.9	18.0	25.0	12.6
Foreign firm	58.6	37.9	37.9	37.9	20.7

Table 2.8 suggests that firms across the different size groups predominantly prefer knowledge from customers, even though more than half of the large-size innovating firms identify parent firms, reverse engineering, consultancy, association, internet, and customers as primarily the preferred source of innovation knowledge. Apart from parent firms, customers, and associations, the other sources could plausibly be preferred by large-size firms since they have the resources to acquire innovation knowledge from these sources. On the contrary, fewer small-sized firms prefer research, consultancy, government, and internet sources of innovation knowledge. These variations in these size groups' preferred source of innovation knowledge could be due to the cost and skilled staff required to acquire innovation knowledge from these sources. Firm size in developing countries could be pivotal in choosing innovation knowledge.

On the contrary, the role of legal status and ownership of firms on sources of innovation knowledge is not quite apparent. For instance, apart from 60.3 percent of the incorporated firms that preferred customers, none of the sources is preferred by more than half of the innovating firms classified by legal status. Similarly, apart from 65.5 percent and 58.6 percent of innovating foreign firms

Consultancy (%)	Association (%)	Publication (%)	Gov't (%)	Internet (%)	Customers (%)	Others (%)	N
			Age				
9.0	16.9	13.9	6.7	6.4	38.6	8.2	267
13.6	25.6	17.6	13.6	8.0	40.9	5.1	176
15.1	20.5	12.3	13.7	5.5	39.7	11.0	73
30.6	36.1	44.4	19.4	36.1	61.1	5.6	36
			Size				
54.1	56.8	40.5	45.9	64.9	86.5	21.6	37
25.0	36.5	28.8	19.2	42.3	51.9	9.6	52
8.0	16.8	13.6	6.9	0.4	36.1	6.0	463
			Legal Status				
7.6	16.7	13.6	7.6	1.5	33.3	6.8	396
25.6	33.3	25.0	18.6	26.9	60.3	9.0	156
			Ownership of Firm				
11.5	20.5	16.3	10.1	6.5	39.4	7.5	523
31.0	37.9	24.1	20.7	48.3	65.5	6.9	29

that preferred customers and parent firms, respectively, as sources of innovation knowledge, barely less than half of the innovating firms categorized by type of ownership preferred the other sources. The extent to which legal status could plausibly influence the choice of the source of firm innovation knowledge needs further examination.

The relevance of a firm's location to acquiring innovation knowledge is essential when examining the relationship between agglomeration and innovation. To the extent that co-located firms tend to share innovation knowledge, apriori, customers, and competitors should predominantly be an essential source of innovation knowledge for innovating firms in urbanized regions characterized by large populations and firms. Table 2.9 shows that, in the Greater Accra region (the capital of Ghana), the most urbanized region, half of the innovating firms identified customers as an essential source of innovation knowledge. Also, firms in this region identified competitors as another vital source of innovation knowledge. Relative to the Greater Accra region, other urbanized regions like the Ashanti, Central, Western, Eastern, and Brong Ahafo regions also indicated similar patterns but varying and lower proportions.

Table 2.9: Sources of Knowledge for Innovation Activities by Region

Region	Parents (%)	Competitors (%)	Supplies (%)	Reverse Eng. (%)	Research (%)
Western	13	20	17	26	13
Central	3	7	7	3	3
Greater Accra	25	25	28	31	22
Volta	15	30	21	30	-
Eastern	19	29	17	29	7
Ashanti	14	18	15	20	16
Brong Ahafo	10	16	8	16	10
Northern	15	30	15	30	9
Upper East	20	17	17	22	4
Upper West	46	51	27	43	16
Total	19	24	19	26	13

Evidence from Table 2.9 suggests that customers and competitors are plausibly an essential medium through which the agglomeration of firms could impact innovation. Among the regions, the evidence suggests very little relevance to the role of public sector institutions, research, and academic institutions. The Greater Accra and the Ashanti regions, where the public sector and research institutions dominate, but firms do not place much premium on them as an essential source of innovation knowledge, is a case in point.

Section 2.7 Innovation Barriers

Relative to non-innovative firms, innovative firms apriori are expected to be more efficient as they find alternative ways to penetrate the market, even in a highly competitive environment. The potential barriers inimical to firm innovation could be factors associated with the firmographics, the firm's industry, geolocation, and inherent systemic institutional and national limitations. Knowledge about barriers is equally crucial as innovation knowledge and activities themselves.

Consequently, we explore the barriers to firm innovation by analyzing how firms agree or disagree with limiting innovation factors such as lack of funds, lack of external sources of funds, lack of qualified personnel, lack of knowledge in ICT, no market information, difficulty in finding partners, a market dominated by established firms, uncertain demand, no need due to prior innovation, and no

Consultancy (%)	Association (%)	Publication (%)	Gov't (%)	Internet (%)	Customers (%)	Others (%)
9	20	9	9	9	39	9
7	13	3	3	3	20	-
21	28	23	17	23	51	8
3	18	18	-	-	48	9
12	26	26	12	2	48	12
12	16	19	8	8	35	4
5	13	11	13	-	25	7
15	24	12	6	3	42	9
9	15	13	9	-	37	7
16	30	16	8	-	46	11
13	21	17	11	9	41	7

demand for innovative products. The study categorizes these factors into cost, knowledge, market, and others, such as no need to innovate or a firm already innovating. We analyze the data using a three-point Likert scale where one (1) is very important, two (2) is important, and three (3) is not important. In this analysis, we categorize firms who select options 1 or 2 as firms who have primarily identified these barriers as inimical to firm innovation and are likely to affect the level of innovation. In contrast, option 3 remains an unessential innovation barrier.

Typically, in a developing country like Ghana, more than half of innovating firms acclaim cost and resource constraints as the most inhibiting innovating factors, inimical to firm innovation (Figure 2.12). The average national percentage distribution of the barriers shows that as much as three-quarters (75.1%) of all firms identify a lack of internal sources of funds as the most critical limiting factor to innovation, followed by a lack of external sources of funds (70.8%) and a high cost of innovation (66.6%). The ranking shows that lack of knowledge in ICT and difficulty finding partners ranked fourth and fifth, respectively. From the perspective of these innovating firms, 'no need due to prior innovation' was the least (34.7%) factor that impedes innovation. This result suggests that, on average, whether similar innovation exists does not substantially hinder the firms from undertaking innovation, but the lack of funds is likely to thwart firms' innovation efforts.

Over the years, the absence of deliberate policies to promote firm innovation is the plausible reason for the high cost and lack of funds for innovation activities, which has invariably become an impediment to firm innovation. The unavailability of specific fund programs for innovation subjects firms to harsh, unfavorable conditions, such as the high cost of credit and non-existing collateral requirements in the financial sector.

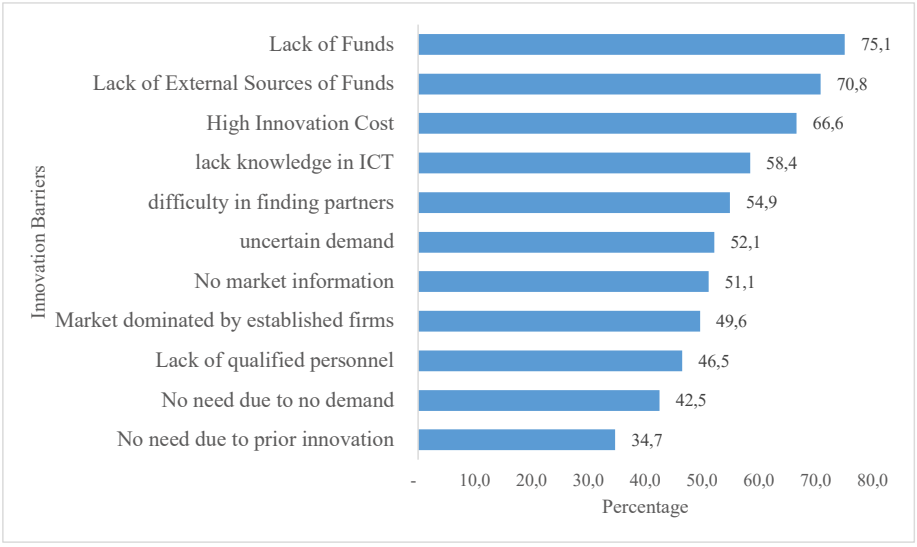


Figure 2.12: Firm Innovation Barriers (%).

2.7.1 Firmographics and Firm Innovation Barriers

Examining the innovation barriers by size attributes of firms, Table 2.10 indicates distinct variations in the proportion of the self-reported innovation barriers between the three firm-size groups. These barriers could primarily be associated with internal firm capacities, capabilities, and size. While large firms are more prone to the lack of internal and external sources of funds and high cost of innovation, small firms also self-report that they are highly prone to capacity-related barriers such as difficulty finding cooperation and lack of ICT knowledge and qualified personnel. These endogenous factors associated with small-sized firms are more related to the capacity of the firms. Nonetheless, relatively small proportions (less than 40%) of large firms are prone to capacity-related factors, indicating that the variations across firm size for the non-capacity-related barriers are not distinctively extensive.

Table 2.10: Firm Attributes and Innovation Barriers

Innovation Barrier	Firm Size			Age_Group of Firms			
	large	medium	small	yrs<10	10=<yrs<20	20=<yrs<=29	yrs>=30
Lack of Funds	46.6	56.7	73.3	73.4	70.9	67.8	61.9
Lack of External Funds	42.7	55.0	68.9	68.7	67.4	63.6	58.7
High Cost of Innovation	46.6	53.6	64.4	64.3	63.5	59.2	57.2
Lack of Qualified Personnel	30.9	39.1	44.9	45.5	43.6	40.8	39.9
Lack of ICT	30.3	43.0	57.2	57.3	54.9	54.0	43.4
Lack of Market Information	32.6	41.3	49.4	50.1	47.6	45.2	41.1
Difficulty in Finding Cooperation	30.9	44.1	53.3	53.4	52.3	49.1	42.8
Established Firms Dominate	35.4	38.8	48.1	48.7	46.5	45.6	39.0
Uncertainty Demand for Innovation Product	39.9	46.4	50.0	49.8	49.7	48.2	47.8
No Need Since Innovation Exist	37.1	36.0	32.8	34.6	31.3	32.9	30.8
No need for innovation since there is no Demand	38.2	38.3	41.0	41.6	40.2	40.6	36.4
Total Number of Firms (N)	178	358	4,891	2,891	1,651	544	341

Typically, older firms are more likely to develop extensive networks to mitigate operational challenges, including implementing innovation activities, than younger firms, though these networks are usually informal in developing countries. Consequently, Table 10 indicates that for all identified innovation barriers, relatively fewer proportions of older firms identify these barriers as impediments to innovation than the younger firms. Contrary to the size distribution of these barriers, there are fewer distinct differences across the age of firms in capacity-related barriers and non-capacity-related barriers. Apart from the lack of internal and external funds where at least ten percentage points difference exists across age groups, relatively fewer differences exist in the other innovation barriers.

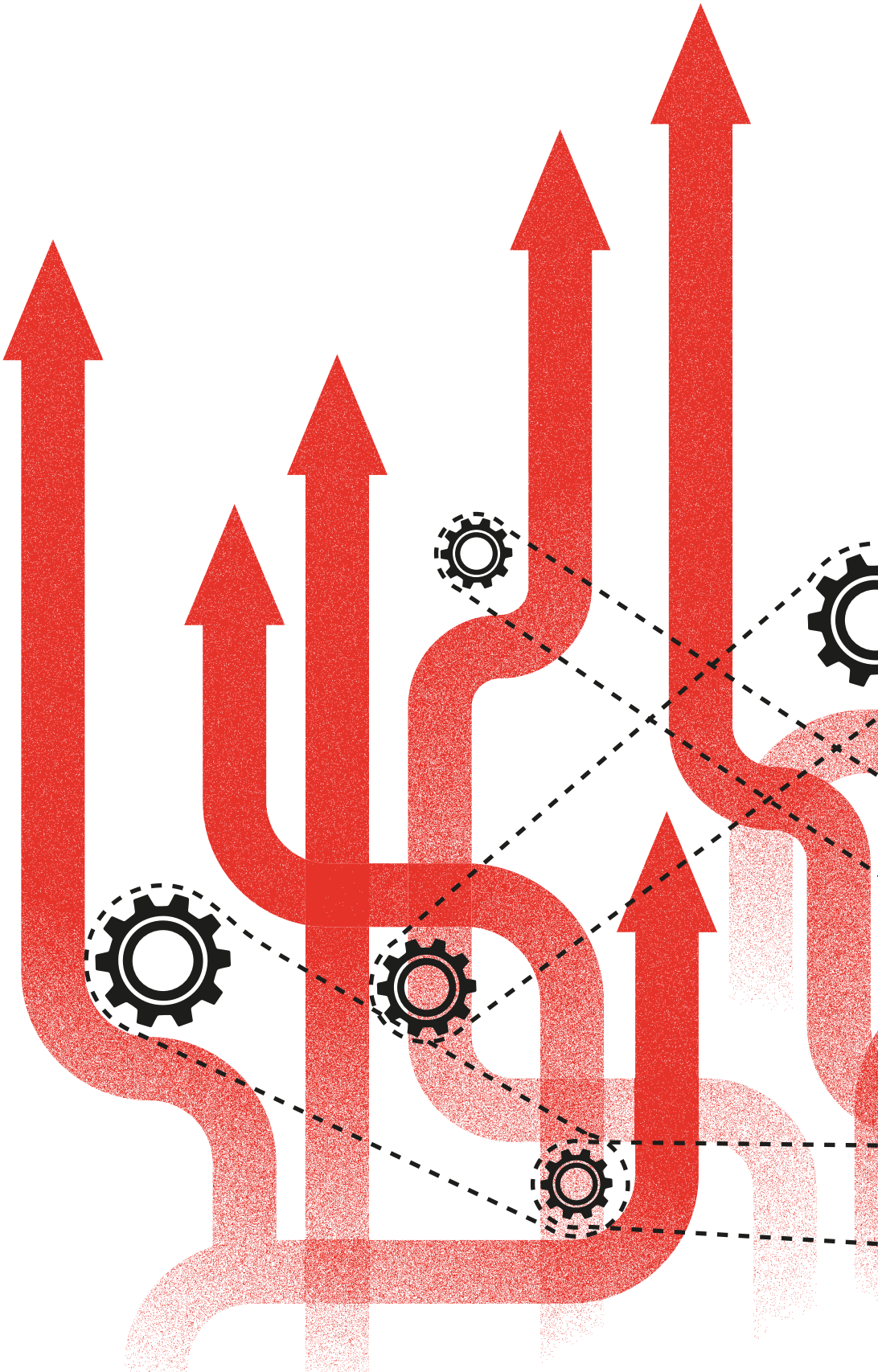
Section 2.8 Conclusion

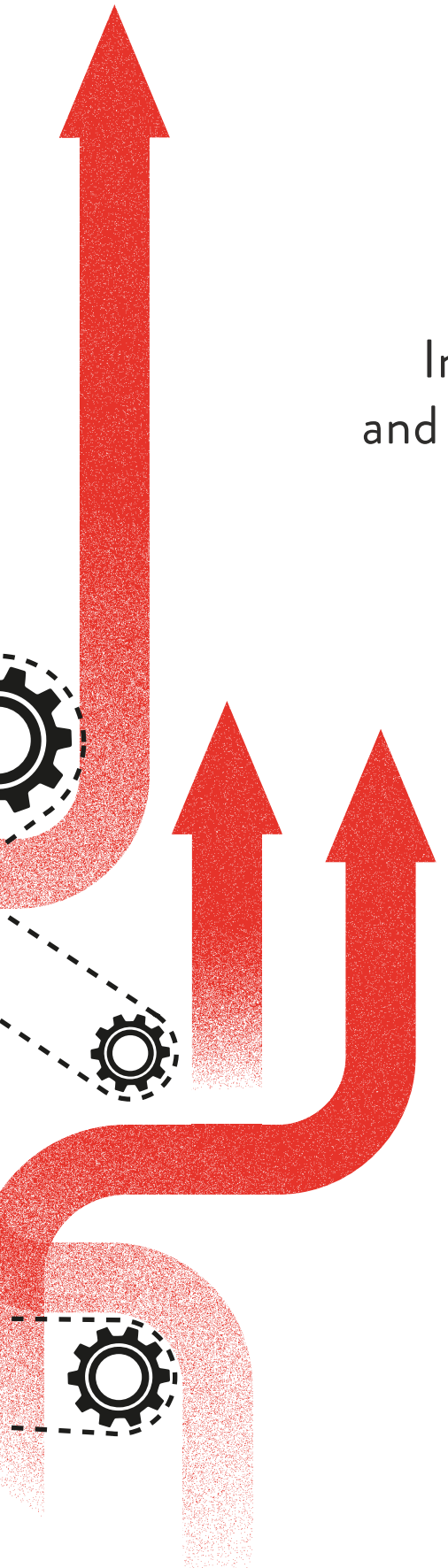
This chapter examines the state of product and process innovation by manufacturing firms in Ghana. The study dwells on primary data on self-reported innovation activities, dynamic capabilities, barriers, and output from an economic survey by the GSS in 2015. The sample distribution shows that nearly one-fifth of the over 5,400 manufacturing firms are in Greater Accra alone out of the ten regions. Similarly, there is a wide variation in the sample distribution across industries, such that while 18 percent of firms are in the food and beverage industry, only six are in the petroleum industry. Due to the survey design, the distribution mimics the overall distribution of manufacturing firms in the sampling frame.

About 10 percent of manufacturing firms undertake product or process innovation, with a three-percentage points gap between Product (8%) and process (5%) innovation. Relatively, urbanized regions with a high concentration of firms have higher innovation activities, suggesting the plausibility of Marshallian externalities effects. The regional spread for product innovation ranges from 5 to 12 percent, while process innovation ranges from 3 to 9 percent. Comparatively, there is far more innovation by firms in non-high technological industries than in the high technology industries, partly due to the enormous capital outlay required, subject to an economy characterized by a high cost of credit. These limitations could also account for fewer firms innovating for the international market relative to the firm or industry.

While many firms in high-technology industries are intrigued by reverse engineering, few firms undertake extramural relative to intramural innovation activities due plausibly to mistrust of external institutions and agents, primarily due to the ineffective and virtually non-existent patenting regime. Consequently, customers (40%) provide vital innovation knowledge to firms rather than research. This phenomenon points to substantial knowledge spillover between firms through informal networks. However, further study is needed to explore how firms internalize knowledge acquired from informal networks to propel innovation performance in developing countries.

Typical of developing countries, most firms are small, micro, and medium-sized. As such, there is some limitation on the benefits associated with large firms concerning the ability to commercialize innovation output, undertake in-depth research and development, and extramural or collaborative innovation activities. Nonetheless, the principal barriers, such as lack of funds and ineffective legal frameworks that impede innovation performance in developing countries, permeate the various firmographics. Barring these negative factors to innovation, an empirical study of the drivers of innovation will require an in-depth understanding of the capability of firms, the role of markets, and the density of firms in urbanization or localization clusters to provide enough basis to offer policy recommendations that will engender the growth of firm innovation.





Internationalization Modes and Innovation Dimensions in Developing Countries

CHAPTER 3

Section 3.1 Introduction

Networking with efficient foreign firms facilitates knowledge transfer (Sutton, 2007), stimulating innovation in domestic firms (Gorodnichenko et al., 2010). Efficient and large firms (Barasa et al., 2017; Aghion et al., 2004 & 2005) can effectively export directly and experience the innovation benefits. Alternatively, firms can also get knowledge transfer when they adopt an indirect mode of internationalization (Williams et al., 2017; Gorodnichenko et al., 2010; Javorcik, 2004) by trading with in-country Multinational Companies or Enterprises (MNCs). Studies on European and Asian economies (Boermans & Roelfsema, 2014; Zimmermann, 1987; Bertschek, 1995) suggest that these two modes of internationalization can affect product and process innovation differently since the two innovation dimensions are conceptually different (Klepper, 1996) and the mechanism for interaction between domestic and foreign firms under the two modes of internationalization also differ. Consequently, we examine the manufacturing sector in Ghana to provide insight into the effects of direct and indirect internationalization modes on the various innovation dimensions independently in developing countries. Our results show that direct exporting has no significant effect on either product or process innovation. Among innovating firms, selling to MNCs as an indirect mode of internationalization drives process innovation significantly but has a null effect on product innovation.

There is ample literature on the nexuses between innovation and exporting, but few (Gorodnichenko et al., 2010; Javorcik, 2004; Zimmermann, 1987; Bertschek, 1995) examine the effects of the two modes of internationalization on innovation dimensions that are conceptually different (Knights, 1967; Utterback and Abernathy 1975). Firms face competition (Gorodnichenko et al., 2010) from within or outside the country when they export directly or trade with MNCs in-country. Primarily, the high fixed export cost (Melitz, 2003), trade barriers, and high-quality standards demands (Ma and Lu, 2011) make efficient and large firms (Nartey and Acheampong, 2016; Carreira & Teixeira, 2009) survive the competition (Giovannetti et al., 2011) when they export directly and benefit from innovation (Aghion et al., 2004 & 2005). Accompanied by obstacles in the business environment (Tandrayen-Ragoobur, 2022), domestic firms in developing countries are primarily small, informal, and inefficient (Aryeetay et al., 2000), making them globally uncompetitive and will rather network with in-country intermediaries such as MNCs (Williams et al., 2017; Ahn J. et al., 2011) to indirectly export while acquiring knowledge transfer for innovation. Typically, efficiency levels and trade relationships facilitating knowledge transfer for

firm innovation differ across developed and developing countries, suggesting different internationalization effects on innovation dimensions. Lack of data (Zanello et al., 2016) deepens the paucity of literature for developing countries, which is even absent in many West African countries, making it imperative to study the relationship in developing economies to address the problems of overgeneralizing conclusions.

We explore self-reported and rich firm-level innovation data of 5,400 manufacturing firms to provide insights into how the two internationalization modes independently affect the dimensions of innovation in developing economies. Consequently, this chapter contributes to the literature in three ways: First, we add to the innovation literature for developing countries by providing insight into the relationship between modes of internationalization and innovation dimensions. Secondly, we show that exporting is ineffective in causing innovation in developing countries where firms are predominantly small and lack capability. Thirdly, we demonstrate the significant effect of selling to MNCs as an indirect internationalization mode on process innovation in developing countries.

Subsequently, we discuss the literature along with developing the hypothesis in section 3.2, the methodology and the empirics in section 3.3, the results and findings in section 3.4, and section 3.5 present the conclusions on the hypothesis, discussions, and policy implications.

Section 3.2 Literature Review and Hypothesis

This paper adopts the innovation definition espoused in the Oslo Manual (OECD, 2005), examining product and process innovation as the dimensions of innovation. Differences in concepts of the innovation dimensions (Utterback & Abernathy, 1975; Cohen & Klepper, 1996) provide the basis for the different outcomes in the relationship between these dimensions and modes of internationalization (Zimmermann, 1987; Bertschek, 1995). Previous studies predominantly focus on exports or import effects on overall innovation (Kafouros et al., 2008; Barasa et al., 2017; Golovko & Valentini, 2011), assuming that both dimensions should have the same effects (Fonseca, 2014). Few studies on the export effect on the innovation dimensions separately argue that exports affect product but not process innovation (Govindaraju et al., 2013), while others (Damijan et al., 2010) also argue that process innovation benefits but not product innovation, and some (Ganotakis and Love, 2011) allude to

the effects of export self-selection in the learning by exporting discourse. Few studies examine the effects of two internationalization modes on overall innovation (Gorodnichenko et al., 2017) and productivity (Javorcik, 2004), portraying the ambiguity and paucity in the literature on how the two internationalization modes affect the innovation dimensions separately, particularly for developing countries.

The mixed outcomes become interesting when studying similar economies. In examining the effects of exports and imports on innovation dimensions in Germany, for instance, Zimmermann (1987) and Bertschek (1995) draw different conclusions, with Zimmermann (1987) arguing that exports and imports affect process innovation but not product innovation, while Bertschek (1995) argues otherwise that direct internationalization and Foreign Direct Investment positively impact each of the innovation dimensions. Barasa et al. (2017) and Tandreyen-Ragoobur (2022) show that export significantly affects firm innovation in Africa, while Avenyo et al. (2021) and Vannoorenberghe (2017) also show varying effects of export on innovation dimensions separately. Differences in innovation dimension outcomes across the two extreme economies are due to the degree of Internationalization (Kafouros et al., 2008) and firms' competitiveness level (Giovannetti et al., 2011), which themselves are factors of firm size, efficiency (Aghion et al., 2004 & 2005), and existing business environment obstacles (Tandrayen-Ragoobur, 2022). These factors explain how internationalization affects the innovation dimensions separately since product innovation precedes process innovation (Damijan et al., 2010). Across the internationalization modes, differences exist in how domestic firms interact with efficient firms that facilitate knowledge transfer, providing the basis for an in-depth study of the relationship in different economies.

Internationalization and innovation are two highly connected strategies (Kylläheiko et al., 2011), with studies (Bilkey et al., 1977) juxtaposing the practice of direct internationalization with the stages of adopting a new product or steps for implementing product innovation. Competition (Cantwell, 2002; Aghion et al., 2004 & 2005) and knowledge transfer (Sutton, 2007) are the two broad mechanisms facilitating product or process innovation when firms engage in internationalization, whether direct (Cassiman & Golovko, 2010) or indirect (Gorodnichenko et al., 2010; Bertschek, 1995). In line with the competition mechanism, studies (Javorcik, 2004; Gorodnichenko et al., 2017) argue that domestic industry competition and knowledge transfer enhance domestic firms' productivity or innovation dimensions when trading with MNCs, even though

some lose out (Veugelers & Vanden-Houte, 1990). Concerning knowledge transfer, Barasa et al. (2017) and Wagner (2007) also argue that it provides the conduit through which direct exporting with exposure to advanced practices and technologies impacts innovation. Irrespective of the internationalization mode, the impact on innovation varies with the level of the domestic firm's technology capabilities (Aghion et al., 2004, 2005) and the skill level of workers (Roper & Love, 2006) since firm efficiency, expressed in process innovation is a prerequisite for survival (Arrow, 1962) in globalization when competing externally or domestically.

Firms in developing countries will typically venture into production and exports, where the industry has a higher comparative advantage emanating from cross-country differences in factor abundance (Wong & He, 2005), which lends new and cheaper inputs to cause product innovation that precedes exports by a few large, efficient, and R&D-intensive (Clerides et al., 1998) firms. This export self-selection may benefit firm innovation after surviving competition from the global market. In addition to obstacles in the business environment (Tandrayen-Ragoobur, 2022), firms in some developing countries are predominantly small, informal, and inefficient (Giovannetti et al., 2011; Aryeetay et al., 2000; Wunsch-Vincent & Kraemer-Mbula, 2016), making them uncompetitive (Awuah & Amal, 2011), leading to high firm attrition (McKenzie & Paffhausen, 2019; Ligthelm, 2011) and deficient (Karna et al., 2015; Schilke, 2012) in internalizing knowledge transfer from few exporting firms for innovation. If exporting firms do not survive global competition, skill and knowledge transfer will not suffice. We argue that the adverse effects of competition from globalization will wipe off the gains that knowledge transfer brings to bear on the innovation dimensions. Therefore, unlike other emerging markets (Vannoorenberghe, 2017; Barasa et al., 2017; Gorodnichenko et al., 2017), direct exports cannot significantly, on average, affect product or process innovation in some developing countries where firms are predominantly small, informal, and inefficient.

Accordingly, we hypothesize that:

> *H^1_0: Direct exporting has no significant effect on product or process innovation.*

MNCs are business entities that operate in more than one country, typically with a headquarters based in one country, while other facilities are in other countries (Tatum, 2010), with an overarching objective of achieving the least-

cost production for the world markets (Gilpin, 2001; Tatum, 2010). The structural model of MNCs described in the literature (Tatum, 2010) includes positioning its executive headquarters in one country and locating production facilities in other countries. Alternatively, parent companies are based in one nation, while subsidiaries are in other countries. Thirdly, the structure establishes the headquarters in one country that oversees a diverse conglomeration that stretches many different countries and industries. Irrespective of the form, the MNCs eventually export products obtained from the domestic countries either by producing themselves or buying from domestic firms (Williams et al., 2017) that are unable to export due to requirements for higher international standards, direct export rigidities, foreign trade barriers (Cefis & Marsili, 2005; Ma and Lu, 2011), coupled with high export fixed cost (Melitz, 2003), and low capability and technological capacity (Aryeetay et al., 2000; Wunsch-Vincent & Kraemer-Mbula, 2016), facilitating trade with intermediaries (Ahn et al., 2011) and consequentially, indirect internationalization for domestic firms.

The upturn in demand for specific domestic products implies that in-country MNCs fuel competition (Yun, 2017; Kruger & Strauss, 2015) among industries in the affected country, which can facilitate innovation (Khachoo & Sharma, 2016; Gorodnichenko et al., 2017). In addition to the conscious capacity building of domestic firms (Williams et al., 2017), the plausibility of labor market pooling of the locally skilled experts that MNCs train (Javorcik, 2004) is enhanced, directly benefiting firms in the same industry (Khachoo & Sharma, 2016), and indirectly for unrelated industries. Also, physical interaction between domestic firms and workers of MNCs while learning new technologies stimulates knowledge spillover (Murata et al., 2014) that can stimulate both dimensions of innovation. However, if a change in demand specifications and product alterations are required, product innovation may improve, but for the few large and efficient firms (Cantwell, 2002; Aghion et al., 2004 & 2005) that enjoy economies of scale to produce the quality products on demand by the MNCs efficiently, notwithstanding that firms in developing countries are predominantly small, informal, and inefficient.

Relatively, we expect selling to MNCs to benefit process innovation more than product innovation from two perspectives. Firstly, with cost minimization as an objective, MNCs self-select and engage domestic firms with comparative advantage (Wong & He, 2005) when purchasing the existing products from domestic countries, intrinsically devoid of causing product innovation, unless in rare cases, when MNCs will subsequently require significant demand-driven

product alterations, typically performed by a few large and efficient firms. Moreover, what seems like product innovation when producing the original product that firms trade with MNCs is induced by the availability of cheap inputs (Wong & He, 2005), independent of and mostly preceding the trade arrangement with MNCs. Secondly, ensuring the survival of these existing products of interest in the global market implies process innovation (Cefis & Marsili, 2005) since higher specification standards are required, compelling the MNCs to build the capacity of domestic firms to improve production methods to facilitate their global competitiveness. Thus, we argue that relative to product innovation, we expect competition (Cantwell, 2002; Aghion et al., 2004 & 2005) and knowledge transfer (Sutton, 2007) to enhance process innovation when innovating domestic firms sell through intermediaries such as MNCs in developing countries.

Accordingly, we hypothesize that:

> *H^2_0: Among innovating firms, indirect exporting (i.e., selling to MNCs) will have a more significant positive effect on process innovation than product innovation.*

Section 3.3 Methodology

3.3.0 Data and measurement

The Chapter uses two sets of data. The 2016 economic survey of 5,400 manufacturing firms, vividly described in chapter two, and data from the 2012 to 2014 waves of the World Bank Innovation Follow-up Survey (IFS). While the main report depends on the 2016 economic survey, data for the robustness checks are from the World Bank IFS firm-level cross-sectional survey.

The IFS collects qualitative and quantitative information through face-to-face interviews with firm managers and owners regarding firms' business environment and productivity. The topics include infrastructure, trade, finance, regulations, taxes and business licensing, corruption, crime and informality, finance, innovation, labor, and perceptions about obstacles to doing business. It is a multi-country, multi-wave survey that connects a country's business environment characteristics with firm productivity and performance, tracking changes and benchmarking reforms' effects on firms' performance, which is helpful for policymakers and researchers (World Bank, 2013).

The survey used a stratified random sampling design with sector, size, and geographic region as stratification factors. The enterprise survey stratifies sectors into four manufacturing industries (food, textiles and garments, chemicals and plastics, and other manufacturing) and two service sectors (retail and other services). The survey categorizes sizes into small (5 to 19 employees), medium (20 to 99 employees), and large (more than 99 employees), and the regions into Accra, North (Kumasi and Tamale), Takoradi, and Tema (World Bank, 2013). Although the survey covered manufacturing and services sectors, for comparison sake, we focus only on the manufacturing sector with 377 data points across the 2013 – 2014 waves.

Data for innovation in the survey is for the current year, while data for direct and indirect exports are for the years preceding the survey period, creating lags for the export data. In the survey, indirect exports are goods sold to a trader or third party who then exports the product without modifications, while direct exports are goods sold directly abroad.

3.3.1 Measurement of variables

3.3.1.1 Dependent variables - product or process innovation

Following the literature (Vannoorenberghe, 2017; Gorodnichenko, 2010; Seker, 2011), the dependent variables are product or process innovation. In the survey, a firm implements product innovation by introducing a new or significantly improved good or service relative to its capabilities, such as improved user-friendliness, components, software, or sub-systems. Process innovation occurs when the firm introduces a new or significantly improved method for producing or supplying goods and services but excludes purely organizational innovation, such as changes in firm structure or management practice. Overall innovation occurs if the firm undertakes either product or process innovation.

