Corruption, Transaction Costs and Innovation in Africa

Laura Nelima Barasa

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Bringing Rigour and Evidence to Economic Policy Making in Africa

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List of abbreviations and acronyms

BC	Bias Corrected
CI	Confidence Intervals
GII	Global Innovation Index
IFS	Innovation Follow-up Survey
LICs	Low Income Countries
NIE	New Institutional Economics
SSA	Sub-Saharan Africa
TCE	Transaction Cost Economics
WBES	World Bank Enterprise Survey
WIPO	World Intellectual Property Organization

Abstract

This paper examines the relationship between corruption and transaction costs, as measured by asset specificity and innovation in Africa. We hypothesize that in the context of developing countries in Africa, corruption is significantly associated with innovation, and that this relationship is mediated by transaction costs, including physical asset specificity and human asset specificity. We test our hypotheses by means of a multiple mediation model. We use the product-of-coefficients approach and bootstrapping techniques to estimate firm-level data from the World Bank Enterprise Survey and Innovation Follow-up Survey for five countries in Sub-Saharan Africa. We find that corruption is positively associated with innovation, and that asset specificity positively mediates this relationship. We conclude that the positive relation between corruption and innovation offers support to the "grease-the-wheels" hypothesis. Furthermore, transaction costs involving physical asset specificity increase the likelihood of innovation in a business environment characterised by corruption, an indicator of poorly functioning institutions. Hence, policies focusing on strengthening institutions are likely to be beneficial for controlling corruption and stimulating innovation Lastly, policies pertaining to tax incentives related to physical asset investments are crucial for enhancing innovation.

Key words: Corruption, transaction costs, innovation, Sub-Saharan Africa

1. Introduction

The link between corruption and transaction costs has been highlighted in explaining economic outcomes in developing countries in Africa. Corruption in Africa has been described as endemic, with a majority of countries in Sub-Saharan Africa (SSA) being among the most corrupt in the world (Mbaku, 2010). Corruption involving the abuse of public power for private gain plays a key role in explaining transaction costs, particularly in developing countries (North, 1987; Dagnino and Farina, 1999). Transaction costs are defined as the costs associated with making an exchange on the open market (Coase, 1961). Moreover, transaction costs are usually present in an innovative environment (Schwiebacher, 2012). Such transaction costs are broadly associated with asset specificity, which refers to costs relating to capital investment intended for the production of innovative products and services. Essentially, firms select the form of economic organisation that minimises transaction costs (Conner, 1991). Furthermore, institutions shape the economic environment and the nature of innovation activities that firms in developing countries undertake. Yet, weak institutions that fail to control corruption increase transaction costs on the market and, consequently, impede entrepreneurial innovation relating to the introduction of new or significantly improved goods and services (Chadee and Roxas, 2013). Hence, there is a higher likelihood of firms opting for the hierarchical production of innovation inputs in an environment with high transaction costs arising from weak institutions that are riddled with a high degree of corruption. Conversely, strong institutions, indicated by low levels of corruption, yield low direct and indirect costs involving time, effort and monetary resources (Zhu et al., 2012). Thus, a low degree of corruption implies low transaction costs that enable firms to source innovation inputs on the market in order to increase innovation. Nevertheless, specialisation in the production of innovation inputs as indicated by high asset specificity leads to hierarchical transactions as opposed to market transactions (Williamson, 1981). Investing in specialised assets increases transaction costs because firms must safeguard against opportunism or hold-up problems. Additionally, weak institutions are likely to give rise to the hold-up problem that also increases transaction costs (Klein, 2000). The transaction cost economics (TCE) theory of the firm suggests that inasmuch as investing in specialised assets fosters productivity, it is important to note that more specialised assets have limited options for alternative uses, exposing firms to a greater risk of opportunism. Notwithstanding, contrary to what the TCE theory of the firm proposes, greater asset specificity has been associated with low transaction costs (see Dyer, 1997) and therefore increased innovation performance. Taking into account that corruption is a key determinant of transaction costs and innovation, we posit that transaction costs mediate the relation between corruption and innovation. In particular, we argue that in a business environment characterised by a low degree of corruption, high asset specificity diminishes transaction costs and fosters innovation performance in manufacturing firms in developing countries. Hence, while many factors shape innovation, the degree of corruption mediated by transaction costs is likely to significantly influence the innovation performance of firms. Therefore, the primary objective of this study is to investigate how transaction costs mediate the relation between corruption and innovation performance.

This paper is structured as follows: first, the notion of innovation in SSA is described. Thereafter the statement problem, objectives and significance of the study are given. Next is a discussion of the TCE theory of the firm in the theoretical background section, and the study's hypotheses are developed in the next section. This is followed by a data and methods section, after which the paper concludes with a results and discussion section, and also provides policy implications drawn from the findings.