3.3.1.2 Independent variables

Measures of direct internationalization mode

Exports

Direct export by manufacturing firms is the central exogenous variable used to measure the direct mode of firm Internationalization, as has been used extensively in the literature (Vannoorenberghe, 2017; Gorodnichenko, 2010;

Wagner, 2012; Alvarez et al., 2005). During the survey, firms indicated the value of the sales outside the country by product. We treat firms that export in 2013 as a dummy variable and assign a one if they export and zero otherwise.

Measures of Indirect Internationalization Mode

Selling to MNCs

In the survey, innovative firms responded to the question- "How important was the decision to engage in innovation activities?" after indicating that they implemented some innovation. The responses were "very important, important, and not important." Firms that indicated that selling to MNCs was either very important or important were assigned a dummy value of one and zero otherwise. This mode of internationalization, which is relatively new in the literature (Williams et al., 2017; Javorcik, 2004; Gorodnichenko, 2010), measures the indirect internationalization mode.

Control variables

The Control Variables are firm size, age, foreign ownership, R&D expenditure, and legal status, used in the traditional literature (Vannoorenberghe, 2017; Barasa et al., 2017). This thesis includes these control variables to exclude spurious relationships that may undermine the effect of the variables of interest on the innovation dimension and enable us to measure the impact of internationalization modes with higher precision.

Firm size

Firm size is one of the internal critical drivers of innovation, with studies (Ayyagari et al., 2012) arguing that larger firms enjoy economies of scale in their production and amortize fixed costs over a broader base and, therefore, are more innovative than smaller firms. However, others (Palangkaraya et al., 2016) show that smaller firms may be less bureaucratic but more flexible and, therefore, more efficient at innovation. Typical in developing countries, the distribution of firms indicates that large firms constitute less than ten percent of the total manufacturing firms in the country (Chapter 2). Our definition of size is the number of workers for the firm, whether paid or unpaid, since they all contribute to productivity, and it is a discrete-continuous variable.

Firm Age

Some studies (Abdelmoula & Etienne, 2010; Becheikh, 2006; Ayyagari et al., 2012) have posited a negative association between firm age and innovation and found

that younger firms are more likely to introduce new products and processes than older firms. Firm age is the relative difference between the commencement year of operation and the survey period and is a discrete number.

Foreign Ownership

Foreign-owned manufacturing firms innovate more than domestically owned firms by their disposition to already developed technology and external markets (Görg et al., 2004). Following the literature (Vannoorenberghe, 2017; Amiti et al., 2007; Alvarez and López, 2005), we include this variable to control the effect of foreign-owned firms in measuring the internationalization modes on innovation dimensions.

Legal status

The legal status of firms is a dummy variable defined by registration during the time of incorporation into the business environment. Studies (Ayyagari et al., 2012) have shown that the legal organization status of firms is significant for innovation since firms organized as corporations report more significant innovation activity than cooperatives, sole proprietors, or partnerships.

R&D Expenditure

Research and Development (R&D) expenditure signals the levels of investment in R&D by firms and affects firm innovation (Archibugi & Sirilli, 2001). Following the use of R&D expenditure as a control variable (Ritter-Hayashi et al., 2019), we introduce R&D expenditure to control firms' levels of R&D investment that could influence the results.

Table 3.1: Measurement Matrix for the Variables in the Model

Variable	Use in Model	Question during survey	How variable we measure in the model	Scope of the variable or target respondent
Product Innovation	Dependent	Has the firm introduced new or significantly improved goods or services that are already available from the firms' competitors in the market or services onto the firms' market before the firms' competitors or into the world	Binary variable with a 1 when the response is YES. 0 Otherwise (if the answer is NO or Do not Know)	ALL firms in the sample

Table 3.1: Continued

Variable	Use in Model	Question during survey	How variable we measure in the model	Scope of the variable or target respondent
Process Innovation	Dependent	Has the firm implemented or used new or significantly improved methods for the production or supply of goods and services that were already available from the firms' competitors in the market but new to the firm or domestic industry in the world	Binary variable with a 1 when the response is YES. 0 Otherwise (if the answer is NO or Do not Know)	ALL firms in the sample
Overall Innovation (OR Innovation)	Dependent	Either Product or Process Innovation	Binary variable with a 1 when Product or Process Innovation is a 1, with 0 otherwise.	ALL firms in the sample
Exporter or exports	Independent	Derived variable when firm exported in 2013	Binary variable with a one when firm exported. 0 Otherwise	ALL firms in the sample
Direct or Indirect exporters from WBIFS	Independent	What percentage of sales are indirect exports (sold domestically to a third party that exports products) OR Direct exports (sold directly abroad)	Binary variables, with 1 for indirect or direct exports greater than 0% and 0 otherwise	
SMNC (Selling to Multinational Companies)	Independent	How important were the following in motivating the firms' decision to engage in innovation activities	Binary variable with a one assigned if the firm responds that multinational buyers in Ghana motivated Innovation. 0 otherwise	ONLY firms in the sample undertaking innovative activities
Firm Age	Independent and Control	Derived variable using the date of commencement	Discrete continuous data. Measured annually relative to commencement date	ALL firms in the sample
Firm Size	Independent and Control	Derived variable: Number of workers	Discrete continuous. Total persons engaged	ALL firms in the sample

Table 3.1: Continued

Variable	Use in Model	Question during survey	How variable we measure in the model	Scope of the variable or target respondent
Foreign Ownership	Independent and Control	Nationality of ownership	Binary variable with one assigned when owners are non-Ghanaian owners. 0 otherwise	ALL firms in the sample
Legal Status	Independent and Control	Type of legal organization	Binary variable with one assigned to limited liability companies as corporate entities. 0 otherwise	ALL firms in the sample

3.3.3 Empirical Specification for Primary Models

This chapter adopts a multiple logistic regression model since product or process innovation is a binary variable.

The effects of internationalization modes on innovation dimensions

$$P(innovator = 1) \quad = \frac{\exp\left(\beta_0 + \beta_1 INTER_i + \beta_{vi} Z_{vi} + \sum_p \beta_p d_p + \varepsilon_i\right)}{1 + \exp\left(\beta_0 + \beta_1 INTER_i + \beta_{vi} Z_{vi} + \sum_p \beta_p d_p + \varepsilon_i\right)} - - - - - (1)$$

Definition of variables

Where: $Innovation_{iz}$ is the innovation of firm i for z dimensions (product or process innovation)

$INTER_i$: a binary for the firms: (1) direct exports, (2) selling to MNCs, (3) direct exports in previous years, or (4) indirect exports in previous years

$\beta_{vi} Z_{vi}$: the term for the vth control variables for firm i

$\sum_p \beta_p d_{P(i)}$: industry dummies for firm i in industry p

ϵ_i: the error terms

3.3.4 Endogeneity

Using cross-sectional observation data requires the need (Bascle, 2008) to address unobserved heterogeneity. For instance, there is the plausibility of self-selection concerns in which very efficient and innovative firms elect themselves for exporting or have become the target of MNCs that could trigger a reverse in the causal relationship that we investigate. There is the likelihood of omitting

the effect of these variables that drive the primary exogenous variables (export and selling to MNCs) of interest, which could indirectly influence innovation and the error term, thereby increasing the bias and minimizing the model's predictive power.

In the literature (Angrist et al., 1996; Heckman et al., 1999; Breg, 2007; Vannoorenberghe, 2017; Beveren & Vandenbussche, 2010), the use of Instrumental Variables (IV) to address the plausibility of endogeneity in the export–innovation model is predominant, with distance to the port as an instrument for exports. Others (Aw et al., 2011) use a structural model, while Filipescu et al. (2013) adopted the Granger causality test. Regarding selling to MNCs and the innovation model, Javorcik (2004) used the semiparametric estimation method, while Gorodnichenko (2010) also used IV, with an index from the data, to instrument the variable selling to MNCs. Barasa et al. (2017) adopted a time-lag model in their bidirectional study of the export-innovation nexus since exposure to the policy and actual treatment status violates the exclusion restriction (Berg, 2001). Other studies (Ritter-Hayashi et al., 2019) use propensity score matching (PSM). This paper employs Instrumental Variables (IV) and Propensity Score Matching (PSM) methods to address endogeneity concerns of the exporter and selling to MNCs, respectively, the two main exogenous variables in the two primary models.

3.3.4.1 The IV for Direct Internationalization Mode and Innovation

We run an instrumental variable model to identify a good instrument that would accurately cause exports, the direct mode of internationalization, but not directly related to the innovation model (Berg, 2001). Otherwise, we violate the conditions for exclusion restriction. Following the literature (Vannoorenberghe 2012; 2017; Angrist et al., 2001), we adopt distance to the air and sea ports as an instrument for the exporter variable. We assume that firms close to the seaport and airport (entry and exit points) would be more engaged in exporting because of close contact with other exporters and that shipping costs would be relatively lower due to proximity to these ports. Notwithstanding, there is the plausibility of firms endogenously locating close to the port to be closer to exporters to benefit from the concomitant knowledge spillovers for innovation.

Generally, we expect the distance to the port to satisfy two conditions necessary to become a good instrument. First, it must be a statistically significant predictor of firm-level exports, such that exporting is contingent on proximity to the port. Secondly, the distance of a firm to the nearest port should satisfy the exclusion

restriction, such that it should not directly affect a firm's innovation except through its effect on exports. Under the second condition, the direct modes of internationalization trigger firm innovation primarily due to the proximity of firms to the ports, affecting the level of firm exports. For instance, proximity to ports implies lower shipment costs to export, providing an incentive to export. However, meeting globalization demands requires higher quality standards and innovation.

We run an IVprobit regression to implement this IV model using equation 5, in which we instrument the exporter variable using distance to the port measured by the distance of firms to the ports located in Accra, Takoradi, and Tema while controlling for R&D expenditure, log of age, log of size, foreign ownership, and legal status. We aim to ascertain whether the exports are endogenous and significantly driven by distance to the port, the plausibly excluded exogenous variable in equation 1, such that discounting the effect of distance to the port on exports, we will ascertain the actual effect of the exporter in causing product or process innovation. Apriori, we expect distance from firms to the ports to negatively correlate with exports, the treatment variables.

Subject to the outcome of equation five, we will conclude that with distance to the ports implicitly measured, it will become a good instrument if the exporter significantly explains the product or process innovation to assess whether, in addition to the control variables, the exporter explains innovation better, or the outcome is worse or indifferent since the instrument is weak.

3.3.4.2 The PSM for the Indirect Internationalization Mode and Innovation

We adopt the PSM to extract the selection bias in selling to MNCs from the cross-sectional observational data since the primary data for this study is not a result of a randomized experiment. As indicated earlier, firms could self-select to sell to MNCs because their outputs are already in demand by MNCs and other motivations, typically due to the firm's size, efficiency levels informed by investment in R&D, or whether the firms are incorporated, raising concern about selection bias and reverse in causality. Consequently, we need to isolate the effects of these endogenous variables to measure the actual effect of causality in our model.

Following the recommendation by Stuart (2010), we empirically select the firm size, foreign ownership, and legal status as the observed covariates for the treatment model since they correlate with selling to MNCs in the primary

model and, by intuition, could influence selling to MNCs. Typically, large-size firms enjoy economies of scale and can efficiently produce improved products to meet the standards required by the MNCs since, in many instances, firms require adequate resources to manufacture high-quality standard products. Also, the exposure of foreign-owned firms to advanced technology and external markets (Görg et al., 2004) makes them an easy target for MNCs to manufacture products befitting the required specifications of the MNCs. MNCs are rational businesses concerned about the security and stability of third-party firms. Therefore, MNCs should relate more to incorporated firms than unincorporated ones. Apriori, these covariates should explain the variability in selling to MNCs (Brookhart et al., 2006) and adequately feed into estimating propensity scores with high precision that will provide the basis to match observed and unobserved treatments efficiently.

In equation 7, the PSM model employs Kernel matching techniques to test the Average Treatment on the Treated (ATT) estimate at a 5% significance level. We test the significance of whether selling to MNCs causes product and process innovation using the common support derived from the selected covariates as the basis for matching the treated and control groups. Consequently, we arrive at robust conclusions about the model specification estimating the effects of the indirect internationalization mode on product and process innovation since the data for the treatment covariates are observations from the sample that births the treatment and the outcome (Heckman et al., 1997, 1999), we expect a significant reduction in the bias, leading to whether selling to MNCs is a consistent and efficient estimator of product or process innovation.

3.3.4 Empirical specification for endogeneity models

Instrumental variable

We adopt the Newey (1987) 2-stage ivprobit method to estimate the model, with an instrument where we instrument the exporter status with distance to the port.

Propensity Score Matching (PSM) model

$$P(innovator = 1/(Treatment = SMNC)_i = \frac{\exp(\emptyset_0 + \emptyset_1(Treatment = SMNC_i) + \sum_j(\emptyset_{ij}X_{ij} + \forall_i))}{1 + \exp(\emptyset_0 + \emptyset_1(Treatment = SMNC_i) + \sum_j(\emptyset_{ij}X_{ij} + \forall_i))} - -(7)$$

Definition of variables

Where: $Innovation_{iz}$ is the innovation of firm i for z dimensions (product or process innovation)

V_i: the endogenous term in the Newey 2SIV ivprobit model instrumenting for exporters with distance to the ports

Z_i: the exogenous term for control variables in the Newey 2SIV ivprobit model

$SMNC_i$: binary variable capturing whether the firm i sell to $MNCs$

$\sum_j \emptyset_{ij} X_{ij}$: covariate vector for the ith firm, J^{th}-covariates

$\emptyset_1(Treatment = SMNC_i)$ the treatment term for firm i

$\forall_i$ and ε_i are the error terms

Section 3.4 Empirical results comparing the effects of internationalization modes on innovation dimensions

This section presents a comparative analysis of the relationship between direct and indirect internationalization modes independent of product or process innovation of manufacturing firms while controlling for age, R&D expenditure, size, legal status, and foreign ownership. Overall, 10 percent of the innovative firms account for 17 percent of the total value of exports, presenting the skewness of depth and firmographics in internationalization (Tables AP2 and AP3) in Ghana. For instance, sectorally, the manufacturing of food and beverage alone accounts for 33 percent of export revenue, while 65 percent of export revenue for the manufacturing sector is from the Greater Accra region, the national capital.

We present the log odds and the corresponding statistic from the logistic regression results with robust standard errors using 17 industry groups for industry dummies, classified by the ISIC revision IV at the division level (2 digits of ISIC codes), to establish the effects of exports or selling to MNCs on product and process innovation in Table 3.2. Thus, it provides the basis for comparative analysis of significant effects on product or process innovation in developing countries when firms engage in direct or indirect internationalization. Columns 1 to 4 and 5 to 8 examine the effects of exports and selling to MNCs on the various innovation dimensions, respectively.

3.4.1 Effects of direct Internationalization Mode on innovation dimensions

In Table 3.2, columns 1 and 2 provide the log-odd estimates from regressing exporters and the exogenous control variables on product innovation, and columns 3 and 4 do likewise for process innovation. The result in the lower part of the table shows that the lower log-likelihood values support the higher sensitivity and specificity estimates that the model in columns 2 and 4, respectively, better explains the variability in product and process innovation since they are better off than not having any model or those in columns 1 and 2.

Before introducing the control variables at a 5% significance level, column 1 and 3 in Table 3.2 reveals that exporting significantly triggers product and process innovation. However, in columns 2 and 4, exporting became insignificant in driving the innovation dimensions after introducing all the control variables, particularly the size of firms, although the exporter relates positively with all innovation dimensions. Also, in column 4, legal status (control variable) significantly accounts for the variability in process innovation. The control variables that significantly explain the innovation dimensions positively correlate with the innovation dimensions, revealing that innovating firms are endogenously large and can produce efficiently with the economics of scale. Relatively, their size ensures that they earn higher returns on investments (R&D inclusive), motivating them to innovate (Love & Roper, 2015), irrespective of whether they export. Apart from the few large firms, registered firms with corporate identity assure businesses of low risk concerning investment, making it easier to potentially acquire R&D knowledge on improved production methods externally that facilitate process innovation. This thesis fails to support the arguments (Vannoorenberghe, 2017; Love & Roper, 2015; Cassiman & Golovko, 2010; Barasa et al., 2017) that interaction with foreign partners through direct exports causes firm product or process innovation.

Subsequently, we examine the adequacy of the sample size that produces the log-odd estimates in Table 3.2 with a powerlog analysis of the predicted probabilities from the product and process innovation models in columns 2 and 4 (Figure 3.0). At a 5% level of significance, following Cohen's recommendation (Cohen, 1988) for a minimum of 80% power, the product and process innovation models will require a minimum sample size of 371 and 393, respectively. Therefore, our sample size of 5,411 for the analysis is above the model requirement, ensuring that the model explains product or process innovation with high precision. Based on the sample size, we are 95% confident that the

conclusion from the test results that exports do not affect product or process innovation is not in error.

3.4.2 Effects of indirect internationalization mode on innovation dimensions

In this section, we investigate innovative firms and compare the effects of selling through intermediaries such as MNCs on product and process innovations, using selling to MNCs as an indirect internationalization mode since MNCs engage in Internationalization (Gilpin, 2001; Tatum, 2010) that could potentially provide competition and knowledge transfer for innovation (Gorodnichenko et al., 2010). Table 3.2 presents exciting and revealing logistic regression results with robust standard errors for the effect of selling to MNCs on product or process innovation. Columns 5 and 6 provide log-odd estimates for the outcome variable, product innovation, and 7 to 8 for process innovation. The values for p, log-likelihood, sensitivity, and specificity suggest that all the models are significant at a 5% significance level in explaining product and process innovation. However, the complete model with control variables in columns 6 and 8 for product and process innovation is better. Columns 5 and 6 show that selling to MNCs does not drive product innovation before and during the introduction of control variables. However, selling to MNCs drives process innovation at both experiment levels in columns 7 and 8. In column 6, apart from R&D expenditure and legal status, none of the control variables significantly affect product innovation. In column 8, apart from process innovation, which has shown resilience in significance, age and legal status are the significant control variables.

Figure 3.1 provides another powerlog analysis to explain the role of sample size in the test results. The powerlog analysis shows that at a 5% significance level, the complete model in columns 6 and 8 in Table 3.2 for product and process innovation requires sample sizes of 75 and 82 to have 80% power to correctly explain the variability in product and process innovation, respectively. The sample size of 550 for the analysis provides power in excess with high precision to correctly conclude in testing the effects of selling to MNCs on product and process innovation. Relative to the sample size, there is a high probability that the conclusion from the test results that, among innovative firms, selling to MNCs affects process innovation and not product innovation is not in error.

Table 3.2: Logistic regression analysis for Effects of Exports vs. Selling to MNCs on Product and Process innovation

Main	Effect of Direct Internationalization				Effects of Indirect Internationalization			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Product innovation	Product innovation	Process innovation	Process innovation	Product innovation	Product innovation	Process innovation	Process innovation
Exporter	1.01*** (0.000)	0.16 (0.583)	1.42*** (0.000)	0.30 (0.335)				
R & D expenditure		0.01 (0.199)		0.01 (0.186)		0.04** (0.046)		0.01 (0.500)
Age_log		0.07 (0.320)		-0.15* (0.092)		0.27 (0.101)		-0.30** (0.035)
Size_log		0.94*** (0.000)		1.29*** (0.000)		0.24 (0.440)		0.50* (0.064)
Foreign own		-0.21 (0.462)		-0.38 (0.186)		0.17 (0.778)		-0.26 (0.605)
legal_status		0.07 (0.662)		0.59*** (0.001)		-0.87*** (0.007)		0.68** (0.018)
Sell to MNC					-0.42* (0.096)	-0.46* (0.080)	1.35*** (0.000)	1.18*** (0.000)
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5411	5406	5405	5400	543	542	548	547
Pseudo R^2	0.031	0.055	0.024	0.067	0.064	0.095	0.076	0.101
ll	-1469	-1430	-1058	-1008	-264	-255	-351	-341
p	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sensitivity (%)	0.00	0.69	0.00	0.37	98.13	97.42	49.08	56.3
Specificity (%)	100.00	99.98	100.00	99.98	8.62	11.21	79.06	74.73

t statistics in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

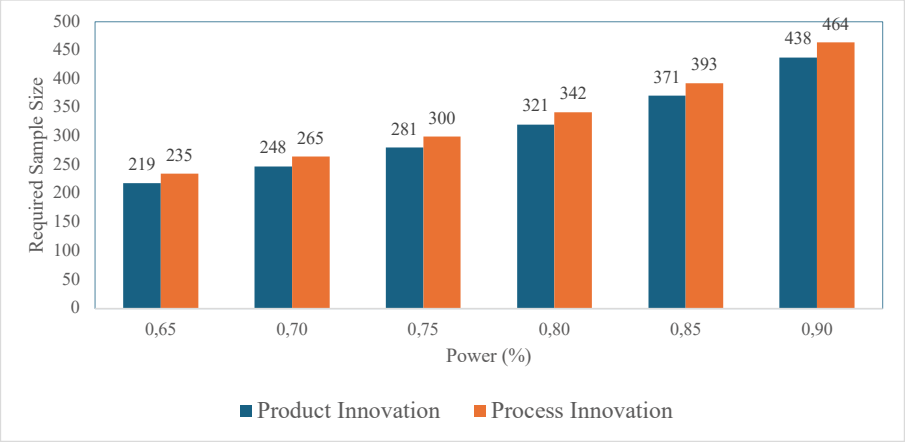


Figure 3.0: Powerlog Analysis of Sample Size for Direct Internationalization Model.

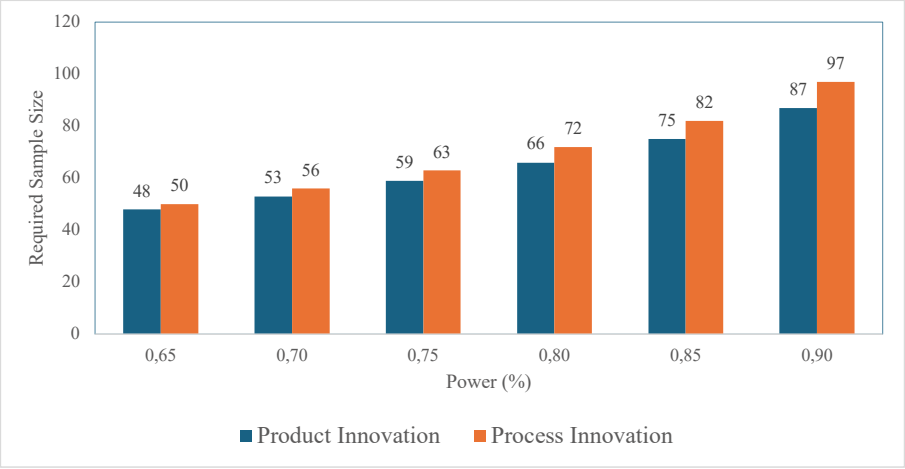


Figure 3.1: Powerlog Analysis of Sample Size for Indirect Internationalization Model.

3.4.3 Endogeneity

3.4.3.1 The IV for endogeneity in effects of current exports in the model

Table 3.3 presents the IVprobit result to address plausible endogeneity concerns from unobserved heterogeneity and self-selection using crossectional observation data, treating distance to the air or sea port as the instrument for the exporter variable. Before analyzing the effect of distance to the ports as an instrument, Table A.11 in the appendix reports the first stage estimates in

columns 1 and 2, with the log odds from the logistic regression with robust standard errors clustered by districts using industry dummies, using the firm's distance from the port in instrumenting for exports. The values for p, sensitivity, and the log-likelihoods show that the model in column 2 was significant at explaining exports better than column 1 and a no model at all, indicating that the model in its totality with all explanatory variables put together and accounting for distance from the port explains export variability better. However, in the first stage, distance to the port is not statistically significant in driving firm exports. On the contrary, the control variables are statistically significant in affecting exports positively, making our instrument weak since it has no significant bearing on exports.

In columns 1 and 2 of Table 3.3 below, we implicitly discount the effects of distance to the port to assess the actual effect of the exporter on product and process innovation, respectively, alongside the other control variables by estimating equation 5. The results for product innovation are in column 1, and that of process innovation in column 2 shows that exports remain insignificant in causing product and process innovation, even after instrumenting for distance to the ports. Apart from R&D expenditure and firm size, none of the control variables significantly affect product innovation in Column 3, and in Column 4, size, R&D expenditure, and legal status significantly affect process innovation. Consequently, the effect of the instrument in our model would lead to bias and an inconsistent model since, exporter, our treatment variable is not significant. In effect, it is irrelevant to include distance to the port in our primary model since it is a weak instrument. Therefore, our model is better off not accounting for distance to the port since it makes no difference in the effects of exports on the innovation dimensions. The IV results vindicate our earlier test result of the null effects of direct exports on product or process innovation, indicating a high probability that our primary model is a consistent and unbiased estimator of product or process innovation variability.

Table 3.3: Newey's IVProbit Results for Effects of Current Exports on Product and Process Innovation

	(1)	(2)
	Product innovation	**Process innovation**
Exporter	0.09(0.48)	0.15 (0.82)
R & D expenditure	0.00*** (3.18)	0.00*** (2.76)
Log (age)	0.04 (1.13)	-0.08* (-1.72)
Log (size)	0.47*** (6.43)	0.62*** (6.70)
Foreign ownership	-0.07 (-0.52)	-0.19 (-1.25)
Legal status	0.04 (0.49)	0.29*** (3.34)
Industry dummy	Yes	Yes
Observations	5356	5350

p-values in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3.4.3.2 The PSM results for selling to MNCs

We run a PSM and present the results in Table 3.4, with selling to MNCs as the treatment variable to extract the treatment effect in selection bias from the cross-sectional observational data since our data is not from a randomized experiment. Following Stuart (2010), we use the firm size, foreign ownership, and legal status as the observed covariates since they have the likelihood to explain why firms sell to MNCs. In Figure 3.3, these observed covariates show that the majority of innovative firms that are motivated to innovate by selling to MNCs (treatment group) and those that did not indicate the same as their motivation (control group) have a P-score of about 0.2, and the spread overlaps, with few firms that are in the treatment group having P-score above 0.6. The spread in distribution provides the basis for matching the P-score of the two groups since there is evidence of common support between the firms that indicate that selling to MNCs motivates them to innovate (treatment group) and those that did not indicate the same (control group).

In Table 3.4, although the pseudo-R^2 from the logit regression was relatively small (6.8%), the P-value shows that overall, the model with the selected covariates is significant in explaining variability in selling to MNCs and good enough for estimating the propensity scores for matching. The second part of Table 3.4 shows the results of the kernel matching separately for product and process innovation, confirming our earlier test results. At a 5% significance level, values of the T-test for the average treatment of the treated (ATT) show that even after minimizing the bias using our assumed selected covariates, selling to MNCs is still insignificant in causing product innovation. On the contrary,

a change in selling to MNCs leads to a 0.285 significant change in process innovation, holding the control variables constant. These results are subject to the assumption that selling to MNCs is mainly a function of R&D expenditure levels, firm size, foreign ownership, and legal status. We conclude that the primary results are not biased, and the models in columns 6 and 8 in Table 3.2 are consistent and unbiased estimators of product and process innovation, respectively. However, we acknowledge the plausibility of some unobserved covariates, such as the proximity of firms to MNCs and the willingness to sell to MNCs for other reasons, which is unmeasurable in this paper due to data that may still bias the results.

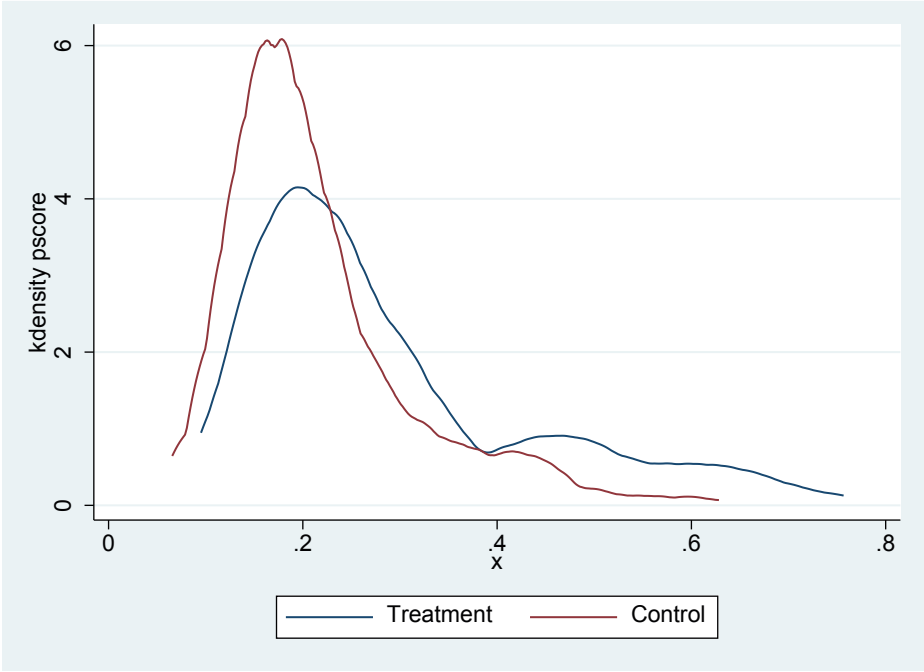


Figure 3.3: Distribution of P-score.

Table 3.4: Kernel Propensity Score Matching for Endogeneity on Selling to MNCs

Logit results for adequacy of the model						
Number of Obs=551	**Pseudo R^2 = 0.062**	**Prob>Chi =0.000**	**LR chi2(4) = 36.980**			
Sell to MNCs	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
size_log	0.390	0.094	4.150	0.000	0.206	0.574
Foreign own	-1.310	0.516	-2.540	0.011	-2.321	-0.298
legal_status	0.518	0.284	1.830	0.068	-0.038	1.074
_cons	-2.175	0.226	-9.610	0.000	-2.619	-1.732
Kernel matching results for Product and Process Innovation						
Dep Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Product Innovation	Unmatched	0.734	0.806	-0.072	0.041	1.75
	ATT	0.730	0.784	-0.055	0.046	1.18
Process Innovation	Unmatched	0.742	0.421	0.321	0.049	6.61
	ATT	0.738	0.453	0.285	0.049	5.83

3.4.4 Robustness Check on the Analysis using Lagged Direct and Indirect Exports

To validate our results, we investigate the relationship with a lag since firms learn by exporting (World Bank, 1997; Solomon & Shaver, 2005), thereby investigating the effects of previous direct and indirect exports on current firms' innovation performance. As a robustness check, we explore another unique data set, independent and different from the primary data for analysis, to investigate whether firms that directly export in earlier years have a higher probability of innovating in subsequent years than their counterparts. Typically, for firms to continue exporting within the competitive environment in the global market, they must respond to the changing demands of customers and competitors. We assume that, intuitively, competition in globalization will compel firms to implement innovative knowledge acquired from previous exports to produce high-quality products to survive if firms seek to stay in the global market, thereby engaging in innovation. Table 3.5 presents logistic regression results with robust standard errors using equation two to regress innovation and its dimensions on lagged direct and indirect exports. The model uses the log age, log size, legal status, and foreign ownership of firms as exogenous control variables. Columns 1 to 4 show the estimates of log odds of lagged direct exports

on product and process innovation, with columns 5 to 8 showing log-odds estimates of the effects of indirect exports on product and process innovation.

In columns 1 and 2, lagged direct export has no significant effects on product innovation before and after introducing the control variables. Subsequently, all the control variables explain product innovation after adding them to the exogenous variables. Similarly, in columns 3 and 4, the corresponding estimates of process innovation indicate that before introducing controls, the previous exports do not significantly affect process innovation in subsequent years, and even adding the control variables, the estimates in column 4 show that the impact of previous direct export on process innovation remains unchanged. Incidentally, in column 4, none of the control variables significantly explains process innovation. Thus, even with the assumption that firms will learn by exporting with a lag, at a 5% significance level, lagged direct exports do not significantly affect product or process innovation. In effect, the null effect is similar across the two innovation dimensions.

Similarly, we examine the effects of lagged indirect exports on innovation dimensions in columns 5 to 8. In columns 5 and 6, the effect of lagged exports on product innovation in subsequent years is unchanged even after including the control variables. Instead, all the control variables are significant at a 5% significance level in explaining product innovation. Concerning process innovation, lagged indirect exports remain unchanged in driving process innovation even after adding the control variables in column 8. In this model, the control variables do not explain the process innovation variability.

The results indicate that, at a 5% significance level, previous direct and indirect exports have no statistically significant effects on average on either product or process innovation. Barring the effects of selection bias and endogeneity concerns, for the robustness check, we are unable to support our assumption that direct or indirect exports precede product and process innovation and, hence, should drive the innovation dimensions with a lag. Consequently, we conclude that there is a high probability that our conclusions on the effects of current exports and selling to MNCs on product and process innovation in our primary model are not affected by model specification, the timing of the exports, or the data.

Table 3.5: Logistic Regression Results for Robustness Checks

main	(1) Product innovation	(2) Product innovation	(3) Process innovation	(4) Process innovation	(5) Product innovation	(6) Product innovation	(7) Process innovation	(8) Process innovation
	Direct Internationalization				Indirect Internationalization			
Direct exporter	0.66* (1.88)	0.72* (1.79)	0.13 (0.36)	0.17 (0.42)				
Age_log		0.75*** (2.92)		-0.05 (-0.21)		0.75*** (2.79)		-0.06 (-0.27)
Size_log		-0.60*** (-3.13)		-0.03 (-0.20)		-0.57*** (-2.96)		-0.04 (-0.24)
Foreign own		-0.01** (-2.55)		-0.01 (-1.42)		-0.01** (-2.45)		-0.01 (-1.45)
legal_status		0.91** (2.48)		0.49 (1.50)		0.84** (2.26)		0.47 (1.44)
Indirect exporter					-0.20 (-0.39)	0.13 (0.22)	0.09 (0.19)	0.24 (0.46)
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	367	327	354	315	367	327	354	315
Pseudo R^2	0.086	0.164	0.038	0.050	0.077	0.155	0.037	0.050
ll	-166	-139	-192	-171	-168	-140	-192	-171
Sensitivity (%)	9.72	23.88	3.37	7.41	2.78	23.88	3.37	6.17
Specificity (%)	97.29	98.85	99.25	99.15	99.66	96.54	99.25	99.57

p-values in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Section 3.5 Conclusion, discussion, and policy implication

3.5.1 Conclusion on Hypothesis 1: The effects of direct internationalization on product or process innovation

Following the results in Tables 3.2, 3.3, 3.5, and Figure 3.1, we reject the alternative hypothesis and accept the null hypothesis at a 5% significance that exports do not significantly affect product or process innovation in developing countries like Ghana. We conclude that the data suggest that the direct internationalization mode in which firms export directly does NOT significantly trigger the probability of product or process innovation. Therefore, our conclusion differs from the traditional literature (Vannoorenberghe, 2017; Alvarez & López, 2005; Barasa et al., 2017). We argue that our data suggest that it is virtually unlikely that benefits that result from knowledge transfer (Wagner, 2007; Sutton, 2007) or competition (Cantwell, 2002; Aghion et al., 2004 & 2005) when directly engaging in internationalization significantly drive product or process innovation in some developing countries like Ghana where the firms are predominantly small, informal, lack capacity and capability. Consequently, the adverse effects of global competition due to direct exports may eliminate the plausible knowledge transfers that drive product or process innovation. Comparatively, at a 5% significance level, the null effect is the same for either dimension of innovation in some developing countries like Ghana.

Discussion: Large firms drive product innovation rather than exports because they enjoy economies of scale and can earn enough to cover innovation-related expenditures, motivating them to invest more in innovation since the results in Table 3.2 indicate that innovators are endogenously large. In addition to size, it is incorporated firms that drive process innovation, indicating that it is the ability to invest in innovation to efficiently produce while giving assurance to the global business partners and research investor community that the firm is legally secure and trusted for investment in R&D that matters for process innovation.

3.5.2 Conclusion on Hypothesis 2: The effects of indirect internationalization on product or process innovation

Concerning product innovation, the evidence from the data suggests that, at a 5% level of significance, we accept the null hypothesis and fail to reject the alternative hypothesis that among innovative firms, the indirect mode of internationalization, defined by selling to MNCs in-country, is vital in driving product innovation in developing countries like Ghana. On the contrary, selling

to MNCs causes process innovation. After addressing endogeneity concerns, we state that selling to MNCs as an indirect mode of internationalization is a consistent, unbiased, and efficient driver of process innovation relative to product innovation. Our conclusion is not in error relative to the sample size since the study has more than 95% power to conclude correctly.

We argue that among innovative firms, selling to MNCs enhances the efficiency of domestic firms in implementing process innovation when they build the capacity of domestic firms to improve production methods and purchase products for export while insisting on higher quality standards (Ma & Lu, 2011; Curtis, 2016) if the MNCs will remain competitive in the global market. Also, the likelihood of heightened competition (Aghion et al., 2004 & 2005; Arrow, 1962) among domestic firms within the same industry seeking to sell to MNCs in-country, for instance, is plausible for fueling process innovation since they have to adopt improved production methods to deliver higher standard products and services. On the contrary, the self-selection of domestic firms in which MNCs deliberately engage with firms in comparative advantage product industries while seeking cost minimization in their objective function portrays cheap inputs-driven product innovation that pre-dates trading with MNCs, making product innovation largely independent of their trading arrangements. On average, knowledge transfer and domestic competition will facilitate process innovation far more than product innovation.

Discussion: Domestic firms in developing countries must network with MNCs by selling to MNCs if they want to internationalize because they do not have the capacity and capability to penetrate foreign markets and compete effectively. Therefore, leveraging the availability and closeness of MNCs can facilitate their growth, efficiency, and competitiveness and ensure their indirect participation in internationalization.

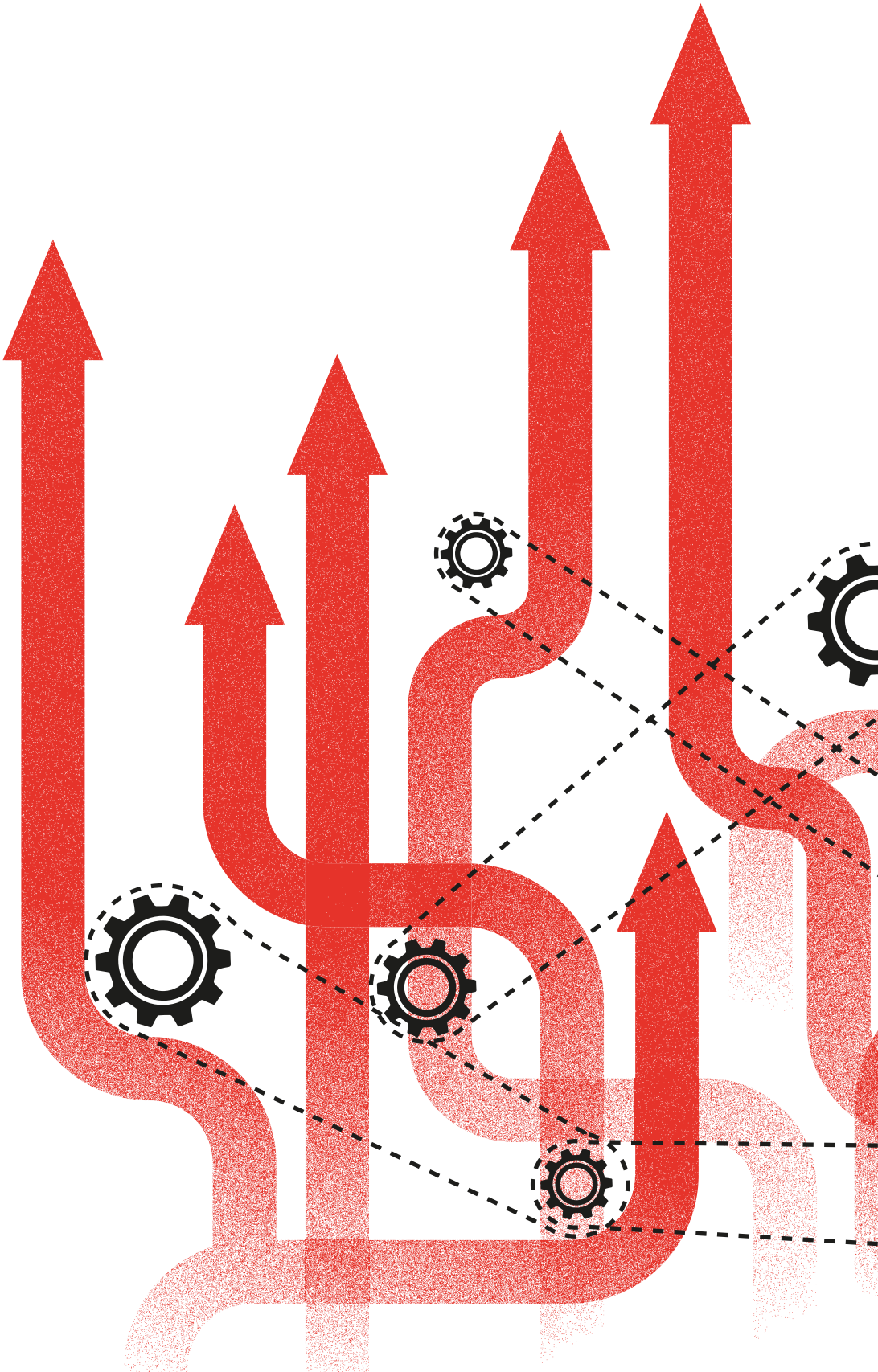
It is evident in Table 3.2 that investments in R&D by large and incorporated firms drive product innovation, confirming our argument that MNCs self-select competent firms for trading. Therefore, capacity building by MNCs is likely to ensure that the existing products of interest can be competitively marketable globally, enhancing process innovation. Firms must overcome the rigidities that breed obstacles in the business environment to significantly build their capacity and capability to participate in product alterations since that will likely ensure their growth and competitiveness. Broadly, the evidence points to effective

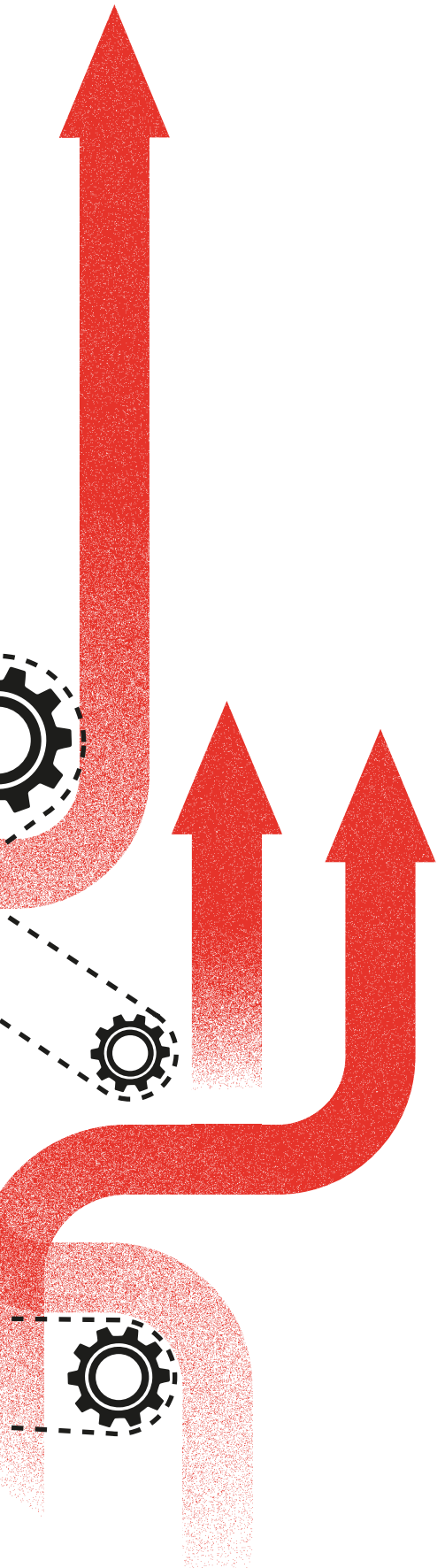
knowledge transfers rather than global competition facilitating process innovation in developing countries.

3.5.3 Policy implication

Our study is from the general philosophy of "learning by directly or indirectly exporting," where firms acquire knowledge and encounter domestic or global competition while they export or trade with in-country MNCs. The result shows that the interplay of scale economies, efficiency, and adverse effects of competition weakens the significant effect of export as a direct mode of internationalization on either product or process innovation. On the contrary, relative to product innovation, knowledge transfer when selling to MNCs benefits process innovation significantly. In addition to the knowledge transfer they acquire from the efficient foreign firms, competition makes the domestic firms innovative if they can overcome the obstacles in the business environment that bedevil firms in developing countries, culminating in their inefficiency. Thus, achieving the fete of "learning by directly or indirectly exporting" will require efforts from the state, firms, and other research institutions in a way that:

1. The state ensures that the legal environment that protects firm innovation is viable so that firms are encouraged to invest in R&D since they are guaranteed good returns. Also, it protects domestic firms from the adverse effects of competition by creating buffer sectors where developing countries have a competitive advantage.
2. The state supports small businesses with investment funds at reasonable interest rates to facilitate investment for innovation. Also, institutionalize a system that facilitates a good relationship between research institutions and firms.
3. Informal businesses should be incorporated since they facilitate business confidence and knowledge transfer for product or process innovation.





Spatial-concentration and Firm-level Innovation

CHAPTER 4

Section 4.1 Introduction

Extant and a large body of research points to a positive effect of economic density on different performance measures, such as firm productivity (Combes & Gobillon, 2015; Duranton & Puga, 2020). Such positive effects, which can help spur development (Duranton, 2015), have a well-established economic rationale that relies on different types of spillovers that firms benefit from when colocating. The literature has distinguished intra-industry (localization) agglomeration in the spirit of Marshall (1890) from inter-industry (urbanization) agglomeration economies, in line with Jacobs (1969). However, the ambiguity about which agglomeration has the most effective externality for innovation performance remains unsettled. Among the extant studies, while Ouwersloot & Rietveld (2000) and Oort (2002) found localization more effective, Feldman & Audretsch (1999) and Duranton & Puga (2000) posit that urbanization is more effective, with Shefer & Frenkel (1998) and Paci & Usai (2000) indicating that both are effective. Most of the evidence (Combes & Gobillon, 2015; Duranton, 2015) points to a positive impact of spatial concentration on firm productivity. However, the existing evidence overwhelmingly relies on data from developed countries, partly for reasons of data availability, exacerbating the gap in the literature. In this thesis, we contribute to unsettling the ambiguity about the most effective agglomeration.

In this chapter, we quantify urbanization and localization economies in the context of Ghana, a major Sub-Saharan African economy. We use recent economic census data that provides data on the universe of firms in the country that precisely maps the location of economic activity and the locality shapefiles from the population frame in Ghana. The economic census contains information on employment, industry classification, and the locality (there are more than 15,000 localities in Ghana) for each firm, irrespective of size, formal or informal status, in the country. We then combine this mapping with a detailed survey for a representative sample of about 5,400 manufacturing firms, including balance-sheet data and detailed questions about their innovative behavior, described in Chapter Two. Contextually, we ask whether firms are more likely to innovate in regions or clusters with a higher density of employment (urbanization) or with a higher density of same-industry employment (localization) while contributing to settling the ambiguity. Our main results are that urbanization and localization have opposite effects: we find a positive and robust effect of urbanization and a mostly negative effect of localization economies on the probability of innovating.

Like the other chapters, we focus on innovation as an outcome variable, where a firm innovates if it introduced a product or a process innovation in 2013. Evidence from the data (Chapter 2) suggests that such innovations are far from the technological frontier, with less than 10% of product innovators reporting an innovation "new to the world." From this perspective, innovation differs significantly from studies examining R&D spending or patenting in developed countries. Instead, innovation is how firms seek to improve their performance incrementally, with the degrees of novelty at the firm, industry, or the world. Thus, this self-declared innovation measure is more transparent and avoids the typical issue that revenue productivity confounds aspects related to the production process (what they aim to measure), to competition (markups), and indirectly to quality or new products.

In the literature (Combes & Gobillon, 2015), identifying a causal effect of spatial concentration on firm performance is particularly challenging, partly due to unobserved factors, which may affect both the density of economic activity and the firm innovation decision. For example, a region offering better infrastructure may attract more workers and be more conducive to innovation by firms. Another issue arises from the mobility of firms. If innovative firms move to denser economic environments, denser places will appear as having a disproportionate share of innovators. However, if these firms innovate in their region of origin, it will cause an upward bias of the effect of spatial concentration on innovation. In addressing unobserved heterogeneity, the literature often relies on the time dimension of the data, typically available in developed countries. In this case, using lagged density as an instrument for current density (Ciccone & Hall, 1996) or comparing the evolution of plants after a natural experiment (Greenstone et al., 2010) allows for capturing some of the endogeneity problems. The use of cross-sectional firm data to measure density (urbanization and localization) limits the adoption of this approach. However, this thesis leverages a unique feature of our data in which all firms in the survey responded to reasons for locating in a particular locality to address endogeneity issues. We replicate our analysis on a subset of firms that declare being close to where their founders come from, which should dampen the mobility issue. We control for firms in localities that indicate infrastructure as a determinant of their location to control for the quality of infrastructure, which is usually unobservable. Notwithstanding the controls, our main conclusions of positive urbanization and a negative localization effect still hold, even if the precision of our estimates slightly decreases.

In disentangling the effects of urbanization and localization economies, we focus on analyzing the distance at which the effects of industrial aggregation, conceptualized as urbanization and localization, materialize. There is a priori no solid theoretical argument for whether spatial concentration should refer to economic activity within 10, 25, or 50km from the firm, with the empirical literature (Rosenthal & Strange, 2003; 2020) primarily focusing on developed countries. Similarly, localization effects could happen between firms within broad sectors, manufacturing, or precisely defined industries. We follow Beaudry and Schiffauerova's (2009) recommendation and test for various distances and industry definitions. Urbanization effects are most robust and significant for 25 to 60km around the establishment. Localization effects negatively impact innovation at most distances when considering relatively precise definitions of industries (2 or 3-digit ISIC). These negative coefficients suggest that size and competition effects may have a more substantial detrimental effect on innovation than the positive Marshallian spillovers in the context of developing countries, similar to studies (Knoben et al., 2023; Knoben & Arikan, 2014; Stuart & Sorenson, 2003; Drucker & Feser, 2012) that result in adverse localization externalities effects on innovation.

The thesis dwells on several questions in the survey to shed some light on the mechanisms behind these results. All firms in the innovation survey report the factors that hamper innovation, whether or not they innovate. Using these factors (described in Chapter 2) as outcome variables, we find that urbanization is associated with lower difficulties in accessing funds or sources of knowledge. However, firms in dense industry-specific employment clusters report the lack of information or the uncertainty about their market as factors hampering their innovation. Among firms innovating, on average, those with a high value of the localization report that their suppliers or buyers were a stronger motivation to innovate and a more critical source of external knowledge. These point to the potential existence of positive Marshallian externalities, even if they seem too weak to generate localization economies positively on average. The positive effect of urbanization and the negative impact of localization that we identify on innovation aligns with the results of Knoben et al. (2022) in a sample of four Southeast Asian countries. The variety of empirical results in the literature, signaling ambiguity in outcomes, relate to the different theoretical mechanisms at stake, which can be positive (Jacobs or Marshall spillovers) or negative arising from congestion, competition, and technology lock-ins, with heterogeneous firms (Knoben et al., 2016) in clusters having different effects.

We structure the rest of the chapter with section 4.2, placing our work in the extensive related literature and the hypothesis. Section 4.3 presents the data sources, descriptive statistics of the data, the conceptualization of the measurement, and the primary empirical strategy for analysis. Section 4.4 presents the results, robustness checks, and channels. Section 4.5 elaborates on the conclusion, discussions, and policy recommendations.

Section 4.2 Literature and Hypothesis

A long tradition in urban economics literature estimates how economic activity density affects several local outcomes, such as nominal wages, productivity, or innovation. The idea that the agglomeration of economic activity can raise productivity dates back to the concept of Marshallian externalities. Marshall (1890) argues that agglomeration economies arise from interactions in the labor market, access to more specialized inputs, and knowledge spillovers. As pointed out by Duranton and Puga (2004), the actual microeconomic mechanisms within each of these "markets" (labor, inputs, and knowledge) can be of three kinds. Agglomeration of economic activity allows firms to share indivisible production factors, raise match quality between agents, and foster learning through frequent contacts. The literature (Marshall, 1890; Arrow, 1962; Romar, 1986; Porter, 1990) shows that the transmission mechanisms of the externalities are more robust if agglomeration happens between firms producing similar goods. On the contrary, Jacobs (1969) emphasizes the diversity of industries within a city as an essential source of spillovers fostering growth.

The empirical estimation of agglomeration effects has been the subject of extensive empirical literature (Combes & Gobillon, 2015). According to Duranton (2015), the elasticity of productivity concerning population density is typically 2 to 4% but can be substantially higher in developing countries (Combes et al., 2013). For the type of spillovers behind such effects, the literature (Glaeser et al., 1992) extensively exploits variation in the growth of industries in US cities, for instance, and identifies the existence of knowledge spillovers between industries a la Jacobs (urbanization), rather than within industries a la Marshall (localization). Exploiting firm-level data, Rosenthal and` Strange (2003) identify a strong localization effect for most industries they study and a somewhat unstable urbanization effect. They use variation at the zip-code level in the US and show that the localization economies dissipate quickly within the first miles around the centroid of a zip-code and much less

quickly beyond 5 miles. In the case of France, Martin et al. (2011) identify a positive effect of localization economies on productivity but no evidence of urbanization economies, at least in the short run. In this thesis, we measure agglomeration economies within 25 kilometers around the centroid, bearing in mind that the Marshallian externalities diminish (Paci & Usai, 1999; Shefer & Frenkel, 1998) with distance.

Relative to our outcome variable, Baptista and Swann (1998) show that firms in the UK innovate much more if there is much employment in their sector, but not in general. Extensive literature has concentrated on the link between agglomeration and innovation (see Carlino & Kerr (2015) for a review). Much of this literature focuses on research activity or patents, i.e., on new innovations[1], as Duranton (2015) and many others suggested. However, innovation in a developing country is typically less often associated with R&D spending, patents, or the introduction of significant product innovations. It is more incremental and relies on the absorptive of existing knowledge, with potentially more scope for spillovers (Siba et al., 2012). These features and the lack of available data may explain the striking fact that Carlino & Kerr's (2015) authoritative survey on agglomeration and innovation virtually contains no reference to studies on developing countries.

Studies on the link between spatial concentration and firm performance in the context of developing countries are still rare but have started emerging in the last decade. Siba et al. (2012) examined a census of firms with over ten employees in Ethiopian manufacturing over ten years. They found no urbanization effect but a significant localization effect that is positive on physical productivity but negative on prices (competition effect). The two cancel out, giving little incentives for firms to agglomerate. Howard et al. (2014), in the case of a census of large Vietnamese manufacturing firms, find positive urbanization and localization effects on productivity. In a cross-country sample of Sub-Saharan African firms, Sanfilippo and Seric (2016) show that urbanization is positively linked to firm

[1] A number of studies argue that research activities are even more concentrated than population or than other production activities, suggesting that agglomeration forces are even stronger for knowledge-related activities. Carlino et al. (2007) show for example that, among metropolitan areas in the U.S., a higher density of employment substantially raises the number of patents per capita. Other studies confirm using patent citations that knowledge spillovers decrease at a very high rate with distance (see e.g. Murata et al., 2014). It is not only the size of the city which may matter but also the diversification of its production base, see Feldman and Audretsch (1999).

productivity while localization correlates negatively with productivity, a result in line with the study of Chhair & Newman (2014) in Cambodia. Compared to these studies, we use data on the universe of establishments in Ghana, giving a much broader coverage than previous studies except for Chhair & Newman (2014), which is similar in size. Complete coverage of small firms is a critical advantage in a developing country where firms are typically small (Hsieh & Olken, 2014), given the previous evidence that agglomeration economies are more prominent for small firms (Rosenthal & Strange, 2010). We look at innovation rather than productivity and can use several detailed questions asked to firms on their motives, which were previously unavailable. Close to our work in terms of the questions, Zhang (2015) finds a positive impact of urbanization on product innovation but no effect of localization in the Chinese context.

Although it diminishes with distance (Paci & Usai, 1999; Shefer & Frenkel, 1998), externalities can spillover naturally (Marshall, 1890), or firms can deliberately and strategically identify, select, and network with the knowledge creators within the cluster (Arikan & Knoben, 2014) to acquire innovation knowledge. However, the beneficial effects of both externalities in an urbanization or localization (technology or industrial) agglomeration or cluster remain ambiguous. Arguments for localization (Marshall, 1890; Arrow, 1962; Romar, 1986; Porter, 1990) and urbanization (Jacobs, 1969) spearhead the basis for extant studies, such that some (Ouwersloot & Rietveld, 2000; Oort, 2002) found localization more effective than urbanization, others (Hatzichronoglou, 1997; Feldman & Audretsch, 1999; Duranton & Puga, 2000) posit that urbanization is relatively more effective, with some (Shefer & Frenkel, 1998; Paci & Usai, 2000) indicating that both are effective.

In developing countries, the few large firms in the same industry that may have the capacity to create knowledge will experience net loss (Shaver & Flyer, 2000; Pouder & St. John, 1996) in unintentional externalities as knowledge spills over mostly in one direction to small-sized firms (Arikan & Knoben, 2014), and as a result, causing large firms to select and network with other knowledge creators outside (Giuliani, 2011; Kesidou & Snijders, 2012) the cluster, that may eventually lead to recycling of obsolete technology in the cluster. Studies (Arikan & Knoben, 2014) show that, in localization or technology clusters, the strong or large firms (few in developing countries) with the capacity to undertake deliberate acts of knowledge creation can have innovation performance benefit from deliberate and unintentional externalities, but this is condition on the level of trust, value, and number of knowledge creators in the cluster. Therefore, we

argue that institutional rigidities, weaknesses, and size constraints (Ekuru et al., 2014) and fewer knowledge creators (Zanello et al., 2016) provide a fertile ground for these conditions to fester adversely, potentially limiting the prowess of deliberate knowledge creation in localization economies for developing countries. In line with Harrison et al. (1996), we argue that since urbanization is receptive to the exchange of skills and diversification, in developing countries, selecting and networking with firms outside the technology cluster can adversely affect localization more than urbanization clusters.

Additionally, clustering can deepen competition for critical resources (Frenken et al., 2015), such as few skilled workers, thereby increasing the cost and offsetting the benefits of externalities. Studies (Arikan and Schilling, 2011) show that in the face of competitive pressure in technology or localization clusters, weak or small firms suffer from diseconomies of agglomeration. Thus, we argue that the agglomeration diseconomies due to the high cost of skilled workers should be more prone to localization than urbanization clusters since, in urbanization, exposure to diverse industries implies the availability of diversely skilled workers (Harrison et al., 1996) that can provide opportunities for substitution, relatively lowering the cost. Therefore, since firms are predominantly small and micro in developing countries, we expect an adverse effect of localization externalities of innovation.

Duranton and Puga (2001) develop a model where young entrepreneurs can learn about their ideal production process by drawing from the experience of firms around them, putting forward a learning mechanism. Helsley and Strange (2002) argue that having access to a denser network of input suppliers may make it less costly to implement new ideas, emphasizing a sharing mechanism. Within an industry, a higher spatial concentration affects the intensity of competition, potentially acting as a driver of innovation in the spirit of Porter (1990). Desmet and Parente (2010) propose a framework in which competition increases the size of firms, giving them additional incentives to conduct process innovation. From a more Schumpeterian perspective, however, competition can be detrimental to innovation, and Aghion et al. (2005) point to an inverted U-shape relationship between competition and innovation. These arguments could imply less innovation in places with more spatial industry concentration, generating a negative localization effect. Heblich et al. (2022) show that opening large plants may, in the long run, limit the incentives for firms that interact with them to innovate. When a regional economy becomes too specialized around a major player, this creates

a long-run "lock-in" effect that stifles local innovation. Such mechanisms could also account for a negative localization effect (Glasmeier, 1992; Pouder & St. John, 1996) when a few large firms dominate knowledge creation in a cluster, with small and micro-sized firms crowding the industry.

Further to our earlier argument, we argue that, in developing countries, intense competition among small and low-capacity firms results in the imitation of obsolete technology that yields adverse competitive effects, leading to diseconomies of agglomeration in industrial clusters. Alternatively, urbanization should positively benefit innovation since the intense competition among firms in the same industry and cluster is minimal, permitting the cross-fertilization of ideas even among small and micro-sized firms. Consequently, we hypothesize that:

> *H^1_0: On average, the Marshallian externalities in urbanization agglomeration positively enhance firm innovation in developing countries, while those in localization agglomeration adversely affect it.*

Section 4.3 Methodology

4.3.1 Conceptualization of the Measurement

Generally, proponents of urbanization claim that cross-fertilization of complementary firms in different sectors fosters knowledge-sharing and innovation, although at a cost (Pouder & St. John, 1996). However, those for localization essentially argue that since knowledge externalities emanate from firms in the same industry, they can monopolize and internalize much of the knowledge created for innovation performance (Glaeser et al. (1992). In the literature (Beaudry & Schiffauerova, 2009), the ambiguity in outcomes (localization or urbanization effects) is attributed to measurement, methodology, and agglomeration forces across industries and periods. Therefore, they recommend testing various measures of dependent and independent variables with the same data set and comparing the two densities to provide conclusions that will minimize the ambiguity concerning which is better. We conceptualize this test in the following fixed-effects model experiment:

Table 4.1: Experiments for the effects of localization and urbanization externalities

`Location (j) Industry(i)	Establishments within a 25 km radius (j=1)	Establishments within a 50 km radius (j=2)	Establishments within a 100 km radius (j=3)
Broad activity (7-groups) (i=1)	X_{11}	X_{12}	X_{13}
ISIC div 2 (i=2)	X_{21}	X_{22}	X_{23}
ISIC div 3 (i=3)	X_{31}	X_{32}	X_{33}

In this experiment, we independently test for an industry group and location effects on innovation. Hence, we expect nine industry-location outcomes each for localization and urbanization. Apart from the control variable, the experiment will estimate outcomes for 18 variables in the industry-location outcome combinations. We arrive at conclusions favoring localization when the ith industry groups have a significant positive effect. Alternatively, regardless of industry groups, urbanization is more effective when externalities from colocated firms significantly affect innovation. However, when the results go in the same direction, we arrive at the same quagmire and cannot choose.

4.3.2 Data

This chapter primarily relies on unique firm-level census and sample survey data collected in 2013 by the GSS, vividly described in chapter two. The resulting data contains many indicators on all establishments, such as sales, employment, ownership structure, and detailed industry and geographic location information. This data collection effort is unique in the context of a lower-middle-income country. The 2014 firm-level census precedes the sample survey, establishing the universe of formal and informal establishments of all sizes, resulting in the enumeration of 638,000 establishments employing more than 3.3. million people. About 100,000 are manufacturing establishments, employing close to 430,000 people, contributing 13% of employment. The largest 2-digit industry is retail trade, with 18% employment. In the manufacturing sub-sector, the manufacture of wearing apparel is the largest industry, accounting for 34% of employment, followed by the manufacture of food products (19%), metal products (8%), wood and wood products (6%) and furniture (5%).

The census contains information about the locality of each establishment, allowing the construction of a precise map of economic activity. Ghana has 15,000 Localities, 216 districts, and ten large regions (see the map in Figure A.1 in the appendix at the time of the survey). As shown in Table 4.2, localities

vary hugely in size, from hamlets with no or one establishment and employee to Accra Central, a district in the national capital, for which the census reports more than 14,000 establishments and 300,000 employees. We observe at least one establishment in the census for 12.463 localities. We also compute the number of employees and establishments per square kilometer in each location to capture the density of economic activity. Figure 4.1 maps the density of employment in Ghana.

Table 4.2: Descriptive Statistics for Localities during the Economic Census

	Mean	Min	p10	p50	p90	p99	Max
Employment	270	1.000	4.00	31	285	4,252	347,139
N. Estab.	51	1.000	1.00	8	66	824	14,329
Area (sq. km)	14	0.010	0.34	2	32	168	1,197
Emp./sq. km	196	0.002	0.28	19	291	2,044	386,385
Estab./sq. km	38	0.001	0.10	5	71	438	41,512

The map in Figure A.2 in the appendix shows the location of manufacturing establishments employing 90,000 people, and Table 2 summarizes several characteristics of these manufacturing establishments. These are, on average, small, with median employment of 5 and a mean of 21. The average age of establishments is 12 years, and only 4% are foreign-owned.

We compute the centroids of enumeration areas and average their coordinates at the locality (localities can consist of several enumeration areas) to obtain an estimated locality center using Ghana Population Sampling Frame Data on the geographic coordinates of localities at the Ghana Statistical Service. We compute the bilateral distance between localities using the great circle distance between the centers of localities. We use fuzzy matching methods to map the 2014 Ghana Business Sampling Frame to the Population Sampling Frame. Misspelling errors sometimes characterize the exact locality reported by the interviewers in the Business Sampling frame. To match those names with the official list of localities in Ghana, we use fuzzy matching methods and match localities with the best match in the official list in the same district, as long as the similarity score is higher than 10%. We show that our results are insensitive to that threshold in the robustness section.

Table 4.3: Descriptive Statistics for Firms for the Sample Data. Nb of obs: 5.285

	Mean	Min	p10	p50	p90	p99	Max
Employment	20.73	1.00	1.00	5.00	29.00	318.00	3,695.00
Innovate	0.10	0.00	0.00	0.00	1.00	1.00	1.00
Age	11.59	0.00	3.00	9.00	23.00	50.00	96.00
Foreign-owned	0.04	0.00	0.00	0.00	0.00	1.00	1.00
Empl./ km^2 ≤ 25km	185.06	0.12	5.31	23.55	847.09	1,123.17	1,224.55
Empl./ km^2 ≤ 50km	75.39	0.32	5.70	15.52	299.83	343.54	348.74

4.3.3 Empirics

4.3.3.1 Localization and Urbanization

Marshallian externalities are more likely for firms in the same industry if they are close geographically, a critical reason why the literature predicts that some industries concentrate geographically. Such externalities could happen at a relatively broad level of industry definition or only within very narrowly defined industries. Similarly, the geographic distance at which Marshallian externalities propagate is unclear, particularly in a developing country context. In this context, we follow the recommendation of Beaudry and Schiffauerova (2009) and present our results at different levels of industrial and geographical aggregation. For a given locality l, we define the set of localities Ldl as those situated less than d km away from l. We define the localization of a firm in locality l and industry s as the density of industry employment in and around the location in line with Marshal (1890), Arrow (1962), and Romar (1986), excluding the firm's employment, which we compute as:

$$Loc_i^{sd} = Log\left(\frac{1 + \sum_{l' \in \mathcal{L}_l^d} Emp_{l's} - Emp_i}{\sum_{l' \in \mathcal{L}_l^d} Area_{l'}}\right) \quad (1)$$

As per the standard literature, excluding the firm's employment from the localization construction guarantees no mechanical correlation between the firm's size and the localization measure (Martin et al., 2011). We let d vary in steps of 5 km between 0 km, considering only employment in the own locality l, and 100km, including all localities of which the geographical center is less than 100km from the center of l. Similarly, we define sectors at three levels of aggregation, with a broad category consisting of 7 manufacturing sectors and 2-digit and 3-digit ISIC classifications. We experiment with alternative measures of localization in the robustness section. As a potential alternative

source of spillovers, we consider more general measures of the density of economic activity in a region that is not specific to an industry, in the spirit of Jacobs (1969). We define the urbanization of a locality l and its surrounding areas as follows:

$$Urb_i^{sd} = Log\left(\frac{1+\sum_{l'\in\mathcal{L}_l^d} Emp_{l'} - Emp_{l's}}{\sum_{l'\in\mathcal{L}_l^d} Area_{l'}}\right) \quad (2)$$

Again, to avoid the localization measure being mechanically related to the urbanization measure, we exclude the employment of the industry s of firm i.

4.3.2.2 Baseline specification

Our baseline specification is:

$$Innov_i = \beta_0 + \beta_1 Loc_i^{sd} + \beta_2 Urb_i^{sd} + \beta_2 \mathbf{X}_i + \delta_{S(i)} + \delta_{R(i)} + \epsilon_i \quad (3)$$

Where $Innov_i$ is a binary measure of innovation by establishment i, in our baseline, we define it as one if firm i conducts either process or product innovation and zero otherwise. We report in the robustness section separate results for process and product innovations. Loc_i^{sd} and Urb_i^{sd} are the measures of localization and urbanization for firm i as defined in (1) and (2), with d indexing the spatial range considered and s the level of industry aggregation. X_i is an establishment-level vector of characteristics typically thought to affect innovation, such as the log age, the log of the number of persons engaged, or whether the establishment is foreign-owned. $\delta_{S(i)}$ denotes the coefficient on a dummy that takes value one if firm i is in the 2-digit industry S(i) and zero otherwise. $\delta_{R(i)}$ is a regional dummy that takes value one if firm i is in the region R, one of the ten administrative regions in Ghana (see map in Figures A1 to A3). We estimate (3) by a complementary log-log regression and cluster standard errors at the locality level. The choice of the complementary log-log model stems from the binary nature of the left-hand side equation, where the probability of innovation in the data is small (10%), making this approach preferable to a standard logit regression. We replicate our analysis with OLS and different levels of clustering of standard errors in the robustness section and show that the results are very similar.

Section 4.4 Results

4.4.1 Baseline Results

Table 4.4 reports our baseline regression for three different definitions of distance (25, 50, and 100km) and all three levels of aggregation of industries. Our localization measure has a negative significant coefficient at all three distances when defined at the 2-digit or 3-digit ISIC level, while it is insignificant primarily when using broad industry levels. On the other hand, urbanization appears positive and significant at 25 or 50km distance but not at 100km. All firm-specific control variables have stable coefficients across distances with economically significant estimated effects. Taking the 25km radius and the 2-digit industry definition, a one standard deviation increase in localization decreases the probability of innovation by about three percentage points for a firm with an average value of all the covariates[2]. The result is a strong effect, considering that only 10% of the firms innovate.

Similarly, a one standard deviation increase in urbanization raises the probability of innovating by four percentage points for an average firm. Firm size, as measured by the log of employment or persons engaged, is a very positive and significant determinant of the probability of innovation. Doubling the size of the average firm raises the probability of innovating by close to 5 percentage points. The other firm-level controls, such as age, legal status, or foreign ownership, do not appear as strong predictors of the decision of firms to innovate. The legal status and the foreign ownership enter with a positive and negative coefficient, respectively, but only sometimes significant at the 10% level.

In Figure 4.1, we run a separate regression for each distance range between 0 and 100km and plot the coefficients on localization and urbanization and their 95% confidence interval. It confirms that the positive and significant effect of urbanization identified in Table 4.4 for a 25 or 50-km radius extends to distances up to 80km depending on the precise industry definition. It is most substantial when considering a radius of 25 to 60km. The negative localization effect is stable and consistent at all distances up to 100km.

[2] The marginal effects of localization, urbanization and log size for a firm with an average value of all the covariates are respectively -0.013, 0.023, and 0.073.

Table 4.4: Urbanization, Localization, and Innovation

	25km			50km			100km		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Innovate	**Broad**	**2-digits**	**3-digits**	**Broad**	**2-digits**	**3-digits**	**Broad**	**2-digits**	**3-digits**
Localization	-0.06 (-0.80)	-0.16*** (-3.39)	-0.11*** (-3.20)	-0.13 (-1.46)	-0.18*** (-3.76)	-0.11*** (-3.38)	-0.22** (-2.24)	-0.20*** (-3.45)	-0.12*** (-3.21)
Urbanization	0.19* (1.81)	0.29*** (3.72)	0.23*** (3.36)	0.27** (2.13)	0.34*** (3.45)	0.25*** (2.89)	0.20 (1.28)	0.20 (1.45)	0.09 (0.76)
Log(age)	0.01 (0.19)	0.01 (0.14)	0.01 (0.12)	0.01 (0.25)	0.01 (0.22)	0.01 (0.15)	0.02 (0.30)	0.02 (0.26)	0.01(0.16)
Log(empl)	0.89*** (5.95)	0.92*** (6.15)	0.90*** (6.06)	0.90*** (6.09)	0.93*** (6.26)	0.91*** (6.17)	0.92*** (6.18)	0.94*** (6.29)	0.93*** (6.24)
Foreign-owned	-0.29 (-1.49)	-0.27 (-1.42)	-0.28 (-1.50)	-0.29 (-1.50)	-0.26 (-1.39)	-0.29 (-1.52)	-0.28 (-1.44)	-0.26 (-1.35)	-0.28 (-1.50)
Incorporated	0.24 (1.64)	0.26* (1.81)	0.24* (1.68)	0.25* (1.71)	0.26* (1.86)	0.24* (1.72)	0.27* (1.83)	0.27* (1.90)	0.25* (1.78)
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5272	5272	5272	5272	5272	5272	5272	5272	5272
Log-Likelihood	-1607.7	-1602.3	-1603.4	-1607.9	-1602.6	-1604.6	-1608.3	-1604.7	-1606.7
Sensitivity	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
Specificity	100	100	100	100	100	100	100	99.98	100

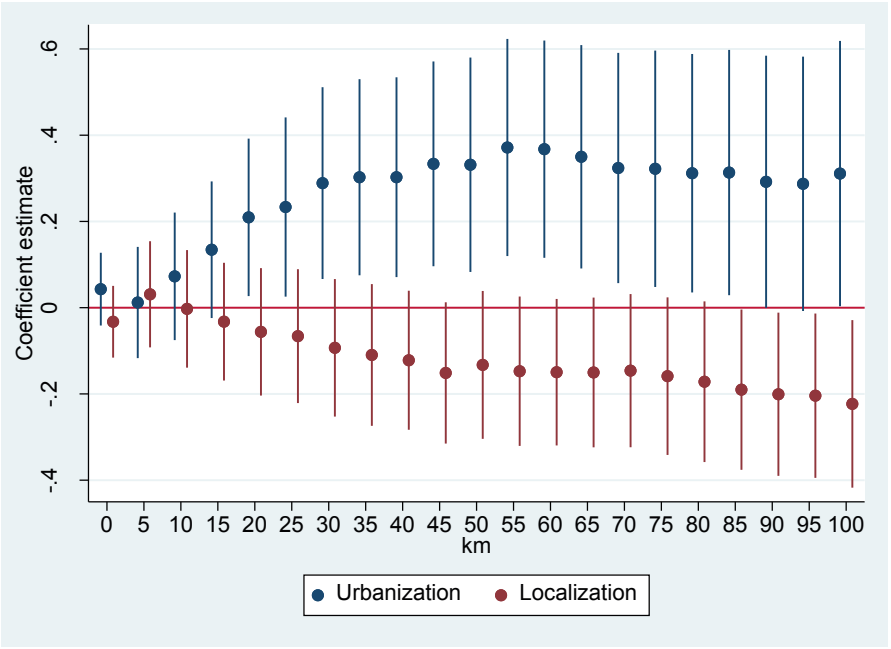


Figure 4.1: Localization defined at the Broad Level.

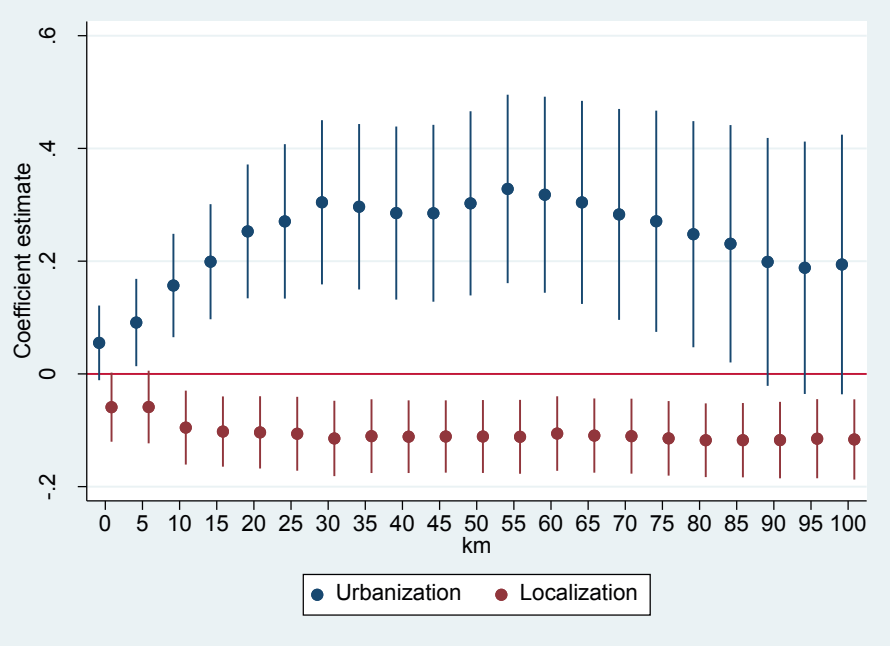


Figure 4.2: Localization defined at the 2-digit ISIC Level.

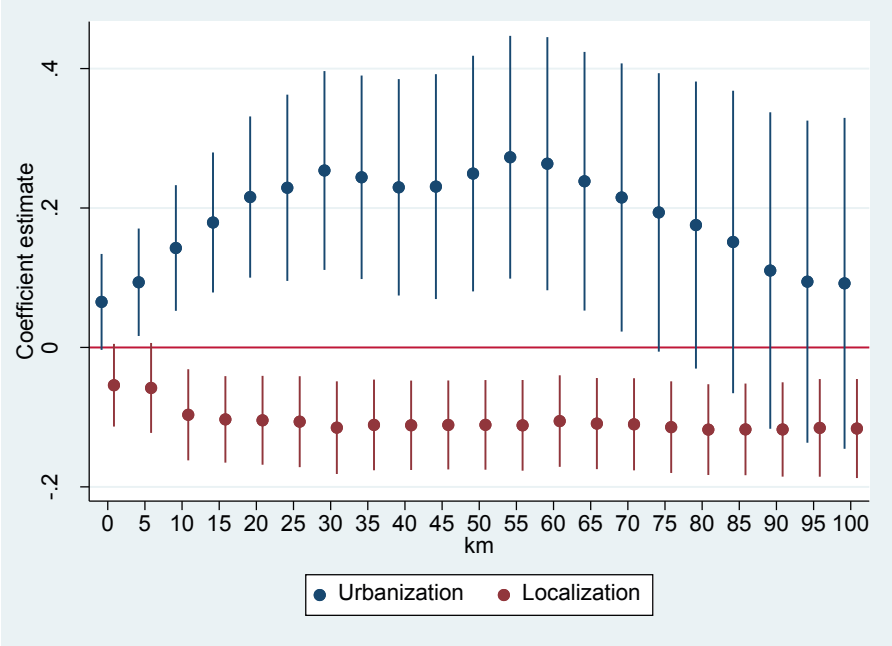


Figure 4.3: Localization defined at the 3-digit ISIC Level.

4.4.2 Endogeneity

The issue of endogeneity is a significant challenge for identifying a causal effect of geography on firm-level outcomes (Combes & Gobillon, 2015). To the extent that firms choose their geographic location endogenously, observing a correlation between the economic activity in a region and the innovation of firms in this region may reflect different forces. First, firms may benefit from the presence of consumers, suppliers, or workers in their region (Marshallian externalities) or have higher incentives to innovate when facing stronger local competition, the causal effect of interest. Second, there can be joint innovation determinants and the choice of firm location at the local level, such that some local amenities may affect both the level of innovation and the choice of firm location. For instance, the presence of a university, the quality of infrastructure, or the efficiency of local public institutions could contribute simultaneously to innovation and the density of economic activity. If these local amenities result from the density of economic activity, their effect on innovation should be considered part of the total effect of local economic activity on innovation. However, if they are not, or only partially so, they will cause a bias in our estimate. Third, the correlation may be due to reverse causality. The most

innovative firms may be more mobile and endogenously decide to locate in regions with a higher density of economic activity[3].

Identifying the direction of causality is essential to determine the strength of externalities and to draw appropriate policy recommendations. The literature (Combes & Gobillon, 2015; Baum-Snow & Ferreira, 2015) widely recognizes this problem, and different studies apply different approaches to tackle the issue. First, to address a potential omitted variable bias due, for example, to local amenities, the literature typically controls for local fixed effects in a panel regression. This strategy, which would not solve the problem of reverse causality and time-varying amenities, is not available in our case due to the cross-sectional nature of our data. A second route followed by the literature is to instrument for the density of local economic activity using historical or geographical instruments. Carlino et al. (2007) use, for example, geographic variables, such as the temperature or the presence of water, as instruments for population density. On the other hand, Ciccone and Hall's (1996) instruments for current population density by the historical location of economic activity. However, finding a credible and robust instrument for an establishment's location in a cross-sectional dataset in Ghana seems a real challenge.

We adopt an alternative strategy by exploiting responses to why the establishment is in the current location ("What were the reasons for locating at the present address?"). Figures 4.1 to 4.3 replicate Figures 4.4 to 4.6 using the subsample of firms from Phase 2 (sample survey data) that report locating "close to where the founder was born, grew up or his family." We argue that using these responses will dampen the concerns resulting from firms' endogenous choice of location in this sample consisting of 1894 firms, 8.2% of which innovate. While the confidence intervals naturally become broader, the main conclusions remain unchanged: localization economies remain predominantly negative, and urbanization positively affects innovation when defined at a range of up to 60km, with close to 5% significance at most intermediate distances.

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[3] The existing evidence on the mobility of entrepreneurs mostly relies on developed economies (see e.g. Figueireido et al. (2002) for Portugal and Michelacci and Silva (2007) for the US and Italy. These studies show that entrepreneurs are typically staying in their home region, suggesting that mobility is not a strong issue. However, these effects may be different in Ghana and even low mobility rates may bias our estimates if innovators have a different propensity to move than non-innovators. In a similar vein, Glaeser and Saiz (2004) find that skilled workers sort into larger cities, an effect which may be picked up by estimates of the urban scale effect on wages.

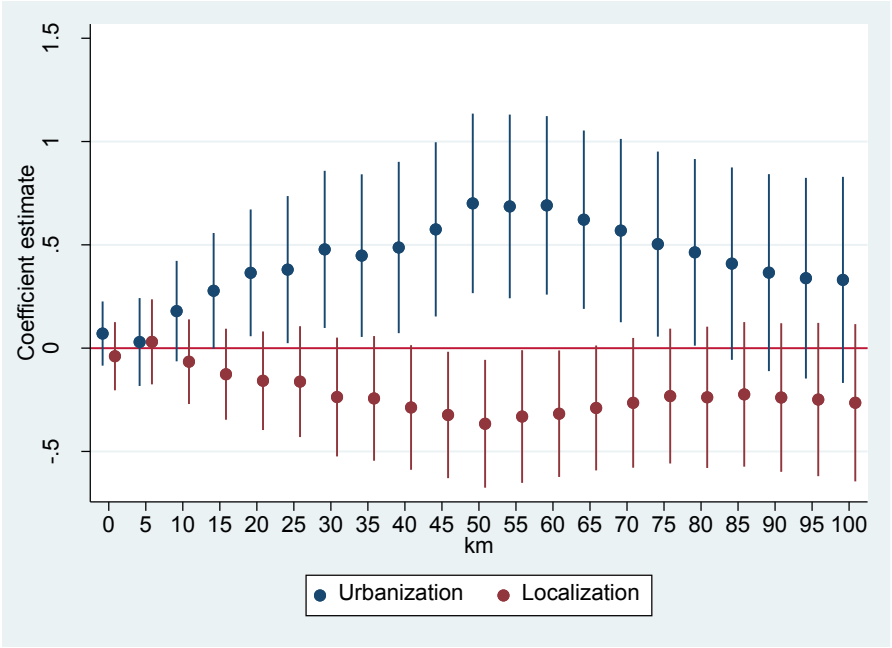


Figure 4.4: Localization defined at the Broad Level Discounting Endogeneity.

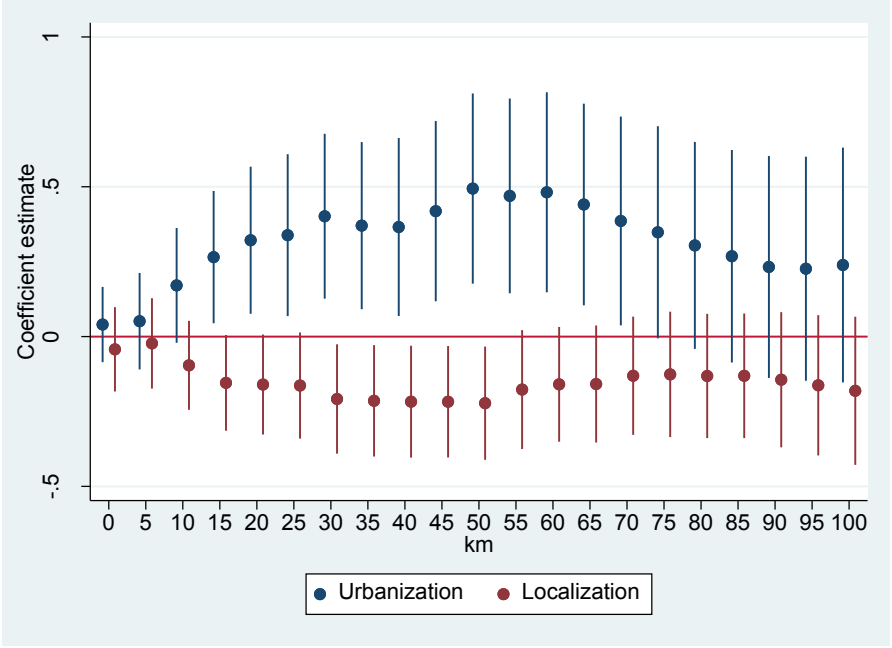


Figure 4.5: Localization defined at the 2-digit Level Discounting Endogeneity.

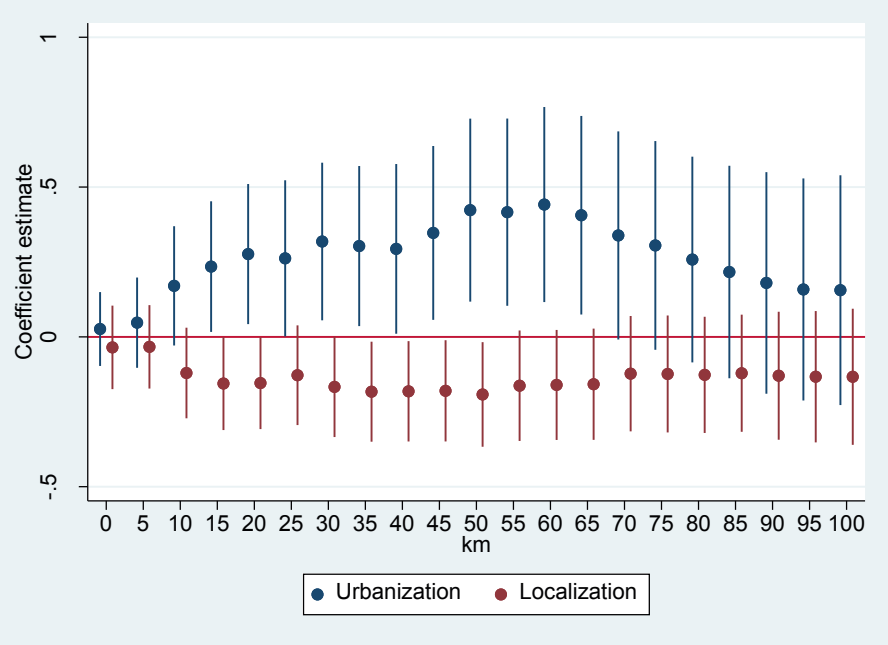


Figure 4.6: Localization defined at the 3-digit Level Discounting Endogeneity.

Proxying for the quality of infrastructure in a locality, a variable typically unobservable, we again exploit the response to the question on the reasons for locating at the present address. We use the share of firms in a locality that mentions infrastructure as a reason to proxy for a locality's quality of infrastructure and add it as a control. Reproducing Figures 4.4 to 4.6 with this additional control (not reported) has virtually no effect.

4.4.3 Robustness Test

In this section, we report several robustness checks. To simplify the exposition, we only present the results for localization defined at the 2-digit level and for urbanization and localization based on a distance of 25km around the locality. We chose this specification as it has the highest log-likelihood in Table 4.4, but the robustness of our results does not hinge on that particular choice. The first column of Table 4.4 reports our baseline specification (Column 2 of Table 4.4) to ease comparison.

Estimator and standard errors: Column 2 of Table 4.5a estimates our baseline with OLS instead of the complementary log-log specification and shows that results are

very similar in a linear probability model. Column 3 explicitly considers the potential correlation of error terms in space and uses Conley standard errors based on a 25km radius around the locality. Our standard errors are barely affected by this exercise.

Measures of urbanization and localization. We experiment with two alternative measures of urbanization and localization. Like Martin et al. (2011), in column 4, we replace employment density per square kilometer in localities around the firm with the number of employees in those localities. The results correspond to using (1) and (2) without the area in the denominator. In column 5, we compute the densities based on the number of establishments, not the number of employees per square kilometer in and around a locality. Both exercises yield similar results to our baseline, with slightly stronger results when using establishments. In column 6, we compute measures of urbanization and localization based on the density of employment within a district and cluster our standard errors at the district level. The coefficients are smaller in magnitude, as our results rely on less variation but point to similar qualitative results. The negative coefficient on localization, however, turns insignificant.

Placing urbanization and localization separately, our measures of urbanization and localization are strongly correlated. At the 2-digit level with a 25km radius, for example, the correlation coefficient is 0.7, even though our measure of urbanization excludes the employment of the industry considered (see the definition of urbanization in (2)). Such a high correlation is not surprising. A high employment density in an industry is likely in places with denser economic activity. For example, taking out the greater Accra region, the national capital and industrial hub reduces this correlation to 0.54. Columns 7 and 8 of Table 4.5a introduce our two measures separately. Urbanization remains positive and significant, while localization alone becomes insignificant. The negative localization effect that we estimate is conditional on a degree of urbanization.

Different sets of fixed effects. Columns 9 to 11 of Table 4.5a experiment with different sets of fixed effects. Column 9 excludes any fixed effects, but Column 10 contains region and industry fixed effects, with industries defined at the 3-digit ISIC level. The results remain very similar in both cases. Column 11 replaces region-fixed effects with district-fixed effects. The coefficient on the localization variable remains negative and significant, while the coefficient on urbanization remains of a similar size but turns insignificant. Including districts, dummies eliminate too much spatial variation for urbanization - defined in a 25km radius - to remain statistically significant.

Table 4.5a: Robustness test for Model Specification Comparison at 2-digit ISIC

	(1)	(2)	(3)	(4)	(5)
main	**Base**	**OLS**	**Conley**	**Prod. Inn.**	**Proc. Inn.**
Localization	-0.16***	-0.01***	-0.01***	-0.16***	-0.17**
	(-3.39)	(-3.10)	(-3.08)	(-2.91)	(-2.44)
Urbanization	0.29***	0.02***	0.02***	0.33***	0.26**
	(3.72)	(3.75)	(3.77)	(3.62)	(2.42)
Log(age)	0.01	0.00	0.00	0.07	-0.12
	(0.14)	(0.50)	(0.57)	(1.06)	(-1.32)
Log(empl)	0.92***	0.07***	0.07***	0.90***	1.41***
	(6.15)	(6.46)	(5.92)	(5.24)	(6.72)
Foreign-owned	-0.27	-0.02	-0.02	-0.30	-0.45*
	(-1.42)	(-1.07)	(-0.88)	(-1.29)	(-1.82)
Incorporated	0.26*	0.03*	0.03**	-0.00	0.58***
	(1.81)	(1.96)	(2.33)	(-0.01)	(2.96)
Ind. dummy	Yes	Yes	Yes	Yes	Yes
Region dummy	Yes	Yes	Yes	Yes	Yes
Observations	5272	5280	5280	5272	5256
ll	-1602.27	-1029.34		-1352.78	-948.56

The regressions in columns 1, as well as all columns 4 to 11, are complementary log-log models. OLS estimates columns 2 and 3. The dependent variable is a dummy for whether a firm innovates. Standard errors are clustered at the locality level except in column 3 (Conley standard errors, 25km) and column 6 at the district level. By default, Urbanization and Localization are computed as in (1) and (2) based on localities within 25km and 2-digit industry. In column 4, Urbanization and Localization are based on the number of employees (instead of density), while they are based on establishments per square km in column 5. Column 6 computes a measure of urbanization and localization at the district level. Columns 7 and 8 introduce localization and urbanization separately. Columns 9 to 11 vary the set of dummies included. In column 9, there are no industry dummies and no regional dummies. Industry dummies in all other columns are at the 2-digit ISIC level except for column 10, where they are at the 3-digit ISIC. Regional dummies in all columns are based on the ten regions of Ghana (see Figure 3) except for column 11, where they are defined at the district level.

Robustness Test using Heterogeneity across industries and firms

Data construction. As described in section 4.3, our procedure requires matching the detailed locality the interviewer reported to the official list of localities for which we have geographic coordinates. We use fuzzy matching methods and match localities with the best match in the official list if the similarity score is higher than 10%. While this generates a robust matching for most observations, the result is more speculative in some cases. In columns 1 and 2 of Table 4.5b, we discard matches below 50% or 80% in similarity score. Consequently, we drop

(6)	(7)	(8)	(9)	(10)	(11)	(12)
Level Emp.	**Estab.**	**Distr.**	**Adv. ind**	**Basic ind.**	**Small firms**	**Large firms**
-0.16***	-0.31***	-0.07	-0.21***	-0.14**	-0.11*	-0.24***
(-3.40)	(-4.47)	(-1.56)	(-2.69)	(-2.21)	(-1.65)	(-3.10)
0.34***	0.40***	0.11**	0.33**	0.29***	0.21**	0.44***
(4.22)	(4.58)	(2.00)	(2.41)	(2.96)	(2.17)	(3.47)
0.01	0.01	0.01	0.00	0.00	0.11	-0.12
(0.17)	(0.20)	(0.10)	(0.04)	(0.05)	(1.29)	(-1.19)
0.91***	0.90***	0.92***	0.80***	0.97***	0.97***	1.33***
(6.08)	(6.00)	(7.29)	(2.69)	(5.78)	(4.86)	(2.81)
-0.26	-0.33*	-0.29	-0.21	-0.31	-0.62	-0.39*
(-1.34)	(-1.73)	(-1.16)	(-0.74)	(-1.13)	(-0.66)	(-1.80)
0.26*	0.22	0.25**	0.44*	0.16	0.66***	-0.09
(1.84)	(1.58)	(1.97)	(1.78)	(0.93)	(2.98)	(-0.45)
Yes	Yes	Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes	Yes	Yes
5272	5272	5272	1553	3719	3679	1511
-1600.41	-1596.06	-1608.69	-482.56	-1116.30	-1027.57	-537.02

those observations from the estimation and the construction of the localization and urbanization measures. In both cases, our results are virtually unchanged.

Process and product innovation: Columns 3 and 4 of Table 4.5b show product and process innovation results distinctly, respectively, as dependent variables. The results are very close to our baseline in both cases.

Heterogeneity across industries, regions, and firms: To test whether the effects differ across manufacturing activities, we group all industries that pertain to ISIC codes 19 to 30, combining industries that typically use high technology during production, such as chemicals, electronics, pharmaceuticals, metal products, and motor vehicles ("Advanced"). We group all other manufacturing industries producing food, textile, wood paper, or furniture in a second category ("Basic"). Column 5 of Table 4.5b reports our baseline result only for advanced industries, while column 5 reports only for basic ones. The coefficients are in line with our baseline estimation for both sub-groups. We then split our sample between firms with less than ten employees in column 7 and firms with ten employees or more in column 8.

Table 4.5b: Robustness test for Model Specification Comparison at 2-digit for Segments of the Data

	(1)	(2)	(3)	(4)	(5)
	Fuzzy > .5	**Fuzzy > .8**	**Prod. Inn.**	**Proc. Inn.**	**Adv. ind**
Localization	-0.15***	-0.14***	-0.16***	-0.17**	-0.21***
	(-3.07)	(-2.71)	(-2.91)	(-2.44)	(-2.69)
Urbanization	0.30***	0.28***	0.33***	0.26**	0.33**
	(3.55)	(3.19)	(3.62)	(2.42)	(2.41)
Log(age)	0.01	0.02	0.07	-0.12	0.00
	(0.10)	(0.36)	(1.06)	(-1.32)	(0.04)
Log(empl)	0.91***	0.93***	0.90***	1.41***	0.80***
	(5.90)	(5.71)	(5.24)	(6.72)	(2.69)
Foreign-owned	-0.29	-0.25	-0.30	-0.45*	-0.21
	(-1.47)	(-1.11)	(-1.29)	(-1.82)	(-0.74)
Incorporated	0.24	0.18	-0.00	0.58***	0.44*
	(1.62)	(1.20)	(-0.01)	(2.96)	(1.78)
Industry dummy	Yes	Yes	Yes	Yes	Yes
Region dummy	Yes	Yes	Yes	Yes	Yes
Observations	5121	4300	5272	5256	1553
Log-Likelihood	-1557.2	-1330.8	-1352.8	-948.56	-482.56

All regressions are complementary log-log models. The dependent variable is a dummy for whether a firm innovates except in columns 3 and 4, where it is respectively a dummy for whether the firm conducts product or process innovation. Standard errors are clustered at the locality level. Urbanization and localization are computed in (1) and (2) based on localities within 25km and 2-digit industry. Industry dummies are at the 2-digit ISIC level, and regional dummies in all columns are based on the ten regions of Ghana (see Figure 3). In Columns 1 and 2, we recompute the data using different thresholds of similarity scores in fuzzy matching (see section 3). Columns 5 to 10 split the sample in different ways. Columns 5 and 6 split firms in advanced and basic industries. Columns 7 and 8 look separately at small and large firms. Columns 9 and 10 exclude firms in the Greater Accra region and the North (Upper East, Upper West)

Again, we confirm our main results for both subgroups, and they appear stronger for large firms. Finally, we exclude firms based in the region of Greater Accra in column 9 and the three regions of the Northern regions (Northern, Upper East, and Upper West) in column 10. Our results remain in both cases and appear firmer when excluding the capital region.

(6)	(7)	(8)	(9)	(10)
Basic ind.	**Small firms**	**Large firms**	**Excl. Accra**	**Excl. North**
-0.14**	-0.11*	-0.24***	-0.23***	-0.10*
(-2.21)	(-1.65)	(-3.10)	(-3.84)	(-1.88)
0.29***	0.21**	0.44***	0.38***	0.24**
(2.96)	(2.17)	(3.47)	(3.92)	(2.46)
0.00	0.11	-0.12	-0.01	0.03
(0.05)	(1.29)	(-1.19)	(-0.21)	(0.40)
0.97***	0.97***	1.33***	0.87***	0.83***
(5.78)	(4.86)	(2.81)	(5.34)	(4.88)
-0.31	-0.62	-0.39*	-0.01	-0.32*
(-1.13)	(-0.66)	(-1.80)	(-0.02)	(-1.65)
0.16	0.66***	-0.09	0.17	0.19
(0.93)	(2.98)	(-0.45)	(0.75)	(1.21)
Yes	Yes	Yes	Yes	Yes
Yes	Yes	Yes	Yes	Yes
3719	3679	1511	4342	4120
-1116.3	-1027.6	-537.02	-1215.4	-1263.4

4.4.4 Channels

In this section, we provide tentative mechanisms explaining the strong positive effect of urbanization on innovation and the negative or zero effect of localization. For this, we use the response to additional questions in the dataset regarding the difficulties firms face when innovating, their motivation, or their sources of knowledge.

4.4.4.1 Factors hampering innovation

All firms in the sample respond to the factors "hampering your innovation activities or influencing your decisions not to innovate." This question gives a precise answer about firms' difficulties, whether they innovate or not. We construct for each factor a dummy that takes value one if the firm declares a factor to be very important. The identified factors are (i) the lack of access to funds, internal or external to the firm, (ii) the high costs of innovating, (iii) the lack of knowledge (lack of qualified personnel, of information about technology or innovating partners), (iv) the lack of information about markets, or (v) the market being dominated by established firms. Firms can also declare that they

did not perceive the need to innovate. Firms can identify several important factors hampering innovation, and they often do. The median firm declares two out of the five factors as very important. Table A.11 in the appendix gives descriptive statistics about the different factors. Those factors that firms mention most often as very important about access to Funding, knowledge, or the high costs of innovation. Table 4.6 shows how our measures of localization and urbanization correlate with each factor hampering innovation, conditional on the same variables as in the previous section. Firms are significantly less likely to mention access to funding or access to knowledge as problematic in denser economic places (urbanization). These negative coefficients are consistent with urbanization's positive effect on innovation and hint at the reason behind that effect. In places with more employment in the same industry (localization), on the other hand, firms complain significantly more about the lack of information and uncertainty about market conditions as reasons not to innovate. Many other firms in the sector may make the environment more challenging to navigate.

4.4.4.2 Motivation to innovate and sources of knowledge

The survey asks all innovating firms about the reasons that motivated them to engage in innovation activities. About 300 firms answered whether customers, competitors, suppliers, or other firms that bought their products ("buyers") were important in motivating their decision to engage in innovative activities. Among the respondents, 88% mention customers as a very important reason to engage in innovation activities. 59% of innovators mention competitors, and 53% identify firms that buy their output as very important reasons for innovation. Only 30% say that suppliers were very important in their decision. The first four columns of Table 4.7 present a similar specification as in the previous section, where the dependent variable is a dummy that takes value one if the firm mentions one particular factor as a very important motivation. The interpretation is different as we are conditioning on a sample of firms innovating. The regression aims to identify whether, among innovating firms, the stated motivation to innovate differs across firms in more or less dense areas. Table 4.7 shows that firms close to other firms in the sector are likelier to mention buyers or suppliers as a motivation to innovate. Considering that many firms will buy or sell inputs to firms in the same industry, this could hint at some positive Marshallian externalities.

Additionally, we use another item in the survey, which asks all firms conducting innovating activities whether they "used [...] external sources of information

or ideas for any innovation activity". Columns 5 to 7 rerun our analysis and suggest that innovating firms with a higher value of localization are more likely to report having used knowledge from other firms (parents, suppliers, or buyers). They show no difference in external knowledge from other types of institutions (Academic, consultancies, or business associations), which we denote as "Research links" or other sources. Conditional on innovating, firms close to other firms in the same sector are thus more likely to report buyers and sellers not only as a motivation to innovate but also as a source of external knowledge, in line with at least some role for Marshallian externalities.

Table 4.6: Factors Hampering Innovation

	(1)	(2)	(3)	(4)	(5)	(6)
	Funding	**Costs**	**Knowledge**	**Market info**	**Competitors**	**No need**
Localization	-0.00	0.01	0.02	0.08**	0.03	0.03
	(-0.01)	(0.32)	(0.91)	(2.34)	(0.79)	(0.80)
Urbanization	-0.05*	-0.01	-0.10***	-0.05	0.08	0.01
	(-1.73)	(-0.37)	(-2.62)	(-1.05)	(1.52)	(0.20)
Log(age)	-0.07**	-0.05	-0.08**	-0.08*	-0.08*	-0.08*
	(-2.50)	(-1.55)	(-2.45)	(-1.87)	(-1.73)	(-1.91)
Log(empl)	-0.07	-0.02	0.01	0.09	-0.12	0.18**
	(-1.24)	(-0.29)	(0.21)	(1.26)	(-1.48)	(2.01)
Foreign-owned	-0.53***	-0.21	-0.45**	-0.50**	0.15	-0.19
	(-3.60)	(-1.23)	(-2.53)	(-2.19)	(0.76)	(-1.18)
Incorporated	-0.19**	-0.02	-0.35***	-0.17	-0.32***	-0.17
	(-2.45)	(-0.17)	(-4.01)	(-1.64)	(-2.60)	(-1.51)
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes
Region dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5277	5015	5272	5273	5021	5272
Log-Likelihood	-3401.9	-3299.5	-3435.5	-2971.9	-2529.8	-2657.1

All regressions are complementary log-log models. The dependent variable is a dummy for whether a firm declares factors hampering innovation. Urbanization is the number of people employed per square kilometer (following (2)) within 25km of the firm's locality. Localization is the number of people employed in the same industry (following (1)) per square km, with 2-digit industries. Standard errors are clustered at the locality level. Industry dummies are at the 2-digit level, and region dummies are based on the ten regions of Ghana (see Figure 3). A detailed description of factors hampering innovation is available in Table 8.

Table 4.7: Motivation to Innovate

	Motivations to innovate					External knowledge	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Consumers	Competitors	Buyers	Suppliers	Firm links	Research links	Other links
Localization	0.11 (1.11)	0.07 (0.71)	0.22** (2.12)	0.25** (2.23)	0.31** (2.40)	0.19 (1.41)	0.15* (1.66)
Urbanization	-0.11 (-0.81)	-0.05 (-0.32)	-0.15 (-0.84)	-0.27 (-1.29)	-0.25 (-1.17)	-0.36 (-1.64)	-0.16 (-1.03)
Log(age)	-0.03 (-0.32)	-0.00 (-0.03)	-0.21* (-1.65)	0.01 (0.08)	0.19 (1.17)	0.01 (0.06)	0.06 (0.56)
Log(empl)	-0.16 (-0.61)	0.45 (1.44)	0.35 (1.12)	0.33 (0.78)	0.59 (1.52)	1.23** (2.36)	0.60** (2.24)
Foreign-owned	0.10 (0.28)	-0.35 (-0.91)	-0.26 (-1.01)	-0.17 (-0.32)	0.67* (1.67)	-0.08 (-0.17)	-0.13 (-0.36)
Incorporated	0.47* (1.82)	0.11 (0.43)	1.01*** (4.19)	0.40 (1.21)	0.61* (1.95)	0.64** (2.04)	0.10 (0.45)
Industry dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Region dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	246	295	292	292	296	294	293
Log-Likelihood	-86.677	-182.85	-171.79	-154.61	-169.76	-157.38	-175.32

All regressions are complementary log-log models. The dependent variable is a dummy for whether a firm declares as very important a motivation to innovate (columns 1 to 4) or a source of external knowledge (columns 5 to 7). Urbanization is the number of people employed per square kilometer (following (2)) within 25km of the firm's locality. Localization is the number of people employed in the same industry (following (1)) per square km, with 2-digit industries. Standard errors are clustered at the locality level. Industry dummies are at the 2-digit level, and region dummies are based on the ten regions of Ghana (see Figure 3).

Section 4.5 Discussion, Conclusion, and Policy Recommendations

4.5.1 Conclusion

This chapter analyzes how the spatial concentration of economic activity affects innovation among firms in developing countries. We use the 2014 census of all establishments to map economic activity at the level of localities, combined with a detailed innovation survey of about 5400 firms. We find a positive and robust effect of the density of economic activity on innovation (urbanization economies), which is significant when defining the density within 25 to 60km of an establishment's locality. Conditional on urbanization, we also identify a negative effect of employment density in an establishment's sector (localization economies). We find that both effects are economically significant, with the probability of innovation for the average establishment increasing by four percentage points or decreasing by three percentage points for a one standard deviation increase in urbanization and localization, respectively. Our results are conditional on many establishment-level characteristics and industry and region-fixed effects.

To tackle the well-known endogeneity issue in such regressions, we replicate our analysis using a subsample of establishments declaring that their location is close to where the founder was born or grew up, i.e., those with a plausibly exogenous geographic location. We also control for some measures of the quality of infrastructure at the district level to further reduce the risk of an omitted variable bias.

The results add to the nascent literature on the agglomeration innovation nexus in developing countries, with exact measures of spatial concentration in an African context. We find a significant positive effect of urbanization on innovation even at a 50km range, a relatively longer distance than typically found in developed countries (Rosenthal & Strange, 2020), where the type of innovation and the channels through which urbanization matters may differ. Our use of detailed survey questions gives new indications of the channels through which urbanization and localization effects act in a country like Ghana. Interestingly, access to knowledge seems indeed facilitated by urbanization economies, consistent with this view of Jacobs. Beyond knowledge, facilitating access to finance appears as a critical component of the positive effect of urbanization, a channel that may be stronger in developing countries.

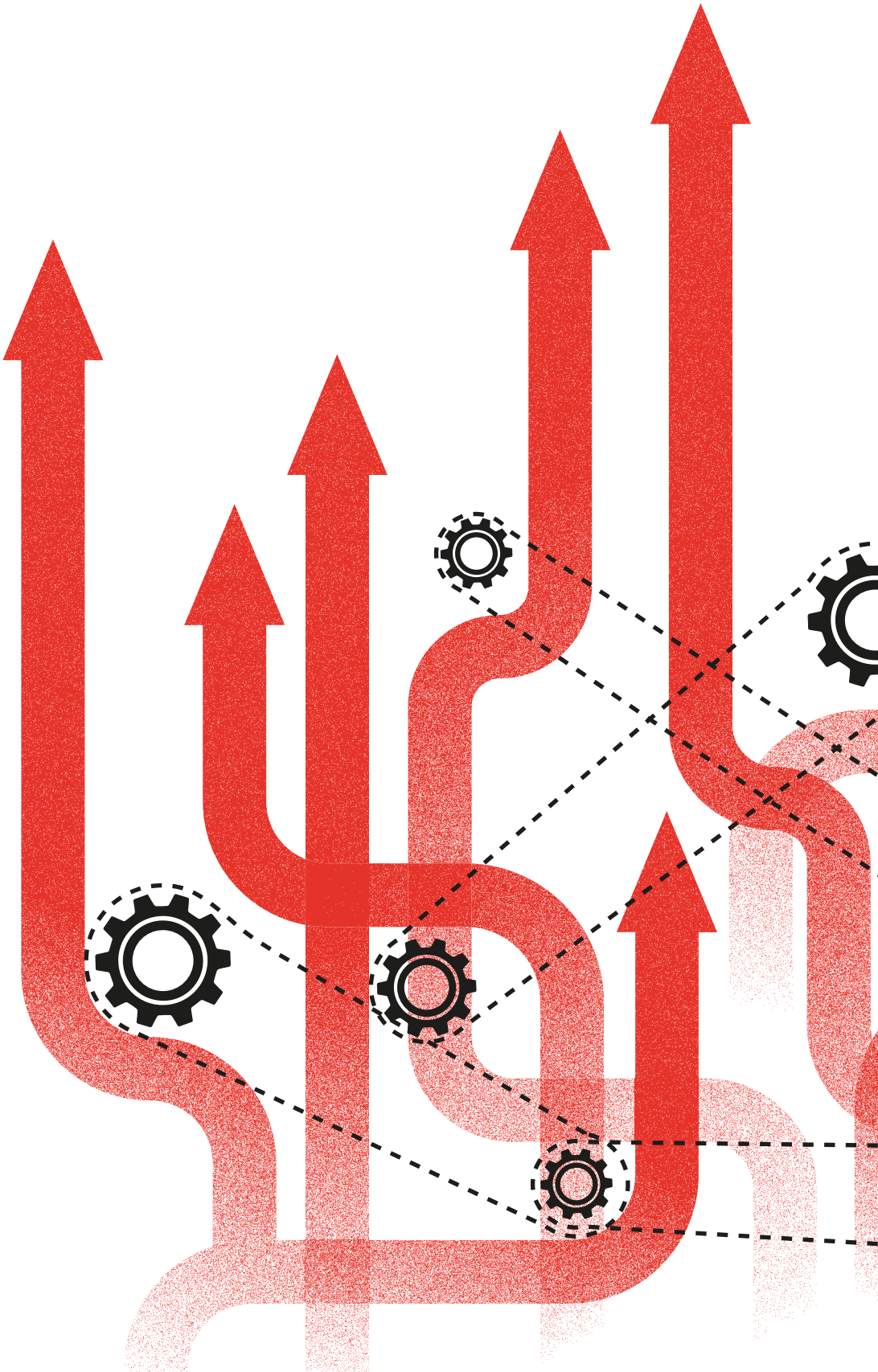
4.5.2 Hypothesis 3 and discussion

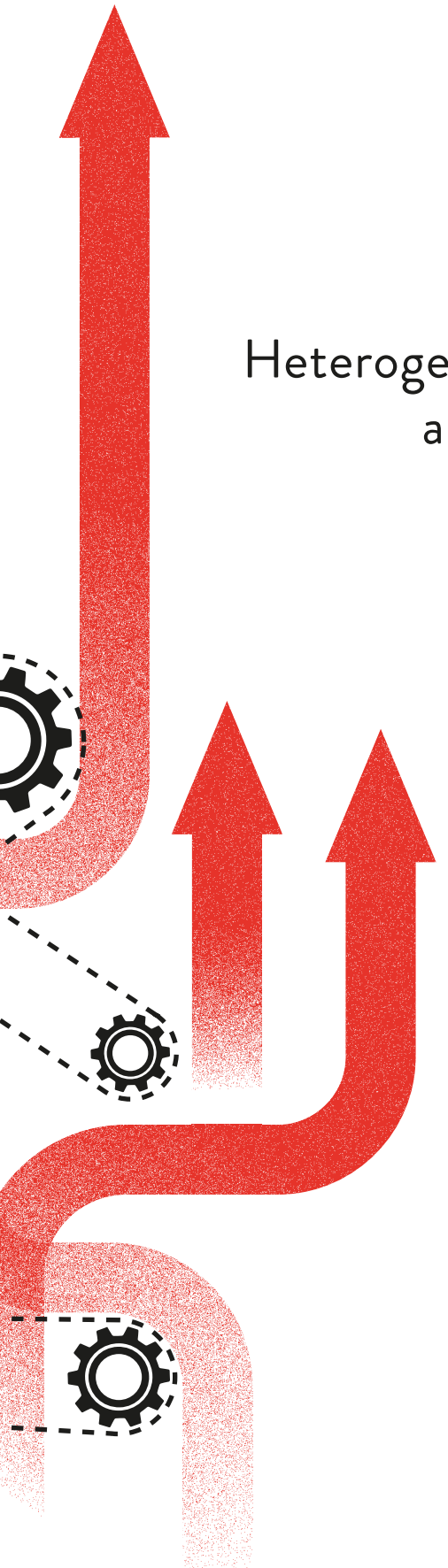
We reject the null and accept the alternative hypothesis that the Marshallian externalities on firm innovation are more effective in urbanization than in localization economies, particularly for developing countries. The benefits of diversity provide opportunities for diversification that lessen the size effect of firms in an agglomeration in developing countries, particularly urbanization clusters, benefitting from the cross-fertilization of ideas across industries and the urbanized market. Small and micro-sized firms with low capacity will typically imitate others by copying obsolete technologies in the same cluster (Pouder & St. John, 1996; Maskell & Malmberg, 2007), resulting in adverse localization effects on innovation, partly because the local localization monopoly economy in which firms internalize much of the knowledge created (Glaeser et al., 1992), can lend itself to restricting externalities spillovers, and limit the identification, selection, and the partnership (Arikan & Knoben, 2014) options available to the firm to tap into the externalities deliberately. In Chapter 2, firms report that customers are critical in the firm's innovation drive, and firms primarily implement reverse engineering, portraying the intensity level of imitation. Thus, in an economy denominated by small and micro-sized firms, large markets without industrial segregation provide the opportunity for input-output sharing. However, in a localization cluster, the few large knowledge creators will leak knowledge as they experience a net loss from knowledge sharing, while the small-sized firms in the majority with resource constraints will imitate, causing congestion (Sorenson & Audia, 2000; Knoben, 2009), and suffer from intense competition (Arikan and Schilling, 2011) with their peers in the same industry.

Turning to the mechanisms behind our results, we show that firms in regions with denser economic activities report fewer problems accessing Funding and knowledge. In contrast, firms in the same sector are more uncertain about the gains from innovating. Notably, the negative coefficient on localization does not necessarily mean the absence of Marshallian externalities. Among firms that innovate, those with a higher value of localization typically disproportionately report their suppliers or buyers as a motivation to innovate and identify them as sources of external knowledge. These externalities, however, seem too weak on average to generate positive localization economies. The uncertain returns to innovation for firms with a higher localization is an exciting result that deserves further investigation and points to the need for further disentangling the specific mechanisms of developing countries in the relationship between agglomeration and innovation.

4.5.3 Policy recommendation

Since externalities in specialized industrial clusters could harm innovation growth in developing countries, we recommend that they direct energies towards the development of urbanization since, on average, the firms could benefit from cross-fertilization of ideas that foster effective knowledge spillover for innovation growth. From the perspective of location effect, urbanization could be the panacea for innovation growth in countries dominated by small and micro-sized firms since knowledge diffusion can effectively affect innovation performance.





Heterogeneity of Firm Capabilities and Agglomeration Effects

CHAPTER 5

Section 5.1 Introduction

The colocation of firms nurtures knowledge externalities that, in turn, foster the innovation performance of firms (Marshall, 1890; Glaeser et al., 1992; Porter, 2000; Arikan & Knoben, 2014). However, research also shows that not all of the benefits of firm colocation are available to all firms. Instead, benefitting from colocation requires specific firm capabilities (Wu et al., 2013). The evidence (Shaver and Flyer, 2000; Knoben et al., 2016) shows that these firm capabilities moderate the effect of cluster externalities on firm-level innovation. Firms without such capabilities cannot tap into the available externalities for their product or process innovation.

In chapter four, we posit that spillover of Marshallian externalities from colocated firms across diverse industries within 25 to 60 kilometers, on average, enhances firm innovation in developing countries. On the contrary, those in similar industries experience adverse externality effects. An open question remains to what extent these effects are heterogeneous across firms. Varying outcomes (Shaver & Flyer, 2000; Chung & Kalnins, 2001; Giuliani & Bell, 2005; Knoben et al., 2016) relative to the heterogeneous features of firms suggest that internal strengths and weaknesses, expressed in capabilities, play a role for firms to be influenced differently, even for colocated firms in close proximities. Although most of these studies (Knoben et al., 2016; Drucker & Feser, 2012) rely on data from developed countries due to the paucity of firm-level data in developing countries, with some focusing only on a segment (Feser, 2002) of industries.

Conflicting findings (Shaver & Flyer, 2000; Pouder & St. John, 1996; Frenken et al., 2015; Cohen & Levinthal, 1990) on the effects of internal strengths and weaknesses on innovation lend ambiguity to the net moderating effects of capabilities on innovation performance in an agglomeration economy. We contribute to minimizing the ambiguity by deploying a binomial logit multilevel hierarchical model with firms nested in localization or urbanization clusters to examine the rich firm-level data for all industries described in Chapter Four, accounting for the variations between the various localization or urbanization clusters and the interactions between firm capabilities and the agglomerations effects (Srholec, 2010). We leverage the nonlinear (Knoben et al., 2016) interactions between firm capabilities and agglomeration effects to simultaneously examine the moderation effect of openness, absorptive, and market capabilities to explain why some firms benefit from the effects

of urbanization and localization economies (in Chapter 4) on innovation in developing countries. Intriguingly, this thesis arrives at different conclusions from what pertains to developed countries (Speldekamp et al., 2020; Knoben et al., 2016), exacerbating the argument of overgeneralization of outcomes in these previous studies.

Foreshadowing the main results, this thesis shows that openness, market, or absorptive capabilities are ineffective in positively moderating the significant effectiveness of urbanization externalities on innovation in developing countries. Similarly, incidentally, market or absorptive capabilities do not provide the mechanism to positively moderate to mitigate the adverse effect of localization clusters on innovation. Openness capabilities, which are supposed to moderate negatively and contribute to the adverse effect of localization clusters on innovation, also indicate a null effect. Firms in developing countries are predominantly small and micro-sized, limiting their capacity to identify and select knowledge creators within cluster densities, potentially limiting the prowess of their capabilities in the innovation and externality discourse. Intrinsically, the Marshallian externalities that engender firm innovation within clusters in developing countries are, on average, not moderated by the firm capabilities.

The subsequent sections in this chapter provide insights into the literature and hypotheses, methodology, results, conclusion, and policy implications.

Section 5.2 Literature and Hypothesis

In the agglomeration, colocating firms can benefit from unintentional knowledge spillovers (Marshall 1890; Porter 2000) or must be deliberate about it (Arikan & Knoben, 2014) by deploying capabilities in identifying and accessing external resources in combination with their internal resources, internalize these external resources, and optimally market the innovation outputs emanating from these resources. The extent to which a firm can internalize accessed external resources and derive maximum innovation performance that provides new value and useful external technology information depends on the individual employee and organizational absorptive capacities (Cohen & Levinthal, 1990), for instance, moderating the extent to which firms benefit from externalities, unintentionally or deliberately. Also, firms naturally benefit from market complementarities that offer lower perceived risk and efficiencies in joint marketing (Porter, 2000).

Nevertheless, firms require internal marketing strength as a competence for commercializing the firm's products, penetrating the markets with products and services that are new while consistently increasing the sales of new products in existing markets and permeating new markets.

From the perspective of the knowledge-based view (Barney, 1991; Arikan, 2009; Arikan & Knoben, 2014), substantial internal resources of firms propel external cluster resources to facilitate innovation performance. Otherwise, unintentional externalities from colocating in an agglomeration economy add little to the firm's innovation performance. Both internally weak (Frenken et al., 2015) and strong (Cohen & Levinthal, 1990; Kogut & Zander, 1992; McCann & Folta, 2011) firms can benefit from externalities in an agglomeration for innovation, although some internally strong firms experience net loss (Shaver & Flyer, 2000; Pouder & St. John, 1996) during unintentional externality spillovers (Arikan & Knoben, 2014), they gain from the externalities during deliberate knowledge partnerships, for instance. Thus, some capabilities could moderately enhance the positive urbanization effect, moderating to enable the adverse localization effects on innovation or offset it.

Openness capabilities involve collecting and sharing information, organizational cooperation, culture, and attitudes toward change that result in extensive inflows and outflows of knowledge, creating more opportunities to access and integrate knowledge for innovation (OECD, 2005). As pointed out by Wu et al. (2013), it can be internal, motivated by rigidities concerning innovation within firms, or external, involving the acquisition of externally sourced ideas that influence a firm's ability to embrace new marketing, strategy, and organizational innovations. Openness capabilities can be expressed in trust (Moulaert & Sekia, 2003) for colocated firms since firms can only open to sharing the knowledge created when they believe in getting a net positive benefit to innovation drive when they open (Arikan & Knoben, 2014; Moulaert & Sekia, 2003; OECD, 2010). Otherwise, knowledge creators engage in adverse selection in agglomeration (Shaver & Flyer, 2000) and partner firms external to the cluster.

However, we argue that opening up can moderate to facilitate access to diverse spillover externalities, which guarantees higher net positive benefits for innovation performance in an urbanization economy, increasing the firm's competitive advantage universally across industries. Complementing the firms' knowledge with externalities from diverse industries enhances the potential for diversification of product and risk portfolios, facilitating firm growth and survival

(Fernandes & Paunov, 2015). Thus, we expect that opening will provide the vehicle for accessing diverse industry externalities for higher positive innovation performance, bringing to the fore the positive moderation effect of openness on positive urbanization externality prowess for innovation performance.

On the contrary, with size, resource, and capacity constraints in developing countries, opening up in localization economies could negatively moderate to worsen the competition-induced adverse effect of localization externalities on innovation. Because, with a net loss (Shaver & Flyer, 2000; Pouder & St. John, 1996) in the localization economy due to opening up, the few large-firm knowledge creators would guard against opening up to prevent further leakage, limiting spillover of cluster externalities. Notwithstanding, small firms cannot assess and access external resources in technological (akin to localization agglomeration) clusters (Kale et al., 2002; Knoben et al., 2014; Arikan & Knoben, 2014), further limiting knowledge in the cluster. With small and micro firms dominating localization clusters in developing countries, a decline in creating new knowledge will lead to recirculating obsolete technology and corresponding technology lock-in (Maskell & Malmberg, 2007; Pouder & St. John, 1996). Also, with net positive effects from the unintentional spillover from strong firms (Arikan & Knoben, 2014), we argue that small and resource constraints firms will open up in localization clusters to access and absorb the externalities, worsening the industry congestion (Sorenson & Audia, 2000; Knoben, 2009) adverse effects, firms face in developing countries since industry entry becomes more accessible and accommodating. In developing countries, competitive disadvantages in a localization economy, as firms open up, abound.

Consequently, we expect opening up in a localization economy to provide a negative energy for externality prowess to negatively moderate the adverse competition-induced effect of localization externalities on innovation.

Hypothesis H^1_0: In an urbanization agglomeration, the openness capability of firms positively moderates significantly the diverse industry externalities to enhance the effectiveness of the positive urbanization externalities on innovation.

Hypothesis H^2_0: Openness capability negatively moderates significantly the adverse effects of localization externalities on innovation in developing countries.

Following Marshall's (1890) work on externalities from colocating firms in an agglomeration, subsequent works in the literature point to the need for the internal knowledge capability of firms as key in moderating the effects of cluster externalities on innovation performance. For instance, Cohen and Levinthal (1990) point out that firms will require absorptive capacities to use basic skills from scientific or technological developments to recognize, evaluate, assimilate, utilize, and exploit the value of new information to achieve innovative performance. Individual workers or the firm acquire this capability through developing R&D, alterations, imitations, training, or communication structures inside or between colocated firms. Some empirical works (Cohen & Levinthal, 1990; Voudouris et al., 2012; Arikan & Knoben, 2014) show that firms' absorptive capability justifies the extent to which firms internalize externalities in the cluster to impact innovation. With sufficient absorptive capabilities, firms can identify, select, and partner with knowledge creators in a technology cluster (Arikan & Knoben, 2014), while weak firms have limitations in internalizing cluster externalities. Albeit that, these studies dwell on evidence from developed countries.

In developing countries, predominantly, resource and size constraints (Edeh & Acedo, 2021; Bartels et al., 2014) lend firms to imitation (Zanello et al., 2016; Lorenczik & Newiak, 2012), resulting in learning by doing (Arrow, 1962), which contributes to improving absorptive capabilities at the individual employee level and, ultimately, the firm. Hence, even small and resource-constrained firms can internalize the externalities that emanate from colocated firms. As a result, even in a highly competitive environment, firms with higher absorptive capabilities can benefit from unintentional Marshallian externalities to gain a competitive advantage over other firms in the same cluster. In developing countries, for the few large firms in urbanization or localization clusters, higher absorptive capacities at the organizational level from investing in R&D (Cohen & Levinthal, 1990; Arikan & Knoben, 2014) can facilitate the internalization of externalities for innovation performance. However, due to their share numbers (Arikan & Knoben, 2014), it may be impossible for large firms in developing countries to identify, select, and partner with knowledge creators in the cluster, leading to a net loss (Shaver & Flyer, 2000; Pouder & St. John, 1996) in cluster externality spillovers.

Consequently, large firms may self-select (Arikan & Knoben, 2014) to partner with knowledge creators outside the cluster, which could lead to innovation knowledge imports (Giuliani, 2011; Kesidou & Snijders, 2012), with spillover

externalities to eventually benefit firms in the cluster, particularly those with higher absorptive capacities. Therefore, in developing countries, irrespective of urbanization or localization clusters, we argue that firms with high absorptive capabilities should be able to internalize knowledge spillover externalities to enhance innovation performance more than firms with lower absorptive capabilities, even for resource-constraint firms. Despite the existence of intense competition and their corresponding adverse effects with lower odds of survival (Stuart and Sorenson 2003) in clusters, we argue that firms with high absorptive capability can have a competitive advantage, enabling this capability to provide positive moderative prowess for externalities to enhance innovation in agglomeration economies.

Hypothesis H^3_o: On average, the absorptive capability of firms should positively moderate the positive significant externalities effects in urbanization clusters for innovation performance, even in developing countries.

Hypothesis H^4_o: On average, the absorptive capability of firms should significantly moderate positively to offset the significant adverse localization externalities effects for innovation performance, even in developing countries.

Firm survival and growth require extraordinary marketing competence to gain a competitive advantage among peers in mounting new approaches to enter and exploit targeted markets (Wang & Ahmed, 2004) while addressing customer needs and deploying new marketing methods with significant changes in the processes of research and advertising products (OECD, 2005). The intense networks in an urbanization or localization cluster from forward and backward linkages naturally facilitate complementarities between activities of colocating firms in marketing across up and down streams (Porter 1990, 2000), which facilitates higher innovation (Harvis-Oliver & Albors-Garrigors, 2009). However, one way to gain a competitive advantage (Harvis-Oliver & Albors-Garrigors, 2009) is to deploy market capabilities as a critical internal strength for diffusing innovation to leverage the externalities with market complementarities in localization or urbanization to foster innovation. Albeit, small and micro-sized firms lack the capacity and resources (Harvis-Oliver & Albors-Garrigors, 2009) to maintain marketing or design departments to keep relationships with suppliers, deploying the competence to sustain the relationship provides a competitive advantage among peers. Thus, having market capabilities should provide a competitive advantage to firms irrespective of the type of agglomeration economy.

Consequently, high marketing capabilities can moderately offset the effects of intense competition among firms, irrespective of the cluster. We expect firms with higher marketing capabilities to obtain higher returns on their innovation output than their counterparts while gaining a competitive advantage in the cluster. Adequate market capabilities can nib in the bud the competitive disadvantages associated with size and resource constraints since firms can have more resources from returns on innovation output to boost the prospects of internalizing knowledge externalities, even in a congested cluster, enhancing their competitive advantage, survival, and growth.

We argue that the market capability of firms complements the market complementarities associated with externalities from diverse industry clusters to foster innovation, and this contributes significantly to moderate the positive urbanization effects on innovation in Chapter Four. Even with adverse effects of localization on innovation due to intense competition, firms with high market capabilities should have a competitive advantage and the ability to navigate and market innovation output, leading to market capabilities moderately contributing positively to offset the competition-induced adverse effect of localization clusters on innovation.

Hypothesis H^5_0: The market capability of firms significantly moderates positively to complement the market complementarities for externalities in urbanization to enhance innovation positively, even in developing countries.

Hypothesis H^6_0: The market capability of firms significantly moderates positively to complement the market complementarities for externalities to offset other localization externalities that adversely affect innovation, even in developing countries.

Section 5.3 Methodology and Empirics

5.3.1 Definition of variables

Dependent Variable for the Primary Model

Innovation or overall innovation is our dependent variable and has the exact definition as in chapters two to four.

Independent Variables

This chapter uses independent variables in two broad categories for the primary model that examines firm heterogeneity and density effects on Innovation, Firm-level capabilities, and agglomeration measures of the firm location. The capabilities are absorptive, marketing, and openness, and the agglomeration measures are urbanization or localization.

Absorptive capability is the extent to which the firm uses its competence in identifying and selecting internal knowledge for effective monitoring to appreciate customer needs, identify market opportunities, and strategize to meet trading partner expectations.

Market capability is the ability to timely deploy competencies that enhance the commercialization of the firm's products with a well-organized marketing department and penetration of markets with products and services that are entirely new to the firm while consistently increasing the sales of new products in existing and new markets.

Openness capability is the extent to which the firm relates with partner institutions, trading partners, and institutional actors, including research institutions, with increased trust.

Localization is the number of workers per industry per the locality area in square kilometers within a 25-kilometer radius of the firm location.

Urbanization is the number of workers per locality area in square kilometers within 25 kilometers of the firm location.

Table 5.1: Measurement Matrix for the Variables in the Model and During the Survey

Variable	Use in model	Questions for firm-level capabilities	Measurement of variable in the model	Target respondents
Absorptive capability	Independent	Please indicate to which extent the firm agrees or disagrees with the identification and selection of the following internal knowledge of acquiring the knowledge required to understand customer needs, identify market opportunities, and comply with the requirements and expectations of trading partners.	For all the questions, respondents responded whether they agreed, were indifferent, or disagreed with the statement. We created ordinal scale values by assigning 0 to disagree, 1 to indifferent, and 2 to agree and summed up all for this indicator. For this indicator, the values ranged between 0 and 6	All firms
Market capability	Independent	Please indicate to what extent the Firm agrees or disagrees with the commercialization of its products by having a well-organized marketing department in the firm; commercializing products and services that are entirely new to the unit in the Firm; Increasing sales of new products in existing markets; the Firm increasing sales of new products in new markets.	For all the questions, respondents responded whether they agreed, were indifferent, or disagreed with the statement. We created ordinal scale values by assigning 0 to disagree, 1 to indifferent, and 2 to agree and summed up all for this indicator. For this indicator, the values ranged between 0 and 8	All firms
Openness capability	Independent	Please indicate to what extent the firm agrees or disagrees with the following statements about relations: The tendency to trust other organizations; No well-established relations with buyers; There is a well-established relationship with suppliers; There are no well-established relations with competitors; There is a well-established relationship with institutional actors.	For all the questions, respondents responded whether they agreed, were indifferent, or disagreed with the statement. We created ordinal scale values by assigning 0 to disagree, 1 to indifferent, and 2 to agree and summed up all for this indicator. For this indicator, the values ranged between 0 and 10	All firms
Competition	Dependent	How important was Competition in motivating your decision to engage in innovation activities: 1: very important, 2; important, and 3: not important	It is an ordinal scale variable where zero (0) is assigned to not important; one (1) to important, and two (2) to very important.	Innovative Firms

5.3.2 Empirical model- Baseline Specification

Following Srholec (2011), we deploy a binomial logit multilevel model hierarchically in a complementary log-log regression model in two levels to correct the effect of the non-linear errors that may lead to erroneously rejecting the significant effect of firm-capability-agglomeration effects on innovation. Because firms are nested in localization or urbanization economies, the cumulative interaction effects result in non-linear errors, violating the independence assumption in a linear regression model. Hence, we estimate the predictors with maximum likelihood estimation (Srholec, 2011). The first level is firm-level capabilities. The second is the agglomeration (regional) level effects, eventually resulting in the cross-level interaction effects between agglomeration and firm capabilities. We cluster errors around industry defined by higher level seven groups in the manufacturing sub-sector.

Binomial logit multilevel modelspecification

$$Innovator_{ij} = \pi_{00} + \pi_{01}Dens_j + \pi_{10}Firm_{ij} + \pi_{11}Dens_jFirm_{ij} + (\varepsilon_{0j} + \varepsilon_{1j}Firm_{ij} + e_{ij})$$

Where

$Innovator_{ij}$ is the dummy variable for innovation in the ith firm in a localization and urbanization Density

π_{00} is the average of firm innovation controlling for the density and capability effects

π_{01} is localization and urbanization density effects on innovation controlling for firm capabilities

π_{10} is the effect of firm i capabilities controlling for localization and urbanization density effects

π_{11} is the interaction effect,simultaneously measuring the localization or urbanization effects on firm innovation,subject to the moderation effect of firm i capabilities

$(\varepsilon_{0j} + \varepsilon_{1j}Firm_{ij} + e_{ij})$ is the nonlinear error term for fixed and random effects

Section 5.5 Results

5.5.1 Results of Baseline Specification

Chapter Four establishes that, on average, the effects of Marshallian externalities on firm innovation differ with the type of agglomeration economy in question. However,

for each cluster, the evidence (Shaver & Flyer, 2000; Chung & Kalnins, 2001; Giuliani & Bell, 2005) shows that agglomeration effects can affect firms differently based on their capabilities. Firm innovation can automatically benefit from unintentional Marshallian externalities when firms effortlessly acquire innovation knowledge from colocated firms in clusters. These channels for innovation diffusion include labor market pooling and input-output sharing, for instance. In an agglomeration, less transport cost, lower input cost, access to large markets, and market complementariness due to intense forward and backward linkage among cluster firms are advantages emanating from indulging in cluster activities.

Deriving maximum benefits from modern and deliberate externalities requires capabilities or skills such as openness, absorptive, and marketing capabilities to identify, select, and partner knowledge creators (Arikan & Knoben, 2014), deploy internal resources to internalize external resources (Cohen & Levinthal, 1990; Voudouris et al., 2012; Arikan & Knoben, 2014) and deploy marketing skills to complement the existing market complementaries to market the output of the internalize resources effectively (Harvis-Oliver & Albors-Garrigors, 2009) in localization or urbanization agglomeration. Accordingly, we expect firm capabilities to moderate the extent to which the cumulative effect of intentional and unintentional externalities affects innovation, with varying directional effects.

In models two, three, and six of Table 5.2a, localization significantly affects innovation, albeit adversely. Thus, it confirms the outcome in chapter four, where we attribute the negative effect of competition and size to this effect, particularly in a developing country. In addition, the Table confirms that urbanization significantly contributes positively to innovation in developing countries. Model one in Table 5.2a shows that market and absorptive capabilities independently are critical firm internal characteristics that matter for innovation in developing countries, but unlike developed countries (Knoben et al., 2015), openness is independently insignificant in driving innovation.

Unlike developed countries (Speldekamp et al., 2020; Knoben et al., 2016), incidentally, none of the capabilities provides the moderative mechanism or platform through which externalities in either localization or urbanization clusters affect innovation. With size and resource constraints, columns four, five, six, and seven in Table 5.2a suggest that in developing countries, openness, absorptive, and market capabilities do not significantly moderate the cluster externalities to affect innovation, limiting the moderating prowess of firm capability in innovation performance and cluster externality discourse.

Table 5.2a: Capability Moderation of Density Effects on Innovation, in 25km Radius for 2-digits of ISIC

Innovate	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Log(age)	0.02	0.01	0.02	0.02	0.02	0.02	0.02
	(0.44)	(0.17)	(0.41)	(0.46)	(0.40)	(0.42)	(0.49)
Log(empl)	0.51***	0.92***	0.54***	0.53***	0.54***	0.54***	0.53***
	(3.06)	(5.90)	(3.32)	(3.26)	(3.32)	(3.35)	(3.37)
Foreign-owned	-0.30	-0.27	-0.28	-0.27	-0.29	-0.29*	-0.28
	(-1.57)	(-1.35)	(-1.61)	(-1.52)	(-1.61)	(-1.65)	(-1.56)
Incorporated	0.01	0.26*	0.03	0.03	0.02	0.03	0.02
	(0.08)	(1.65)	(0.17)	(0.23)	(0.10)	(0.18)	(0.12)
Openness_cap	-0.01		-0.01	-0.00	-0.01	-0.01	-0.00
	(-0.27)		(-0.28)	(-0.01)	(-0.29)	(-0.28)	(-0.08)
Absorptive_cap	0.13***		0.13***	0.14***	0.04	0.13***	0.05
	(3.94)		(3.74)	(4.43)	(0.40)	(4.00)	(0.48)
Market_cap	0.25***		0.25***	0.26***	0.25***	0.20***	0.23***
	(9.62)		(8.67)	(10.81)	(8.89)	(3.37)	(3.34)
Localization		-0.16***	-0.15***	-0.13*	-0.11	-0.12**	-0.10
		(-2.98)	(-3.02)	(-1.95)	(-1.40)	(-2.00)	(-1.06)
Urbanization		0.29***	0.24***	0.28***	0.16*	0.22***	0.19*
		(4.28)	(3.79)	(3.89)	(1.70)	(2.75)	(1.82)
Localization # openness				-0.00			-0.00
				(-0.47)			(-0.58)
Urbanization # openness				-0.01			-0.01
				(-1.15)			(-1.26)
Localization # Absorptive_cap					-0.01		-0.00
					(-0.61)		(-0.18)
Urbanization # Absorptive_cap					0.02		0.02
					(1.07)		(1.02)
Localization # market_cap						-0.01	-0.01
						(-0.90)	(-0.50)
Urbanization # market_cap						0.01	0.01
						(0.91)	(0.38)
Observations	5273	5273	5273	5273	5273	5273	5273
ll	-1487.06	-1602.27	-1480.84	-1479.16	-1480.20	-1480.31	-1477.85

Table 5.2b: Robustness Test on Capability Moderation using Restricted Market Capabilities

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log(age)	0.02	0.01	0.02	0.02	0.02	0.02	0.01
	(0.42)	(0.16)	(0.35)	(0.27)	(0.34)	(0.35)	(0.30)
Log(empl)	0.69***	0.92***	0.71***	0.71***	0.71***	0.71***	0.71***
	(4.30)	(5.82)	(4.55)	(4.62)	(4.68)	(4.71)	(4.73)
Foreign-owned	-0.33*	-0.27	-0.31*	-0.30	-0.32*	-0.34*	-0.33*
	(-1.69)	(-1.34)	(-1.70)	(-1.61)	(-1.86)	(-1.93)	(-1.92)
Incorporated	0.12	0.26	0.13	0.14	0.12	0.11	0.11
	(0.76)	(1.63)	(0.81)	(0.85)	(0.77)	(0.70)	(0.67)
openness1	-0.01		-0.01	-0.01	-0.01	-0.01	-0.02
	(-0.40)		(-0.42)	(-0.51)	(-0.51)	(-0.56)	(-0.79)
Absorptive_cap	0.21***		0.20***	0.19***	0.12	0.20***	0.16*
	(6.67)		(6.96)	(6.89)	(1.57)	(7.19)	(1.88)
market_cap	0.09*		0.10*	0.09	0.10**	-0.13	-0.13
	(1.82)		(1.80)	(1.46)	(1.96)	(-0.89)	(-0.85)
Localization		-0.16***	-0.15***	-0.09	-0.12*	-0.13**	-0.07
		(-2.72)	(-3.00)	(-1.43)	(-1.69)	(-2.54)	(-0.87)
Urbanization		0.29***	0.25***	0.23***	0.18**	0.22***	0.17*
		(3.99)	(3.89)	(3.20)	(2.09)	(3.33)	(1.80)
Localization # openness				-0.01			-0.02*
				(-1.42)			(-1.85)
Urbanization # openness				0.00			0.00
				(0.40)			(0.40)
Localization # Absorptive_cap					-0.01		0.00
					(-0.51)		(0.19)
Urbanization # Absorptive_cap					0.02		0.01
					(1.11)		(0.58)
Localization # market_cap						-0.02	-0.02
						(-1.20)	(-0.91)
Urbanization # market_cap						0.05*	0.05*
						(1.85)	(1.78)
Observations	5273	5273	5273	5273	5273	5273	5273
ll	-1561.85	-1602.27	-1555.31	-1554.06	-1554.70	-1553.80	-1551.85

In Table 5.2b, we undertake a robustness test for the model in Table 5.2a with a restrictive definition of market capabilities. In this test, we exclude two responses: increasing sales of new products in existing markets and those increasing sales of new products in new markets, checking whether we could arrive at different conclusions. We exclude these variables because they could introduce reverse causality in our model, eliminating the plausibility of innovation firms ranking high with market capability. Thus, innovation causes market capability when our interest is the reverse. The results are similar to what exists in Table 5.2a, where none of the capabilities moderate the agglomeration effects on innovation in developing countries. Therefore, at a 5% significance level, the conclusions from Table 5.2a are unaffected by reverse causality, which will likely increase the bias in the parameter estimates.

Section 5.4 Conclusion, Discussion of Hypothesis, and Policy Implications

5.4.1 Conclusion

Firms in developing countries are predominantly small and suffer from capacity and resource draught, making them imitators of technology (Zanello et al., 2016). Resorting to imitation resonates with the incremental level and the degree of innovation novelty (Chapter 2) in developing countries in the face of cluster and global competition, reinforcing the viewpoint (Zanello et al., 2016) that fundamental innovation is a developed country phenomenon due to the high cost and risk associations. Evidence from Chapter Four shows that Marshallian externalities in urbanization clusters facilitate innovation in developing countries, while localization adversely affects innovation significantly. In this Chapter, we investigate which firms are likely to benefit from cluster externalities, subject to firms' openness, absorptive, and market capabilities, since we do not expect all firms to be equally affected in a cluster. Investigating the moderative prowess of these capabilities, we focus on the interaction between the firm capabilities and the localization and urbanization clusters to explain the capabilities that moderate the effect of these cluster externalities on innovation. We conclude that in developing countries like Ghana, none of the firm capabilities significantly moderate localization or urbanization externalities effects on innovation.

5.4.2 Discussion of Hypothesis

The evidence in Table 5.2a suggests that we reject hypothesis one (H^1_0) at a 5% level of significance that the openness capability of firms positively moderates the effectiveness of diverse industry externalities to enhance innovation significantly. Similarly, the data suggests rejecting hypothesis two (H^2_0) at a 5% significance level, that openness negatively moderates significantly the adverse effects of the localization externalities on innovation in developing countries.

Apart from unintentional externalities, there is evidence (Arikan & Knoben, 2014) that firms require capabilities to tap into deliberate cluster externalities to ensure that innovation benefits from these externalities by selecting, identifying, and partnering with knowledge cluster firms. The evidence (Arikan & Knoben, 2014) suggests that these acts require that the focal firm avail itself to have partners, have the skill and knowledge to know the knowledge firms, have value to share with potential knowledge firms and be a trustworthy partner so that firms are comfortable sharing knowledge. Thus, the capabilities facilitating these acts can moderate the effectiveness of urbanization or localization clusters on innovation performance since focal firms can access the tacit and codifiable knowledge required for a higher degree of novelty without relying solely on innovation diffusion from unintentional externalities.

Trust is a cardinal requirement for the effectiveness of opening capabilities (Arikan & Knoben, 2014). However, exacerbated by weak institutions and inefficient legal regimes (OECD, 2010), firms in developing countries cannot effectively protect their knowledge novelties, weakening their trust in other firms and the moderative prowess of opening capability. Dominating in developing countries, small and resource-constrained firms cannot invest in R&D (Zanello et al., 2016), resulting in less value (Arikan & Knoben, 2014) to share with potential partners, making them unattractive. Similarly, focal firms in developing countries do not have skilled workers to know and select the adequate knowledge to assess and for partnership. Thus, these deficiencies in developing countries are both at the firm level and structurally inherent and systemic.

Although the few large and resource-rich firms could have value to share and skilled workers, they will not partner and share knowledge within the cluster for fear of net loss (Arikan & Knoben, 2014), limiting the knowledge spillovers in the cluster, as these firms will protect (Dyer & Hatch, 2006; Arikan & Knoben, 2014) the knowledge from spillover. The large firms can self-select

to partner firms outside the agglomeration environment and globally, importing knowledge (Giuliani, 2011; Kesidou & Snijders, 2012) into the cluster. However, weak institutions and mistrust among firms will force these firms to protect the knowledge from spillover (Dyer & Hatch, 2006; Arikan & Knoben, 2014), weakening the moderative prowess of opening capability on externalities that can benefit other cluster firms. Thus, the weakness of the moderative prowess of opening capability on the effectiveness of externalities is eminent and independent of whether the externalities are from localization or urbanization agglomeration. The benefits of access to diverse externalities in urbanization and the adverse effects of increased industry congestion and related technology lock-in when firms open up, for instance, are too weak to offset the null effect associated with mistrust and institutional rigidities, hence the null effect of the moderative prowess of opening up.

In Table 5.2a, the data lend credence to reject hypothesis three (H^3_0) that, at a 5% significance level, on average, the absorptive capability of firms positively moderates the positive significant externalities effects in urbanization clusters for innovation performance in developing countries. Similarly, at a 5% significance level, we reject hypothesis four (H^4_0) that, on average, the absorptive capability of firms positively moderates to offset the significant adverse localization externalities effects on innovation in developing countries.

Chapter 2 indicates that imitation and reverse engineering can provide opportunities for small and resource-constrained firms to learn, enabling them to build absorptive capabilities recirculating the obsolete technology in the cluster without creating much value. In contrast, a few large firms invest in R&D or network with MNCs (Chapter 3) to enhance their absorptive capability and gain innovation knowledge. However, they can eventually partner with firms outside the cluster, limiting cluster externalities when they protect knowledge spillover (Dyer & Hatch, 2006; Arikan & Knoben, 2014) for fear of net loss due to mistrust or weak institutions (OECD, 2010). Thus, the ineffectiveness of the moderative prowess of openness capability on externalities would not permit firms with absorptive capabilities to effectively internalize tacit and codifiable external knowledge since, on average, focal firms cannot effectively identify, select, and partner with knowledge creators in the cluster. Similar to openness, the structural and systemic challenges can limit the moderative prowess of absorptive capability in developing countries because, to internalize externalities from tacit and codifiable external knowledge, cluster firms must access it first.

Although the evidence in Table 5.2a points to the significant independent effects of the firm absorptive capabilities on innovation, size and resource constraints of firms in developing limits the interactive and moderative prowess of the internal absorptive capabilities. For instance, weak institutions and mistrust among firms (Chapter 2) in developing countries render firms with value, created from investment in R&D to protect the knowledge from leakage and refrain from a partnership with cluster firms to gain competitive advantage, particularly in a localization or technology cluster, to survive the intense competition in the clusters. Therefore, in developing countries, gaining absorptive capabilities through investment in R&D has a null moderating effect on localization externalities, particularly those associated with deliberate acts, lacking the moderating prowess to offset the competition-induced adverse effect of localization externalities on innovation. Even though urbanization positively drives innovation, issues relating to weak institutions and mistrust among firms that affect firms in localization clusters also affect those in urbanization clusters since having high absorptive capabilities will not significantly moderate the diffusion of deliberate externalities to be internalized.

Besides, the high costs associated with the geographic concentration of firms (Sorenson & Audia, 2000; Knoben, 2009), high land prices, and competition for inputs such as qualified labor further strain the limited firm's resources in developing countries, otherwise required for investment in R&D, and the value from the investment. On the other hand, the overwhelming number of small and resource-constrained firms cannot create new value to share in either localization or urbanization agglomeration. Hence, they are unattractive partners and do not have the advanced knowledge to internalize sophisticated tacit and codifiable knowledge spillovers.

Notwithstanding the competitive advantage that accrues to firms with absorptive capabilities to independently affect innovation, the size, resource constraint, and mistrust forces that cause limitation of externalities in clusters and the inability to deploy internal knowledge to identify, select, and partner with the few knowledge creators render the absorptive capability weak in moderating the positive effects of urbanization or localization externalities on innovation.

The evidence in Table 5.2a suggests that at a 5% level of significance, we reject hypothesis five (H^5_0) that the market capability of firms moderates positively to complement the market complementarities for externalities in urbanization to foster innovation positively, even in developing countries. Similarly, at a 5%

level of significance, we reject hypothesis six (H^6_0), that the market capability of firms moderates positively to complement the market complementarities for externalities to offset other localization externalities that adversely affect innovation, even in developing countries.

Size and resource constraints limit the moderating prowess of market capabilities from complementing the marketing complementarities associated with clusters to foster innovation. With predominantly small and micro-sized firms, firms in developing countries cannot establish and sustain a sophisticated marketing unit (Harvis-Oliver & Albors-Garrigors, 2009) that will select, identify, and partners in the forward and backward linkages in the cluster to gain the competitive advantage needed for survival in an intense cluster competition, incapacitating the moderating prowess of market capabilities to facilitate the effectiveness of cluster externalities. When resource-endowed firms with market capabilities buy inputs external to the cluster, this could deny capacity and resource constraints firms to benefit from the market complementarities in the cluster for innovation. Similarly, the few knowledge-creating firms with market capabilities could engage in globalization if the opportunity cost of global trade is lower, for instance, dampening the moderating prowess of the marketing capability of cluster firms to enhance cluster externalities to foster innovation. Aside from size and resource constraints, weakness in institutional and legal regimes (OECD, 2010) in developing countries affects trust and confidence in cluster firms to deliver the standard required adequately.

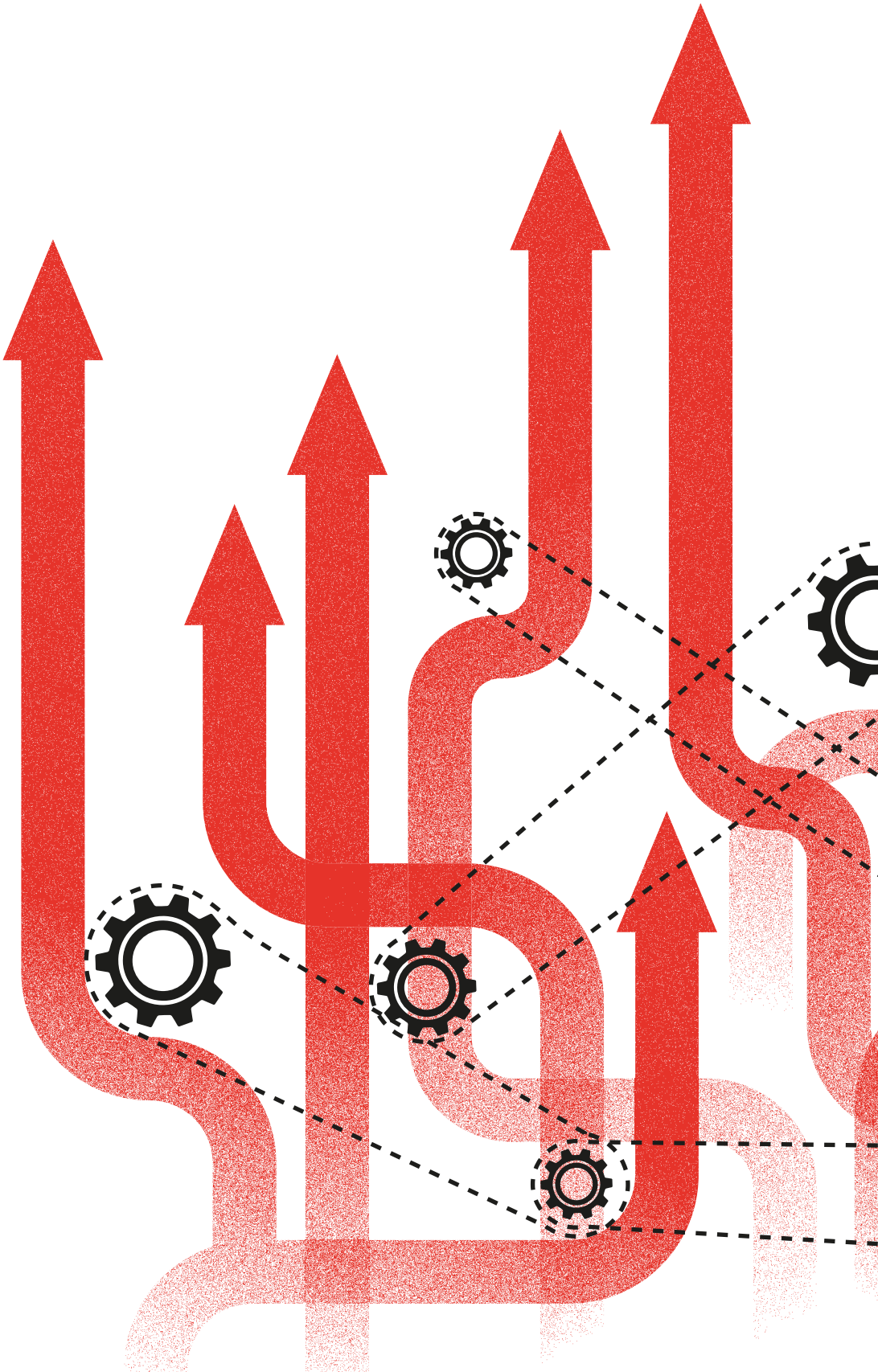
Consequently, lower costs associated with input-output sharing in clusters, with its attendant effects on innovation, are adversely affected as firms trade with MNCs (Chapter 3) or internationalization firms demand higher quality products. For instance, the current over-reliance on imported inputs by manufacturing firms in developing countries signals the low patronage of internationalization firms in the forward and backward market linkages, which, otherwise, could benefit size and resource-constraint firms with high market capabilities to trade their innovation output, enhancing their competitive advantage in the cluster. Thus, market capabilities can independently affect their innovation performance but do not significantly moderate cluster externalities to foster innovation, irrespective of whether it is an urbanization or localization agglomeration. Like openness and absorptive capabilities, size and resource constraints, as well as institutional weakness in developing countries, are inimical to firms' moderative prowess of market capability in driving cluster externalities to positively foster

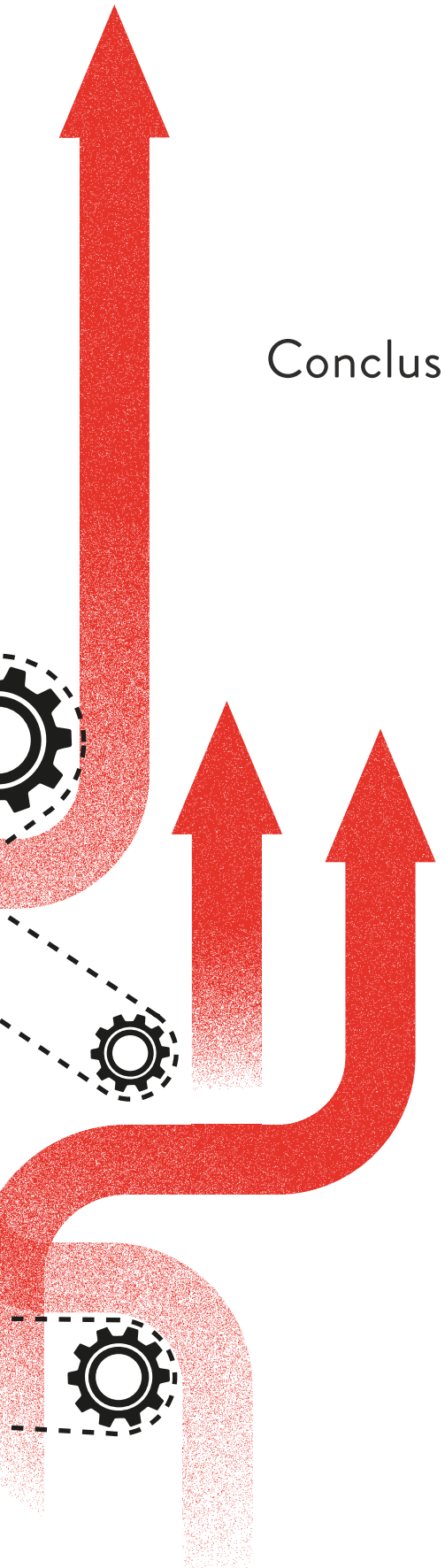
innovation, primarily because they cannot create value and be trusted (Arikan & Knoben, 2014), as worthy cluster partners in either urbanization or localization.

5.4.3 Policy Implications

Overall, the evidence points to the concomitant firm-level effects such as size, resource constraints, mistrust, and systemic institutional and structural rigidities that reinforce the adverse effects of mistrust, dampening the moderative prowess of openness, absorptive, and market capability. The forces directly affect openness, whose weakness offsets the likely significant effects of the market and absorptive capabilities to moderate the effects of urbanization and localization externalities to propel innovation. Therefore:

1. The state in developing countries should improve their institutional and legal regimes, enhancing firms' trust so that confidence in the expected net positive effects of openness would foster knowledge and input-output sharing in the cluster. Then, the firm capabilities will be effective in its moderative and interactive prowess for enhancing externalities to affect innovation. For instance, improving the legal regimes for acquiring property rights and patents minimizes the institutional rigidities (Hotho, 2014) in developing countries that will engender firm trust.
2. Additionally, deliberate efforts are required to strategically address the innovation resource constraints of firms so that they can invest in R&D and have value to be worthy cluster partners, as well as internalize the access externalities to foster innovation. Such efforts, for instance, can enable market capabilities to complement market complementarities in the cluster, enabling firms to supply inputs to cluster firms and eventually enhancing innovation performance and leapfrogging the current incremental innovation in developing countries.





Conclusion and Policy Implication

CHAPTER 6

6.1 Conclusion

The thesis examines the determinants of firm innovation in developing countries, testing nine hypotheses on a rich cross-section of firm-level datasets from Ghana, a sub-Saharan African country. Among the data sets, one is a census of all firms, and two are sample surveys, predominantly on manufacturing firms and their innovation behavior, collected by the Ghana Statistical Service (GSS) and the World Bank (different waves). The comprehensive firm data reflects the innovation activities of manufacturing firms in developing countries, which facilitates an examination of the innovation theories in developing countries, testing the hypotheses to arrive at conclusions that will contribute to the innovation literature better than other studies focusing on a segment of industries. Thus, Chapter 2 provides a vivid description of manufacturing firm innovation in developing countries and sets the stage for empirical work in Chapters 3, 4, and 5, where we empirically interrogate the role of the market, location, and capabilities in determining firm innovation in developing countries.

The firmographic reveals that firms in developing countries are small or micro, young (less than 30 years), and in low or medium-technology industries but centralized in urbanized regions, and suggests that innovation is incremental (10%), with 7% regional level variation in innovation, signaling the depth of regional-level innovation inequality that can affect variations in regional knowledge externalities. The incremental (10%) and low degree of novelty could plausibly result from the lack of funds, the high cost, and the presence of many small-sized firms, a phenomenon that calls for more profound empirical studies. Comparatively, the incidence of firm innovation is higher in non-high-technological industries than in the high-technology industries, with many firms in high-technology industries being intrigued by reverse engineering, with a substantial portion of the innovation activities involving intramural rather than extramural. Empirical investigation of this phenomenon in developing countries could add to the innovation literature, particularly from a developing country perspective.

The chapter on internationalization modes and innovation dimensions suggests that, at a 5% level of significance, selling to MNCs in-country as an indirect mode of internationalization drives process but not product innovation, even after addressing endogeneity concerns. The direct internationalization mode in which firms export directly does NOT significantly trigger the probability of product or process innovation. Apart from size constraints, the adverse effects

of direct export competition could wipe out the knowledge transfers that drive product or process innovation when firms engage in direct exports. Selling to MNCs enhances the efficiency of domestic firms through capacity building and demand for improved production methods and higher quality standards (Ma & Lu, 2011; Curtis, 2016) if the MNCs can remain globally competitive.

Subsequently, in chapter four, we contribute to minimizing the ambiguity concerning the most effective externalities in urbanization (ala Jacobs) or localization (ala Marshall). After addressing endogeneity concerns with exogenous geographic locations of firms, following the recommendation of Beaudry and Schiffauerova (2009), at a 5% level of significance, we test various distances of agglomeration alongside the different levels of industrial groupings and find a robust positive effect of externalities in urbanization on innovation but an adverse effect in localization economies, between 25 to 60 km radius. Underlying these, we also find that firms in regions with denser economic activities report fewer problems accessing funding and knowledge, while firms in the same sector are more uncertain about the gains from innovating. Results from heterogeneous analysis further support the hypothesis that for developing countries with predominantly small and micro-sized firms, with competition and congestion effects (Maskell & Malmberg, 2007; Pouder & St. John, 1996), externalities are effective at positively driving innovation in urbanization but ineffective in localization economies, leading to diseconomies of localization agglomeration.

Agglomeration externalities affect firms differently (Shaver & Flyer, 2000; Chung & Kalnins, 2001; Giuliani & Bell, 2005; Knoben et al., 2016). In chapter five, we address the question of which firms are likely to benefit from cluster externalities by delving into the individual firm attributes, particularly their absorptive, market, and openness capabilities that leverage the effectiveness of urbanization or localization externalities to affect innovation. Apriori, we expect these capabilities to moderate the extent to which these cluster externalities significantly cause innovation via the interaction of the capabilities and agglomeration externalities. For instance, we expect that the positive significant urbanization externalities (deliberate and unintentional) affecting innovation should leverage each of the three capabilities, such that those with relatively higher absorptive, market, and openness capabilities will benefit more from the urbanization externalities. Similarly, market and absorption will moderate the localization externalities to offset the adverse effects on innovation, while open capabilities will moderate adverse localization externalities.

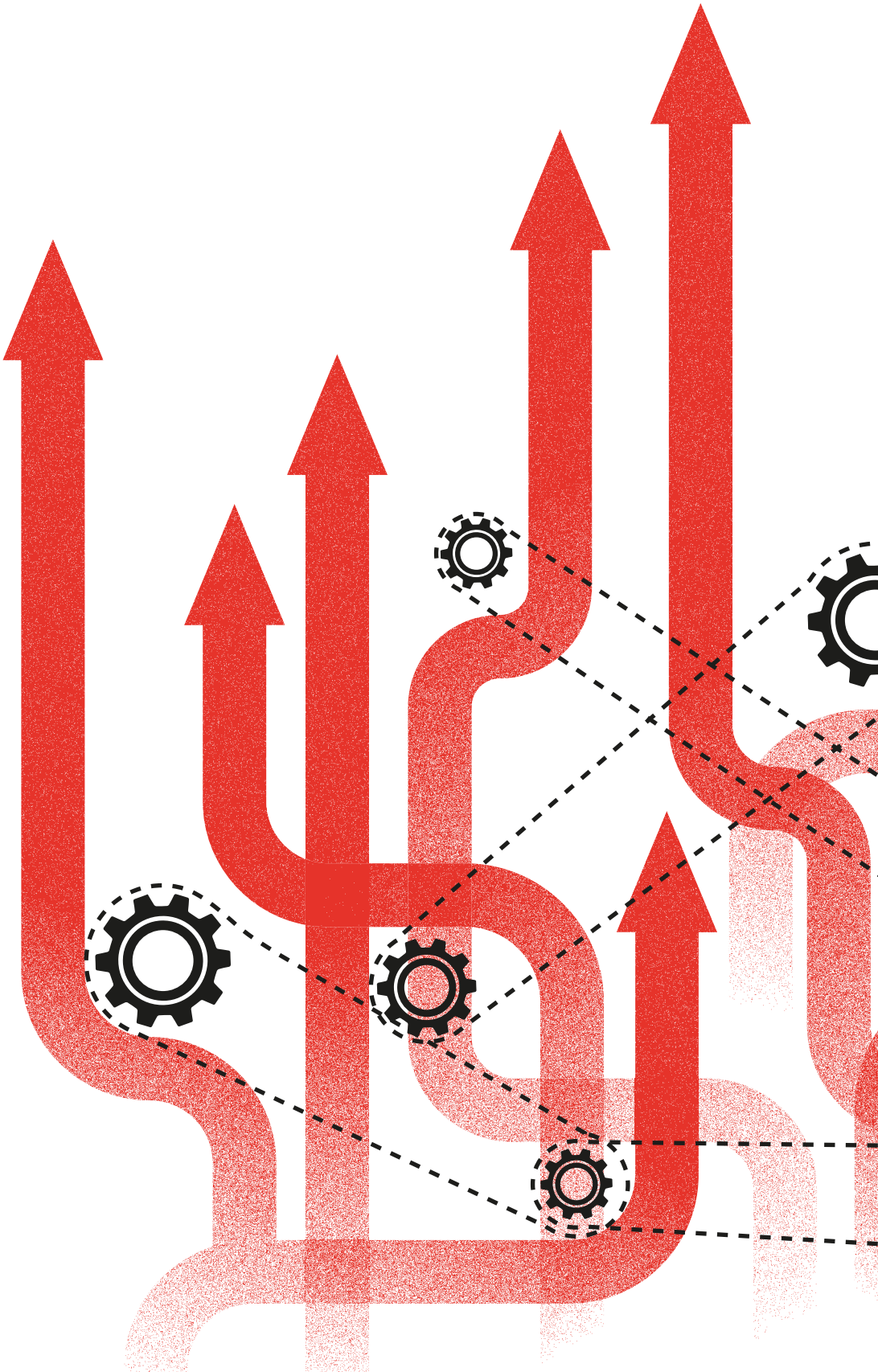
Incidentally, at a 5% significance level, we cannot accept any of the six hypotheses that seek to advance the role of the market, absorptive, and openness capabilities in moderating the effects of externalities on innovation performance in developing countries since they all have null interactive or moderative effects. For instance, the firm size and resource constraints in developing countries limit these capabilities' interactive or moderative prowess in identifying, selecting, and partnering knowledge creators in clusters to internalize deliberate knowledge spillover from colocated firms to enhance innovation. Also, mistrust due to weak and institutional rigidities (Ecuru et al., 2014; OECD, 2010) culminates in the null effect of openness that offsets the prowess of market and absorptive capabilities and, subsequently, their moderative and interactive effect in the agglomeration and innovation discourse.

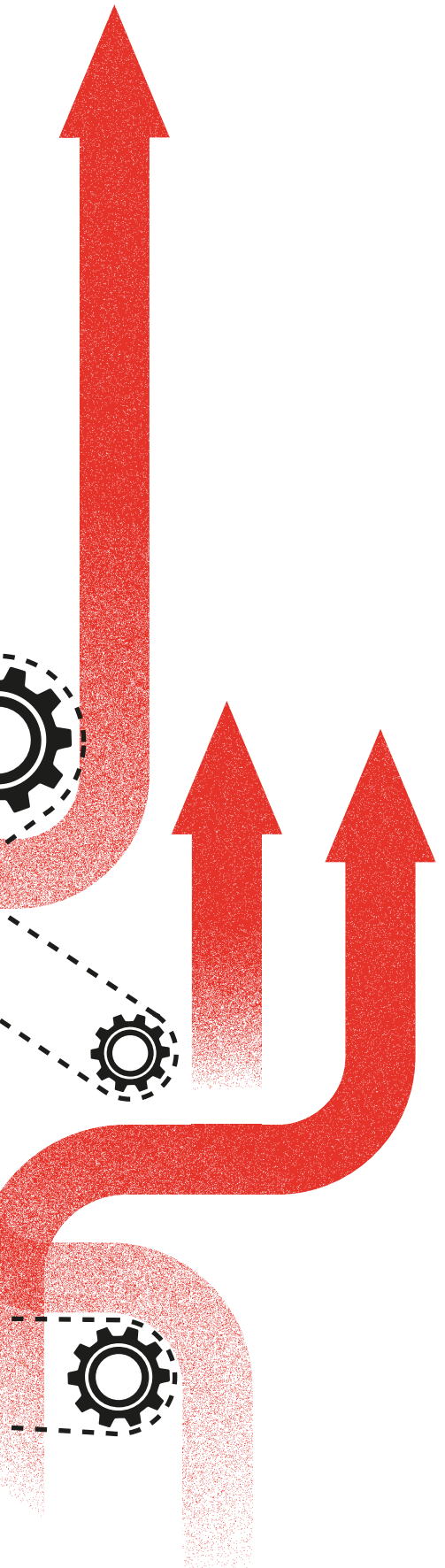
6.2 Policy implication

From the market perspective, to fully harness the benefits of internationalization to innovation in developing countries, the state should implement national policies and programs that guarantee returns on R&D investment so that these investments will equip and enable firms to internalize the knowledge transfer from foreign partners during internationalization for innovation. Firms should be self-motivated to register and formalize their activities since incorporating informal firms engenders business confidence and knowledge transfer for product or process innovation.

In developing countries, urbanization agglomeration externalities enhance innovation. However, unlike in developed countries, in localization agglomeration, competition and congestion among size and resource constraint firms culminate in imitation of obsolete technology and eventual technology lock-in, adversely affecting externality effects on innovation. Escaping these adverse effects and ensuring realistic externality effects across all firms will require intensifying efforts at promoting and developing industrial parks across different industries with the requisite infrastructure since it facilitates the cross-fertilization of ideas that foster innovation and the diversification of products and risks. Dominated by small and micro-sized firms, externalities from urbanization rather than localization could be the panacea for innovation and firm growth in developing countries.

Deliberate efforts at addressing the ineffectiveness of openness capability are vital since virtually absorptive and market capabilities will be enhanced to complement and moderate the agglomeration externalities for innovation performance. Deliberate budgetary allocations informed by state policies to strategically address innovation resource constraints and eliminate institutional rigidities are necessary to build trust among firms for the effectiveness of the moderative prowess of the capabilities. Eventually, this will ensure the survival and growth of firms in developing countries in the face of global competition, as it requires empowering internal strengths to gain a competitive advantage and internalize the accessed externalities.





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CHAPTER 7

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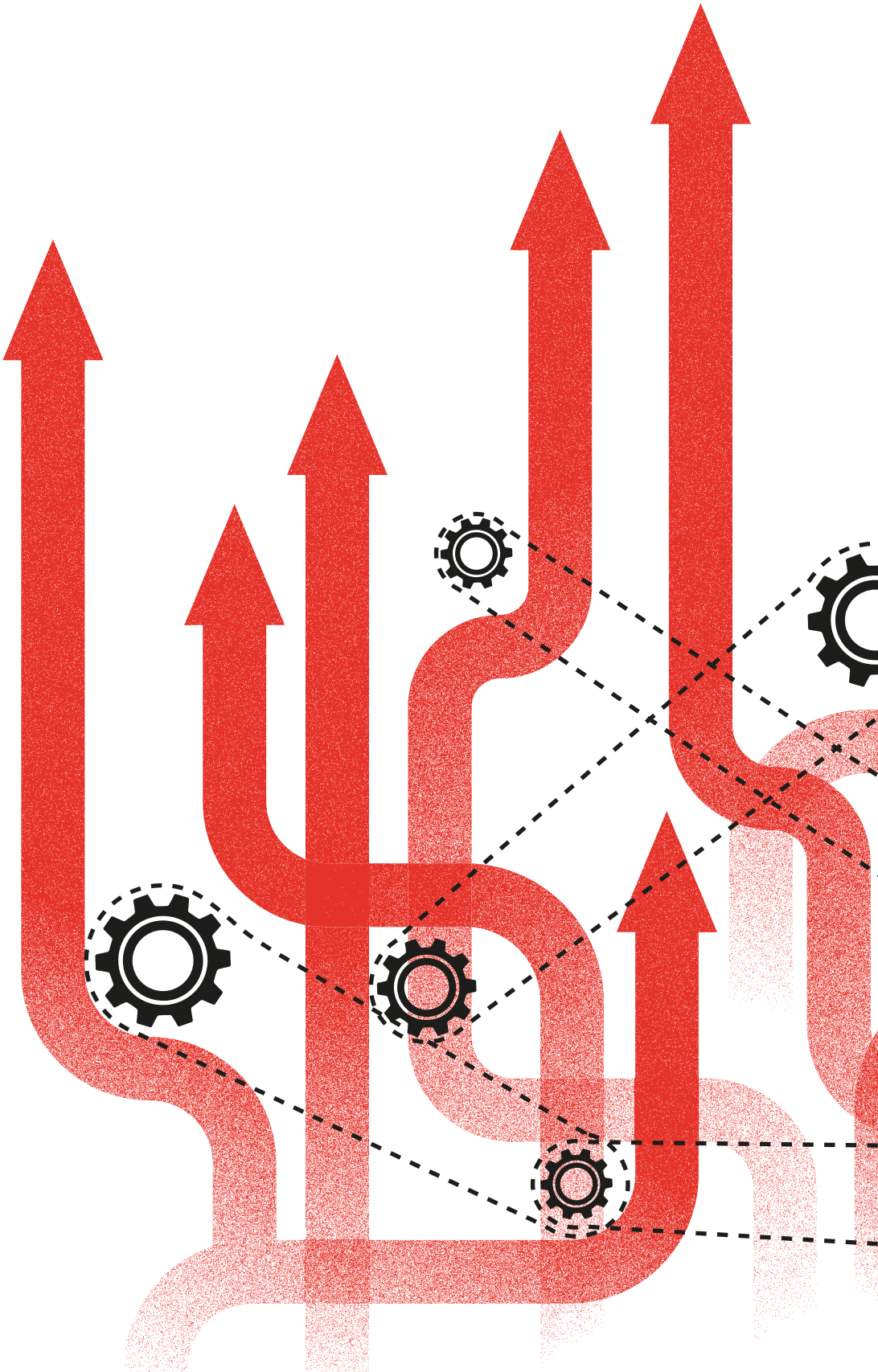

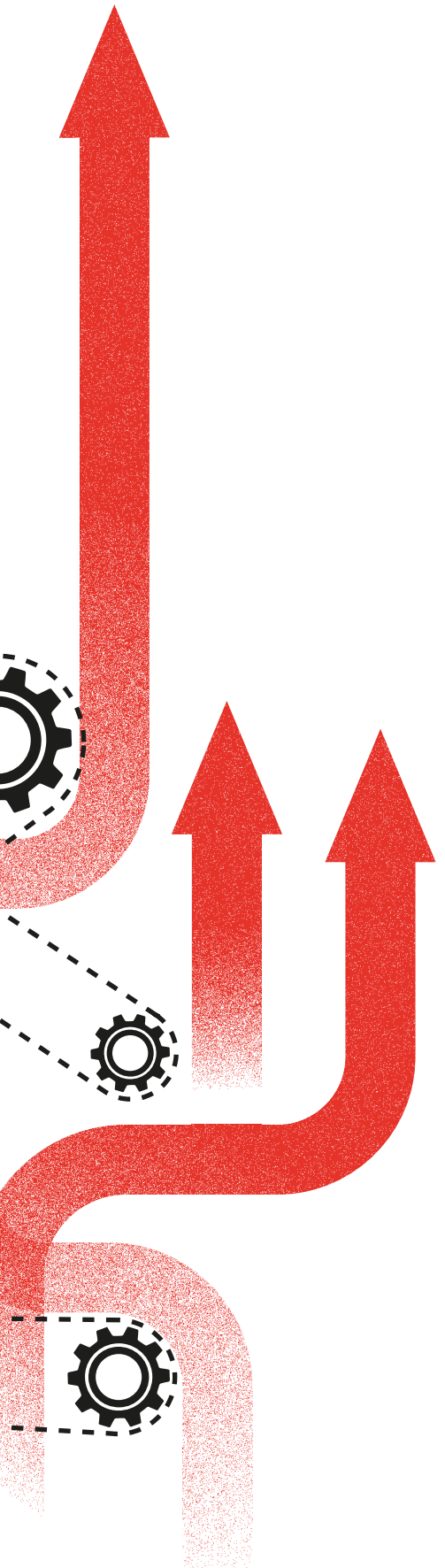

Curriculum Vitae
Acknowledgements

CHAPTER 8

Curriculum Vitae

Tertiary Education

Ph.D. Candidate, Development Economics **(2018-2023)**, Main Field: Firm Innovation. Nijmegen School of Management (NSM), Institute of Management Research (IMR), Radboud University (RU), The Netherlands

MSc in Business and Economics, Main Field: Business Administration **(2011**), Blekinge Institute of Technology Karlskrona, Sweden

MPhil in Economics **(2010)** at the University of Cape Coast, Cape Coast, Ghana

BA (Hons) in Statistics and Economics **(2004)** at the University of Ghana Legon, Ghana

HND in Statistics at Ho Polytechnic **(1997)**, Ho, Ghana

Professional experience

Organization: Statistical Service, Accra, Ghana: 1999 to present
Current Position: Head, Industrial Statistics Section (2007 to Present)
Current Rank: Principal Economic Statistician

Key Responsibilities:

a. Coordinate the conduct of Economic Censuses and Surveys
b. Supervise and coordinate monthly and annual surveys on firms
c. Supervise the preparation of survey instruments for firms
d. Coordinate the preparation of timely periodic reports and dissemination/ publication, e.g., PPI and IIP.
e. Manage staff of industrial section/department
f. Periodic training of regional statisticians and field staff in industrial statistics
g. Periodic in-house training of staff in the industrial statistics section
h. Produce and present timely performance reports to senior management.
i. Coordinate the activities of the department.
j. Enforcing the organizational goals regarding industrial statistics
k. Coordinate other surveys upon demand and produce reports.
l. Focal Person on Infrastructure Statistics

Key Outputs and Performance:

a) Project Coordinator/Manager for Integrated Business Establishment Survey (IBES), the First comprehensive Economic Census in Ghana
b) Developed project document, survey instrument, and Survey Design for IBES
c) Advocacy and supervision of field activities for successful IBES
d) Coordinated and reviewed the publication of Five (5) IBES reports.
    - National Summary Report, Employment Report, Job Creation Report, Regional Spatial Business Report, and the National and District Business Registers for the 216 Districts of Ghana
e) Monthly compilation and publication of the Producer Price Index (PPI)
f) Developed methodology and Project document for rebasing of PPI
g) Coordinated training and data collection for rebasing PPI
h) Compiled and published rebased PPI
i) Quarterly compilation and publication of the Index of Industrial Production (IIP)
j) Prepared the methodology paper for the annual survey of establishments.
k) Organized several annual PPI training workshops for regional statisticians and field staff.
l) Coordinated fieldwork during the 2003 Industrial Census.
m) Supervise training in the 2010 Population and Housing Census.
n) Editor of the 2010 Population and Housing Census reports
o) Coordinated DCOs during the 2021 PHC.
p) Reviewed GLSS 6 and 7 reports.
q) Leading member for 2015 and 2017 Ghana poverty profile reports
r) Assistant coordinator for Job Tracker Surveys
s) Coordinated the successful implementation of:
    - World Bank Technology Adoption Surveys in 2020
    - World Bank Global Value Chain Surveys in 2021
    - MoF Demand-side Financial Inclusion Survey in 2020
    - GIZ project to assess the Impact of COVID-19 on Agribusiness in 2020
t) Coordinated data collection on Energy (Petroleum and natural gas, Coal and other solid mineral fuels, Electricity, and Non-electric energy), Transport, ICT, Water, and Sanitation.
u) Analyze and publish data relating to the above thematic areas of infrastructure.

International and local professional responsibilities

a) Member, UN Committee of Experts on International Standard Industrial Classifications, **2008 - Present**

b) Member, UN Committee of Experts on Central Product Classifications, **2008 - Present**
c) Member, UN Experts Group member on Industrial Statistics, **2008-2010**

Publications

a) Krakah, A., Nsowah-Nuamah, N., Awoonor-Williams, M., & Teal, F. (2009, March). Manufacturing firms in Ghana: Comparing the 1987 and 2003 Censuses. In *Available on http://www. csae. ox. ac. uk/conferences/2009-edia/papers/497-Teal. Pdf (retrieved on 18 July 2015)*.

Thesis

a) Krakah A. & Ameyaw A. (2010); Determinants of Bank Profitability in Ghana, The case of Merchant and Commercial Banks, *Master Thesis, B.T.H. Karlskrona, Sweden.*
b) Krakah Anthony (2008), The Dynamics of Poverty in Ghana, 1992 – 1999, *MPhil Thesis*, University of Cape Coast

Contributed to writing or editing the following Books and Reports

a) Ghana Statistical Service (2007), **Economic Survey Report, 2005: 2007**
b) Ghana Statistical Service (2016), **National Employment Report**, Ghana
c) Ghana Statistical Service (2016), **Job Creation Report**, Ghana
d) Ghana Statistical Service (2016), **IBES Summary Report**, Ghana
e) Ghana Statistical Service (2016), **Regional Spatial Business Report**, Ghana
f) Ghana Statistical Service (2016), **Ghana Business Register**, Ghana
g) Ghana Statistical Service (2007), **Ghana Standard Living Survey 2005**
h) Ghana Statistical Service (2013), **Ghana Poverty Profile, 2014**
i) Ghana Statistical Service (2016), **Ghana Poverty Profile, 2015**
j) Ghana Statistical Service (2018), **Ghana Poverty Profile, 2017**
k) Ghana Statistical Service (2019), **Ghana Standard Living Survey 2015**

Made Input into the following International Manual

a) UNSD (2010), **International Recommendation for Industrial Statistics,** 2010

Tailored Training Programs

Financial Programming and Policies, I.M.F. Washington DC, U.S.A.	2009
Energy Analysis and Modeling, IEA, Paris, France	2011
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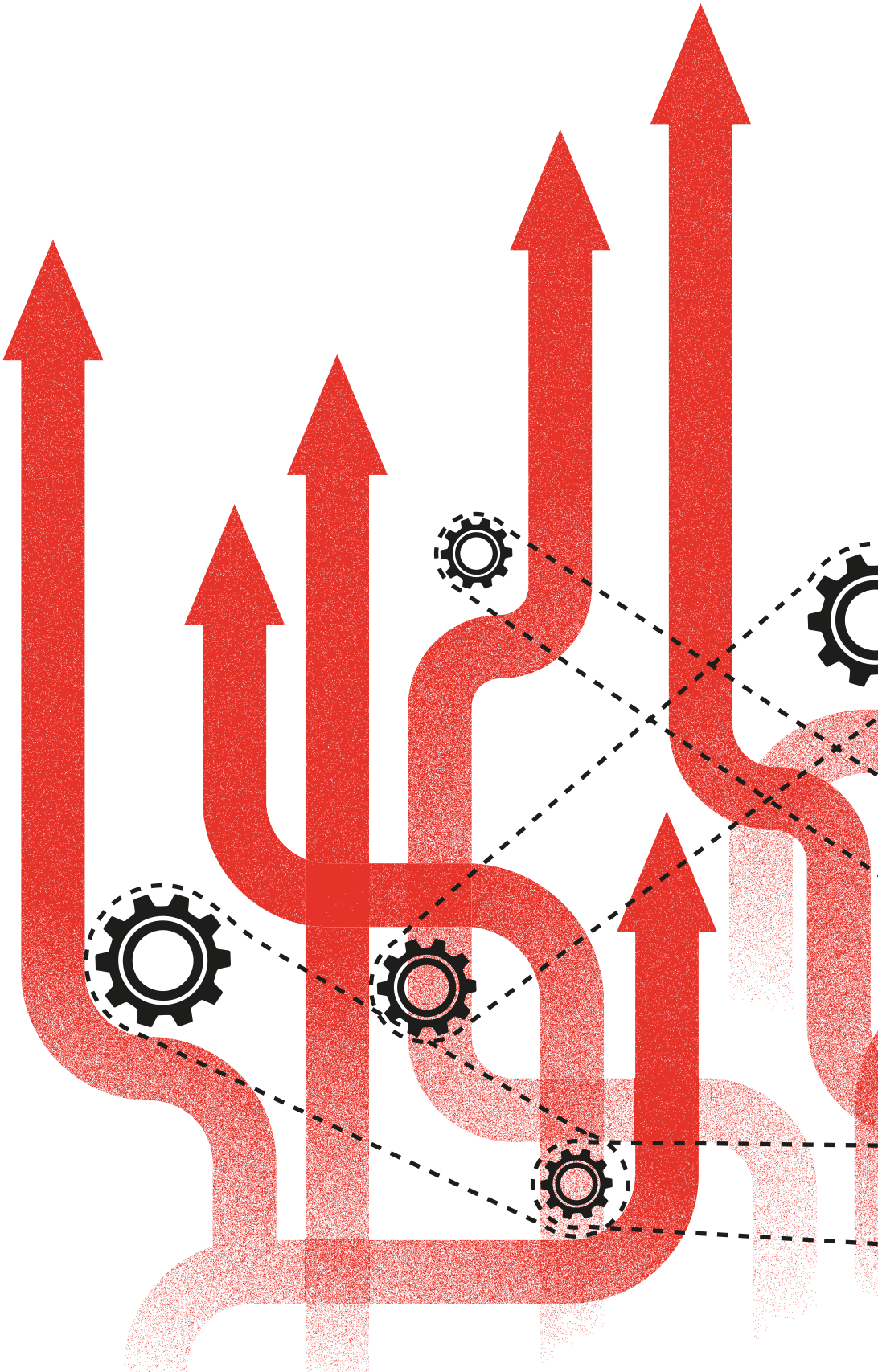
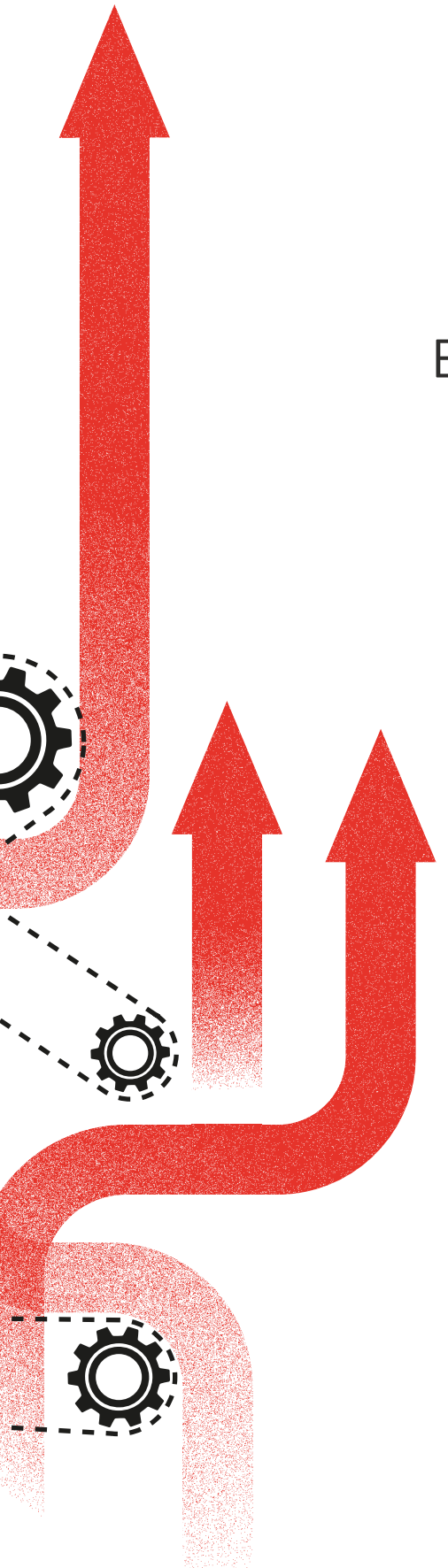




Extended Tables and Maps

APPENDIX A

Table A.1: Summary statistics of the survey data

Statistics	min	p25	p50	p75	max	mean	N
Turnover	0	11,220	38,592	180,000	4,793,010,176	5,836,062	5,427
Persons engaged	1	3	5	12	3,695	22	5,422
Employment	0	0	1	6	3,668	17	5,423
Age	0	5	9	15	96	12	5,427
Labor productivity	0	3,137	8,042	23,115	89,583,928	70,535	5,421

Table A.2: Distribution of manufacturing firms in the sample by sector and region

Sector	Western	Central	Greater Accra	Volta	Eastern	Ashanti	Brong-Ahafo	Northern	Upper East	Upper West	Total
Food, beverages, and tobacco	122	85	160	170	97	119	75	104	109	115	1,156
Textiles and wearing apparel	94	76	118	91	60	132	63	118	95	123	970
Leather	59	39	20	20	23	66	30	20	12	4	293
Wood	36	21	35	30	32	55	37	12	19	16	293
Paper and paper products	1	6	40	1	3	15	2	2	1		71
Publishing and printing	23	19	83	5	28	41	23	12	2	2	238
Refined petroleum			6								6
Chemicals and pharmaceuticals	14	30	58	9	22	31	13	13	16	7	213
Rubber and plastics	4	4	56	5	1	13	2	3	1	1	90
Nonmetallic	41	22	87	19	18	22	16	20	4	6	255
Basic metals	23	5	25		2	7		2	1	4	69
Fabricated metals	81	61	109	52	67	83	74	67	54	40	688
Electronics and computers	4	6	30	11	5	16	6	1		6	85
Machinery and equip	8	18	11	16	16	11	11	7	10		108
Transport and motor vehicles	6	7	15	17	11	14	10	5	1	3	89
Furniture	95	77	91	57	74	47	60	51	31	43	626
Other manufacturing	14	36	30	7	32	29	19	3		5	175
Total	625	512	973	510	491	702	441	440	356	375	5,425

Table A.3: Distribution of Exporting Firms in the Sample Data

Industry	Firms Exporting		N
	Number	%	
Food and beverages	36	3.1	1,156
Textiles and wearing apparel	6	0.6	970
Leather	3	1.0	293
Wood	25	8.5	293
Paper and paper products	3	4.2	71
Publishing and printing	1	0.4	238
Refined petroleum	0	-	6
Chemicals and pharmaceuticals	13	6.1	213
Rubber and plastics	14	15.6	90
Nonmetallic	3	1.2	255
Basic metals	4	5.8	69
Fabricated metals	12	1.7	689
Electronics and computers	2	2.4	85
Machinery and equip	1	0.9	108
Transport and motor vehicles	1	1.1	89
Furniture	1	0.2	626
Other manufacturing	2	1.1	176
Total	127	2.3	5,427

Table A.4: Prevalence of Innovation Dimensions within Region

Region	Innovation		Product Innovation		Process Innovation		N
	Number	%	Number	%	Number	%	
Western	46	7.4	36	5.8	20	3.2	625
Central	30	5.9	28	5.5	14	2.7	512
Greater Accra	150	15.4	118	12.1	87	8.9	973
Volta	33	6.5	23	4.5	18	3.5	510
Eastern	42	8.6	34	6.9	20	4.1	491
Ashanti	74	10.5	61	8.7	26	3.7	702
Brong Ahafo	61	13.8	47	10.7	26	5.9	441
Northern	33	7.5	28	6.4	16	3.6	440
Upper East	46	12.9	33	9.3	26	7.3	356
Upper West	37	9.9	28	7.5	21	5.6	375

Table A.5: Objectives for Product Innovation by Attributes of Firms

Objectives of Product Innovation	Replace (%)	Extend product (%)	Market share (%)	Export (5)	Reduce cost (%)	Competition (%)	Comply with Standards (%)	Address Demand (%)	Other (%)	N
Feature of Firm										
Age of Firm										
yrs<10	30.7	68.3	51.5	10.4	5.4	12.4	31.2	21.8	28.2	202
10=<yrs<20	30.8	73.3	52.7	16.4	11.0	17.8	35.6	26.0	32.2	146
20=<yrs<29	30.0	58.3	55.0	10.0	11.7	13.3	26.7	11.7	31.7	60
yrs>=30	25.0	92.9	78.6	25.0	3.6	10.7	46.4	35.7	17.9	28
Size of Firm										
Large	26.7	56.7	60.0	30.0	3.3	16.7	26.7	33.3	16.7	30
Medium	14.3	54.3	42.9	22.9	-	14.3	25.7	31.4	14.3	35
Small	32.1	72.8	54.7	11.1	9.2	14.0	34.2	21.0	31.8	371
Legal Status										
Unincorporated	32.3	73.7	54.2	10.3	9.1	14.4	34.5	18.5	32.9	319
Incorporated	24.8	60.7	53.8	21.4	5.1	13.7	29.1	34.2	19.7	117
Owners Nationality										
Local firm	30.6	71.8	54.7	12.8	8.2	14.0	33.0	22.2	29.6	415
Foreign firm	23.8	38.1	42.9	23.8	4.8	19.0	33.3	33.3	23.8	21

Table A.6: Objectives of Process Innovation by Attributes of Firms

Objectives of ProcessInnovation	Increase Product Qty (%)	Increase production (%)	Increase the flexibility of production (%)	Increase the speed of production (%)	Increase the speed of delivery (%)	Decrease cost of production (%)	Other (%)	N
Feature of Firms								
Age of Firm								
yrs<10	65.5	68.3	61.3	53.5	49.3	33.1	16.9	142.0
10=<yrs<20	68.8	72.7	53.2	53.2	42.9	37.7	16.9	77.0
20=<yrs<29	71.0	64.5	61.3	58.1	54.8	25.8	19.4	31.0
yrs>=30	75.0	79.2	79.2	79.2	58.3	54.2	4.2	24.0
Size of Firms								
Large	73.1	80.8	76.9	73.1	65.4	50.0	23.1	26.0
Medium	51.4	57.1	60.0	60.0	71.4	37.1	17.1	35.0
Small	70.0	70.9	58.7	53.5	43.2	33.3	15.0	213.0
Legal Status of Firms								
Unincorporated	71.6	71.6	59.1	50.0	42.6	30.7	15.3	176.0
Incorporated	61.2	67.3	63.3	67.3	60.2	43.9	17.3	98.0
Ownership of Firms								
Local Firm	67.8	69.8	59.6	55.3	48.6	35.3	15.3	255.0
Foreign Firm	68.4	73.7	73.7	68.4	52.6	36.8	26.3	19.0

Table A.7: Objectives for Product and Process Innovation by Firms Within Regions

Regions / Objectives	Western	Central	Greater Accra	Volta	Eastern	Ashanti	Brong Ahafo	Northern	Upper East	Upper West
Product Innovation										
Replace (%)	28	25	26	22	38	36	34	29	39	25
Extend product (%)	44	82	58	78	76	59	94	71	94	82
Market share (%)	42	39	56	61	59	48	66	57	52	61
Export (5)	8	-	18	4	18	16	9	18	12	14
Reduce cost (%)	14	7	14	17	15	11	28	7	9	18
Competition (%)	25	29	31	30	32	28	47	36	33	43
Comply with Standards (%)	11	4	32	17	32	15	26	25	21	21
Address Demand (%)	19	25	19	43	26	34	32	39	39	46
Other (%)	14	7	4	13	12	10	11	7	3	7
Number of Firms	**36**	**28**	**118**	**23**	**34**	**61**	**47**	**28**	**33**	**28**
Process Innovation										
Increase Product Qty (%)	70	64	68	83	80	62	65	56	69	62
Increase production (%)	70	50	69	83	85	73	69	75	65	62
Increase the flexibility of production (%)	75	43	67	83	75	38	42	63	65	43
Increase the speed of production (%)	65	43	61	67	70	54	35	63	42	57
Increase the speed of delivery (%)	60	14	53	50	70	42	35	56	50	43
Decrease cost of production (%)	50	21	38	44	55	46	38	13	12	24
Other (%)	20	14	15	11	20	19	15	25	15	10
Number of Firms	**20**	**14**	**87**	**18**	**20**	**26**	**26**	**16**	**26**	**21**

Table A.8: Industrial distribution of exports and domestic revenue (unweighted)

Manufacturing activity	Exports Revenue	Exp. Share (%)	Dom. Revenue	Dom. Share (%)
Food and beverages	3,873,896,117	33	7,958,199,346	67
Textiles and wearing apparel	55,085,859	19	240,307,864	81
Leather	37,930,746	36	67,554,227	64
Wood	212,670,355	13	1,405,905,375	87
Paper and paper products	33,617,418	8	388,333,813	92
Publishing and printing	38,234,416	19	164,285,870	81
Refined petroleum	-	-	2,698,882,140	100
Chemicals and pharmaceuticals	724,265,829	50	715,545,025	50
Rubber and plastics	1,242,907,512	66	652,482,761	34
Non-metallic products	24,017,088	3	856,044,427	97
Basic metals	1,043,736,013	36	1,863,589,261	64
Fabricated metals	199,591,226	26	577,508,601	74
Electronics and computers	714,334	0	1,976,523,932	100
Machinery and equip	2,301,194	18	10,318,968	82
Transport and motor vehicles	1,045,770	99	15,600	1
Furniture	3,049,922	2	139,542,016	98
Other manufacturing	322,214,743	88	42,368,920	12

Table A.9: Regional distribution of domestic and export revenue (unweighted)

Region	Export Revenue	Regional share of export revenue (%)	Domestic revenue	Regional share of Domestic revenue (%)
Western	1,283,530,022	16.4	392,406,134	2.0
Central	48,098,985	0.6	110,256,718	0.6
Greater Accra	5,132,851,357	65.7	13,830,986,771	70.0
Volta	17,897,572	0.2	483,043,173	2.4
Eastern	714,191,419	9.1	4,225,959,475	21.4
Ashanti	559,828,826	7.2	583,194,109	3.0
Brong Ahafo	58,131,179	0.7	19,259,910	0.1
Northern	421,680	0.0	69,885,740	0.4

Table A.9: Continued

Region	Export Revenue	Regional share of export revenue (%)	Domestic revenue	Regional share of Domestic revenue (%)
Upper East	327,500	0.0	39,548,965	0.2
Upper West	-	-	2,867,150	0.0
Total	7,815,278,541	100.0	19,757,408,145	100.0

Table A.10: Regional distribution of the export share of the revenue for innovating firms (unweighted)

Region	Export revenue by innovating firms	Share of Tot. Rev. by innovating firms	Tot. Export Rev.	Freq.
Western	40,550,558	3	1,230,493,646	46
Central	-	-	43,332,779	30
Greater Accra	639,545,980	27	2,377,525,236	150
Volta	-	-	17,897,572	33
Eastern	628,487	1	92,611,131	42
Ashanti	54,560	0	204,837,916	74
Brong Ahafo	885,000	2	36,442,768	61
Northern	366,725	71	519,475	33
Upper East	-	-	327,500	46
Upper West	-		-	37
Total	682,031,310	17	4,003,988,023	552

Table A.11: Instrumental Variable Estimation- First Stage Estimate for Distance to Port

	First Stage Estimate		Second Stage Estimate	
	1	2	3	4
	Exporter	Exporter	Product innovation	Process innovation
Exporter			0.09	0.15
			(0.48)	(0.82)
R & D expenditure		0.00	0.00***	0.00***
		(0.16)	(3.18)	(2.76)
Log (age)		0.27	0.04	-0.08*
		(1.56)	(1.13)	(-1.72)
Log (size)		6.57***	0.47***	0.62***
		(12.45)	(6.43)	(6.70)
Foreign ownership		0.64***	-0.07	-0.19
		(3.24)	(-0.52)	(-1.25)
Legal status		0.82***	0.04	0.29***
		(2.60)	(0.49)	(3.34)
Log of distance to the port	-0.01	0.23		
	(-0.03)	(1.37)		
Industry dummy	Yes	Yes	Yes	Yes
Observations	5355	4740	5356	5350
P-value	0.000	0.000	0.000	0.000
ll	-535.17	-276.52	-1419.05	-998.51
Sensitivity (%)	0.00	34.92	0.69	0.37
Specificity (%)	100.00	99.44	99.98	99.98

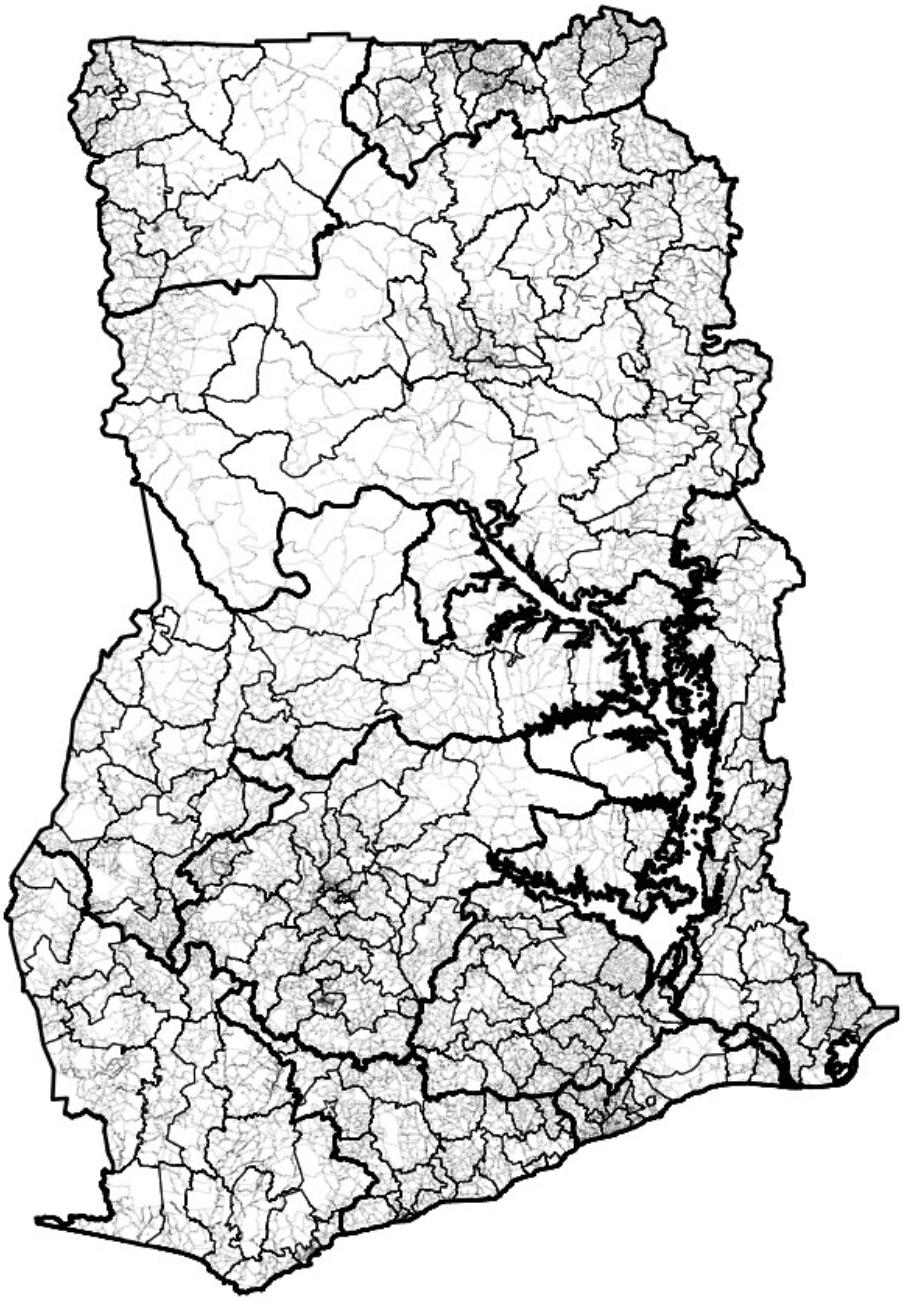


Figure A1: Administrative map of Ghana.
The thinnest lines represent localities, the intermediate lines show districts, and the thickest lines the regions.

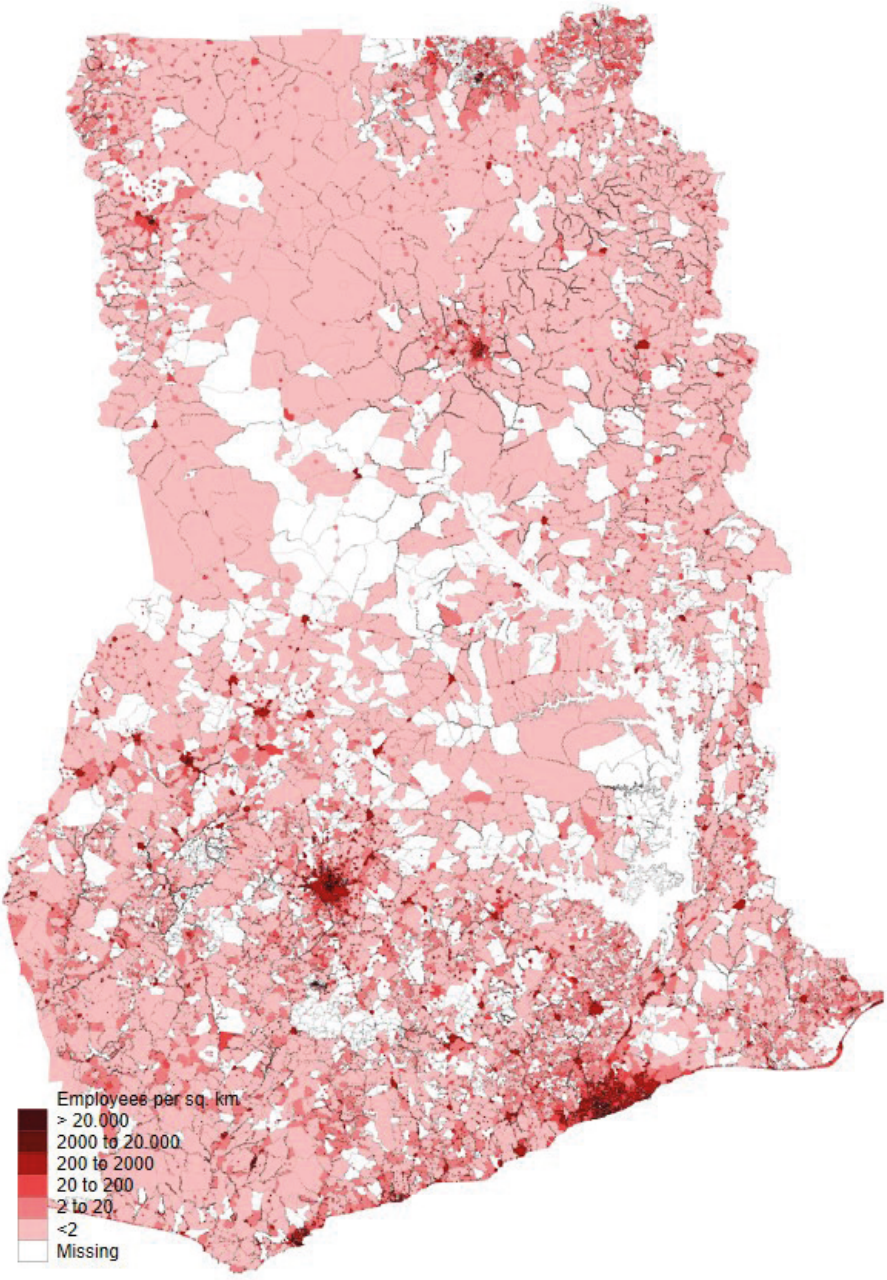


Figure A2: Employees per Square Km by Locality During the Economic Census.

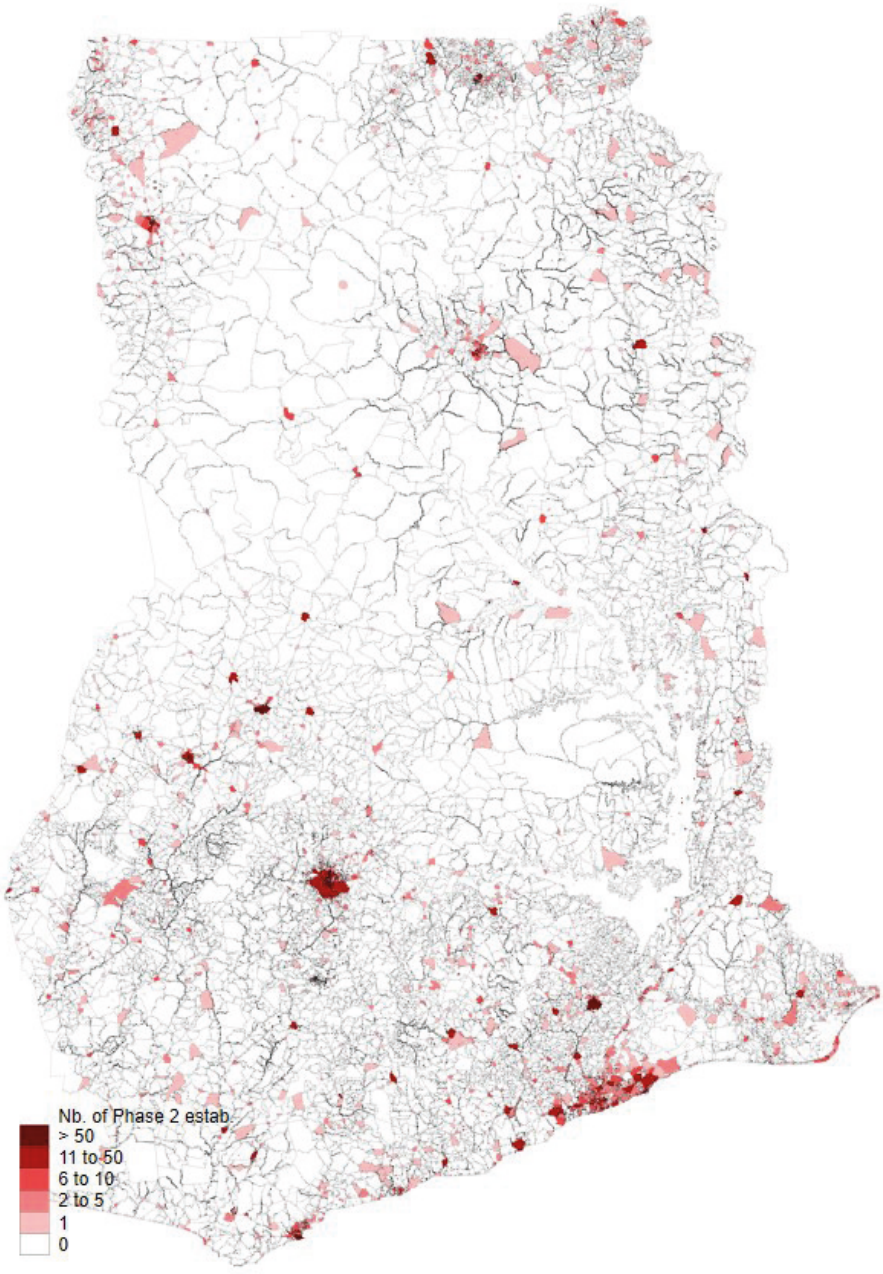


Figure A3: Location of Sample Establishments.

Table A.12: Factors that Hampered Innovation

	Non-innovators		Innovators	
	Yes	**No**	**Yes**	**No**
Funding	2721	2029	333	198
Costs	1740	2768	206	309
Knowledge	1968	2782	216	315
Market info	1227	3523	156	375
Established firms	934	3575	125	391
No need	1025	3725	74	457

Answers to the question, "How important were the following factors hampering your innovation activities or influencing your decisions not to innovate." "Yes" means "very important," and "No" to "important" or "not important." Yes to funding means that the firm answered very important to "Lack of funds within your firm or group" or to "Lack of external sources of funding." Costs refer to the answer "Innovation costs too high." Yes, knowledge is very important to "Lack of qualified personnel," "Lack of information on technology," or "Difficult in finding cooperation partners for innovation." Yes, to Market info means very important to "Lack of information on markets" or to "Uncertain demand for innovative goods or services." Yes to No need means very important to "No need due to prior innovation" or "No need because of no demand for innovation." Innovators are those firms that self-report having introduced a process or a product innovation in 2013.

Table A.13a: Capability Moderation of Density Effects on Innovation, in a 25km radius at 3-digits of ISIC

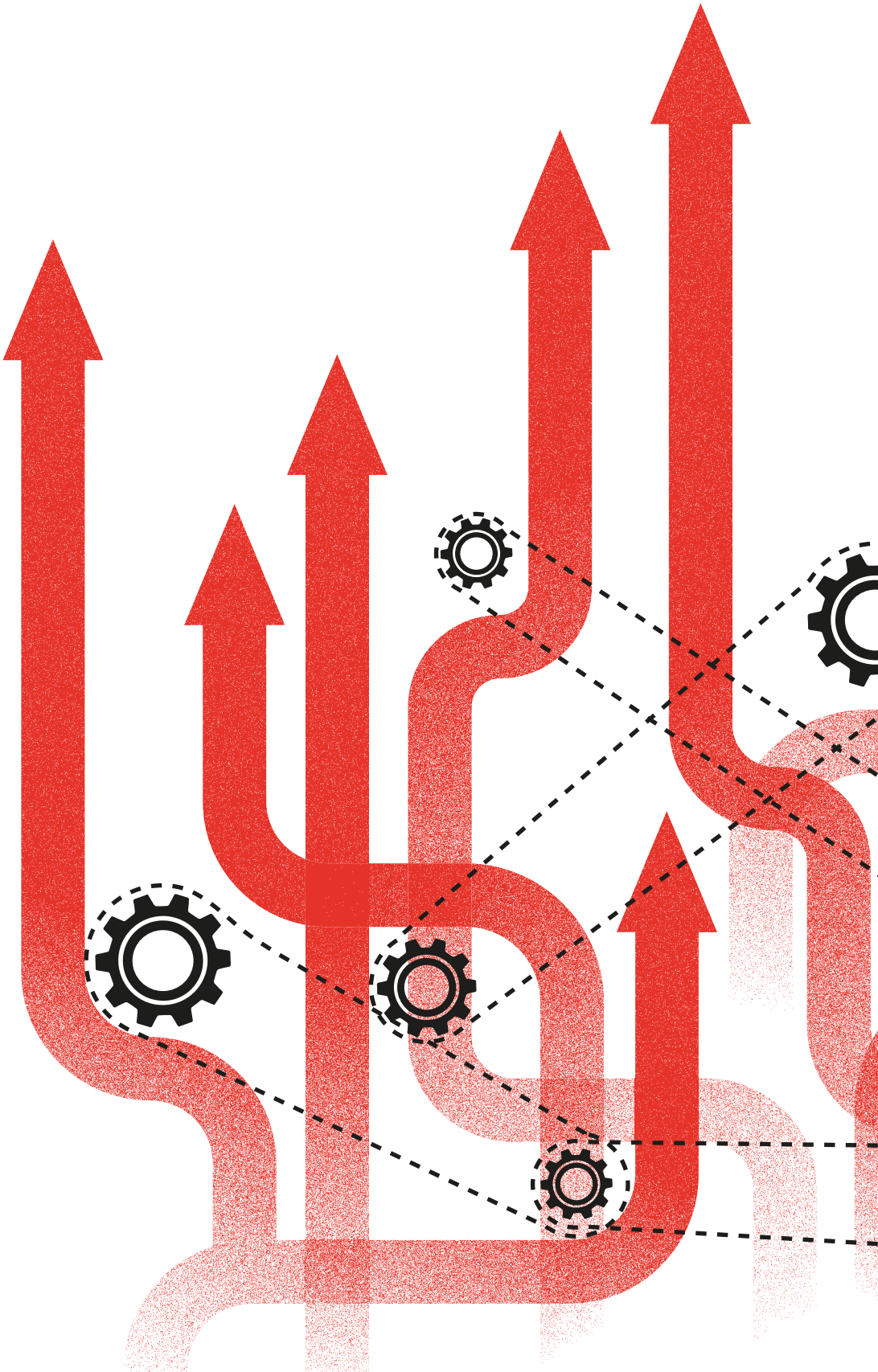
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Innovate	**Innovate**	**Innovate**	**Innovate**	**Innovate**	**Innovate**	**Innovate**	**Innovate**
Log(age)	0.06* (1.71)	0.04 (0.97)	0.05 (1.42)	0.05 (1.34)	0.05 (1.42)	0.05 (1.38)	0.05 (1.28)
Log(empl)	0.30 (1.62)	0.65*** (3.72)	0.28* (1.70)	0.29* (1.76)	0.28* (1.70)	0.28* (1.68)	0.29* (1.78)
Foreign-owned	-0.30* (-1.66)	-0.35* (-1.79)	-0.38** (-2.16)	-0.38** (-2.08)	-0.39** (-2.24)	-0.38** (-2.09)	-0.39** (-2.14)
Incorporated	-0.06 (-0.46)	0.07 (0.45)	-0.16 (-1.11)	-0.15 (-1.06)	-0.17 (-1.18)	-0.15 (-1.03)	-0.16 (-1.09)
openness	-0.05*** (-2.87)		-0.05*** (-2.60)	-0.13 (-1.64)	-0.05** (-2.51)	-0.05** (-2.53)	-0.10 (-1.29)
Absorptive_cap	0.14*** (4.48)		0.14*** (4.74)	0.14*** (4.81)	0.03 (0.31)	0.14*** (4.63)	0.02 (0.25)
market_cap	0.28*** (13.47)		0.27*** (12.76)	0.28*** (12.55)	0.27*** (12.17)	0.27*** (5.63)	0.31*** (6.62)
Localization		-0.06 (-1.56)	-0.06 (-1.45)	0.04 (1.30)	0.00 (0.07)	-0.04 (-0.99)	0.06 (1.16)
Urbanization		0.15*** (3.16)	0.11** (2.38)	0.06 (0.80)	0.02 (0.25)	0.12* (1.82)	0.01 (0.07)
Urbanization # openness				0.01 (0.76)			0.01 (0.38)
Localization # openness				-0.02** (-2.14)			-0.02* (-1.88)
Localization # Absorptive_cap					-0.01 (-1.18)		-0.01 (-0.56)
Urbanization # Absorptive_cap					0.02 (1.46)		0.03 (1.46)
Localization # market_cap						-0.00 (-0.52)	0.00 (0.23)
Urbanization # market_cap						-0.00 (-0.02)	-0.01 (-0.80)
Observations	5280	5280	5280	5280	5280	5280	5280
chi2	1119.91	162.25	1104.82	1485.33	1432.64	1265.78	3667.30
ll	-1554.28	-1680.33	-1548.47	-1546.33	-1547.50	-1548.25	-1545.33
t statistics in parentheses ="* p<0.10	** p<0.05	*** p<0.01"					

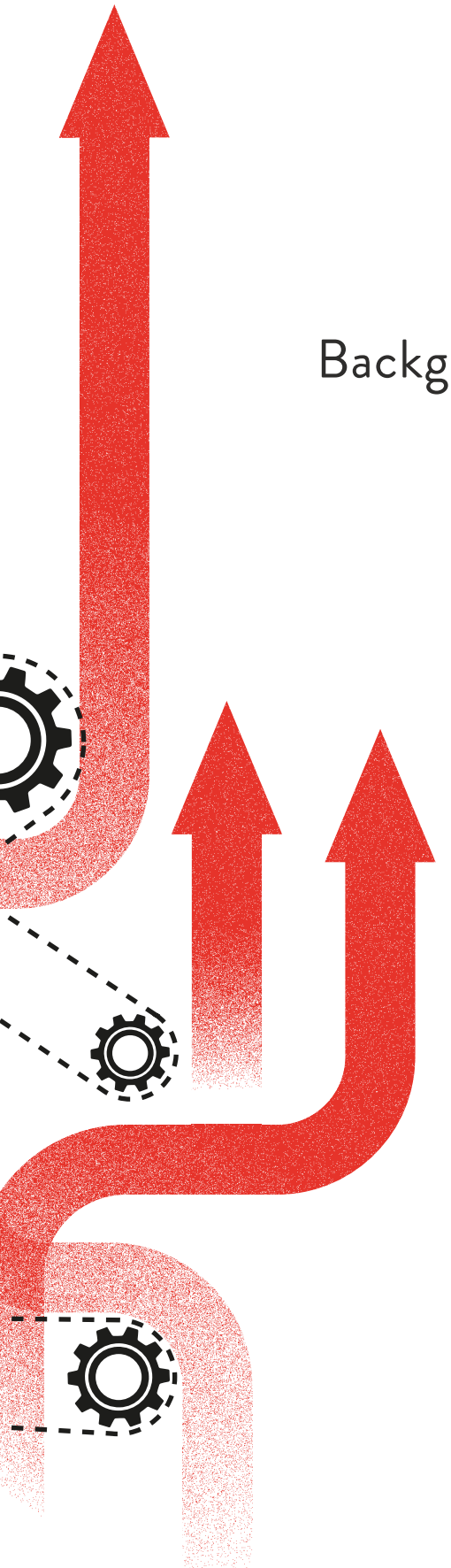
Table A.13b: Capability Moderation of Density Effects on Innovation, in a 50km radius at 2-digits of ISIC

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Innovate	**Innovate**	**Innovate**	**Innovate**	**Innovate**	**Innovate**	**Innovate**	**Innovate**
Log(age)	0.06* (1.71)	0.04 (1.27)	0.06 (1.63)	0.06 (1.60)	0.06* (1.68)	0.06 (1.61)	0.06 (1.63)
Log(empl)	0.30 (1.62)	0.69*** (3.85)	0.31* (1.84)	0.31* (1.86)	0.31* (1.84)	0.31* (1.83)	0.31* (1.86)
Foreign-owned	-0.30* (-1.66)	-0.33 (-1.61)	-0.36* (-1.95)	-0.35* (-1.84)	-0.37** (-2.08)	-0.35* (-1.85)	-0.36* (-1.91)
Incorporated	-0.06 (-0.46)	0.10 (0.64)	-0.15 (-1.02)	-0.14 (-1.00)	-0.17 (-1.16)	-0.14 (-0.98)	-0.16 (-1.11)
openness	-0.05*** (-2.87)		-0.05*** (-2.71)	-0.09 (-1.25)	-0.05*** (-2.75)	-0.05*** (-2.62)	-0.06 (-0.87)
Absorptive_cap	0.14*** (4.48)		0.14*** (4.60)	0.14*** (4.64)	0.04 (0.39)	0.14*** (4.57)	0.05 (0.48)
market_cap	0.28*** (13.47)		0.28*** (12.94)	0.28*** (12.91)	0.28*** (12.40)	0.23*** (3.85)	0.26*** (4.54)
Localization		-0.09* (-1.73)	-0.09 (-1.64)	-0.01 (-0.21)	-0.07 (-0.73)	-0.05 (-1.11)	-0.01 (-0.17)
Urbanization		0.17** (2.47)	0.14** (1.98)	0.11 (1.19)	0.03 (0.29)	0.12* (1.69)	0.05 (0.37)
Urbanization # openness				0.01 (0.32)			-0.00 (-0.22)
Localization # openness				-0.02 (-1.34)			-0.01 (-1.33)
Localization # Absorptive_cap					-0.01 (-0.33)		0.01 (0.28)
Urbanization # Absorptive_cap					0.03 (1.22)		0.03 (1.24)
Localization # market_cap						-0.01 (-1.24)	-0.01 (-0.89)
Urbanization # market_cap						0.01 (0.75)	0.00 (0.18)
Observations	5280	5280	5280	5280	5280	5280	5280
chi2	1119.91	114.72	978.52	1144.06	1547.45	1138.41	2741.28
ll	-1554.28	-1680.52	-1547.19	-1546.26	-1546.14	-1546.53	-1544.19
t statistics in parentheses	="* p<0.10	** p<0.05		*** p<0.01"			

Table A13c: Capability Moderation of Density Effects on Innovation, in a 50km Radius at 3-digits of ISIC

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Innovate	**Innovate**	**Innovate**	**Innovate**	**Innovate**	**Innovate**	**Innovate**	**Innovate**
Log(age)	0.06* (1.71)	0.04 (1.09)	0.05 (1.45)	0.05 (1.38)	0.05 (1.47)	0.05 (1.43)	0.05 (1.38)
Log(empl)	0.30 (1.62)	0.67*** (3.90)	0.30* (1.79)	0.30* (1.81)	0.29* (1.77)	0.29* (1.76)	0.29* (1.81)
Foreign-owned	-0.30* (-1.66)	-0.34* (-1.72)	-0.37** (-2.11)	-0.37** (-2.03)	-0.39** (-2.23)	-0.37** (-2.06)	-0.38** (-2.13)
Incorporated	-0.06 (-0.46)	0.10 (0.67)	-0.14 (-0.99)	-0.13 (-0.94)	-0.16 (-1.13)	-0.14 (-0.93)	-0.15 (-1.04)
openness	-0.05*** (-2.87)		-0.05*** (-2.72)	-0.11 (-1.40)	-0.05*** (-2.71)	-0.05*** (-2.63)	-0.08 (-1.01)
Absorptive_cap	0.14*** (4.48)		0.14*** (4.60)	0.14*** (4.64)	0.01 (0.09)	0.14*** (4.56)	0.02 (0.15)
market_cap	0.28*** (13.47)		0.28*** (12.99)	0.28*** (12.68)	0.28*** (12.33)	0.24*** (4.33)	0.28*** (5.60)
Localization		-0.07 (-1.50)	-0.06 (-1.38)	0.03 (0.58)	-0.01 (-0.16)	-0.03 (-0.81)	0.04 (0.58)
Urbanization		0.15** (2.53)	0.11** (1.96)	0.08 (0.81)	-0.01 (-0.14)	0.10 (1.49)	-0.00 (-0.03)
Urbanization # openness				0.01 (0.43)			-0.00 (-0.10)
Localization # openness				-0.02 (-1.62)			-0.02 (-1.59)
Localization # Absorptive_cap					-0.01 (-0.80)		-0.00 (-0.14)
Urbanization # Absorptive_cap					0.03 (1.63)		0.03* (1.72)
Localization # market_cap						-0.01 (-1.09)	-0.00 (-0.43)
Urbanization # market_cap						0.01 (0.44)	-0.00 (-0.34)
Observations	5280	5280	5280	5280	5280	5280	5280
chi2	1119.91	120.24	1032.81	1194.53	1607.46	1132.18	3165.78
ll	-1554.28	-1683.03	-1549.48	-1548.06	-1548.15	-1549.05	-1546.25
t statistics in parentheses	="* p<0.10	** p<0.05	*** p<0.01"				





Background of the Survey Data

APPENDIX B

Appendix B: Background of the Survey Data

The thesis relies primarily upon data from firms in an innovation survey integrated into an economic survey conducted by the Ghana Statistical Service (GSS) in 2015, The Integrated Business Establishment Survey II (IBES II), conducted with a representative sample of business establishments or firms across all sectors of the Ghanaian economy. During the survey, the author developed a series of questions to comprehensively collect innovation data from the manufacturing firms in the sample.

B1 Sampling design

Many innovation survey designs usually collect innovation data from a specific cluster of firms or target population. In the European Union, while the Community Innovation Survey (CIS) by countries targets enterprises that employ at least ten people, innovation surveys in emerging countries by the World Bank usually target large firms in high-technology industries. However, the design of this survey focuses on estimating business statistics that will produce sub-sectorial statistics with high precision at the national and regional levels across a broad spectrum of issues, including innovation. Consequently, the sample reflects all categories of manufacturing firms, irrespective of size (micro, small, medium, and large-sized firms), level of technology, industry, or formal status, mimicking the national distribution of firms in a developing country.

The sampling frame for this survey is the most current Business Register, made up of 638,480 non-household business establishments, cutting across all economic sectors of Ghana, compiled in 2015 during the census (IBESI) of all non-household establishments. In this register, the manufacturing sector has about 100,000 firms, of which 6,800 were randomly selected based on a five percent precision level for each domain (ten administrative regions), resources, and operational constraints. The sampling design selected all establishments with 50 or more persons engaged with certainty while sampling the others with a non-zero probability. This survey's unit of inquiry is the establishment, not the enterprise. The optimum sample allocation for each stratum is subject to the number of establishments in the sampling frame and the standard deviation for the variable of interest. The number of persons engaged was the critical variable for calculating the standard deviation since most of the survey estimates correlate with employment, and the data for this variable were available in the sampling frame. The sampling design adjusted the initial sampling rates for regions, activities, and size, and the overall optimum sampling rates

by total persons engaged (TPE) size stratum to determine the differential relative sampling rates for the size strata within each economic activity domain categorized by the two-digit International Standard Industrial Classification (ISIC) level by region.

B2 Field data collection and quality control

Over 6,800 manufacturing firms were included in the initial sample for the data collection by interviewers and supervised by supervisors, zonal coordinators, and regional monitors. During the GSS surveys, the author developed questions for firm innovation for this thesis. The survey collected data on employment, wages and salaries, direct inputs (domestic and imports), turnover (domestic sales and exports), other revenue, indirect costs, product and process innovation, and other related variables based on the Oslo model. The other innovation variables include data on activities that culminate in product and process innovation, the target for innovation novelty, the various innovation activities, the objectives of firms implementing these innovation activities, the dynamic capability of firms to innovate, trust-related issues in implementing firm innovation, R&D expenditures, as well as the barriers to firm innovation (see appendix 3 for the questionnaire).

The survey acknowledges that the precision of the survey results depends on both the sampling and non-sampling error. Therefore, quality control procedures were employed to reduce the non-sampling error through quality training, field monitoring, and editing completed questionnaires. All field workers were trained intensively for 21 days in all the regional capitals on the survey instruments and the interviewing techniques by economists and statisticians with substantial experience and knowledge in surveys and business accounting concepts using practical sessions, demonstrations, and mock interviews. Monitors visited field staff to ascertain the quality of the data collected and resolve any issues regarding the survey instruments while addressing challenges regarding refusals to participate in the survey, contributing to a high response rate of 78.2%. Also, Supervisors, zonal coordinators, office editors, and coders edited the completed questionnaires for completeness, consistency, and accuracy and instructed correction for errors in the field and the office at various levels (GSS, 2016).

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