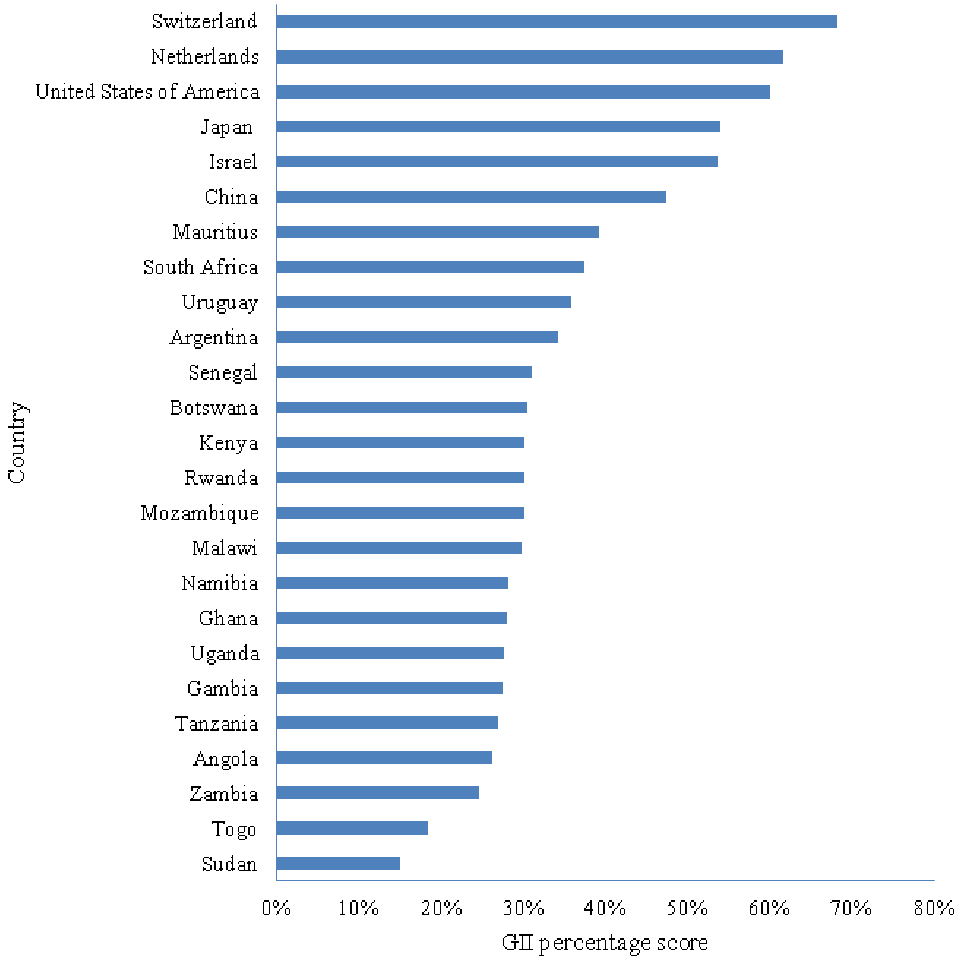
Innovation in Africa

In the recent past, considerable attention has been devoted to examining the relationship between innovation and firm growth. Various authors underscore the significance of innovation performance for firm growth (Audretsch et al., 2014; Coad et al., 2016). Innovations are usually classified according to their degree of novelty. Typically, innovations may be classified as incremental or radical innovations. Incremental innovation refers to successive improvements in existing products and services with a low degree of novelty, whilst radical innovation involves the creation of products and services that are new to the international market (Cirera, 2015). Radical innovations are characterised by a high degree of novelty. Incremental innovation contributes to firm growth and survival in SSA (Ács and Audretsch, 2005). In the context of developing countries, innovation also relates to the adoption and/or imitation of foreign technologies. Defining innovation as "something new to a local context" (Aubert, 2005: 11) is more meaningful for understanding innovation in the context of developing countries in Africa. Additionally, distinctive features of the innovation climate in Africa include the presence of weak or fragile institutions, low levels of human capital and poor infrastructure, and low levels of investment in Research and Development (R&D) that give rise to a business environment that is not conducive to radical innovation. Çapoğlu (2009) asserts that despite a vast literature on innovation, a precise definition of the term remains elusive in the context of low-income countries (LICs). Typical definitions of innovation include three key elements: newness, value creation, and process. Newness encompasses products or services that are new to the firm, market or the world (Kotabe and Swan, 1995). Process relates to the initiation and management of the innovation process that includes the actualisation of ideas into new products and services. Lastly, value creation arising from innovation is manifested by a reduction in input costs or increased sales revenue (Porter, 1985). Firms may invest in new technologies with the aim of lowering input costs and production costs. Furthermore, firms may also pursue a sales strategy that entails the production of high quality products to deliver new customer value to the market.

In a qualitative exploratory study on the nature of innovation in manufacturing firms in Kenya and Tanzania, Voeten (2015, 2016) reveals that firms introduce a variety of changes in their products and processes for survival. Essentially, these changes are not radical, neither are they new inventions. Nevertheless, the innovations are new to the firms. Furthermore, there are no systematic records of R&D expenditure, nor do firms have registered patents. Hence, in line with Szirmai, Naudé and Goedhuys (2011) innovation in this context comprises incremental adoption and adaptation of existing technologies. In fact, Voeten (2015) argues that a broad definition of innovation manufacturing firms would include every new thing that firms do to survive and remain ahead of their competition. Yet, Voeten (2016) claims that firms in Tanzania were observed to be less innovative than those in Kenya given that firms in Tanzania introduced relatively minor innovations for survival. Hence, this study adopts a broad measure of innovation that encompasses the introduction or significant improvement of products or services that are new to the firm. The World Bank recently launched a series of innovation surveys in Africa. The 2013 Innovation Follow-up Survey (IFS) was carried out after the 2013 World Bank Enterprise Survey (WBES). The aim of the IFS was to collect information on innovation and innovation related to activities at the firm level (www.enterprisesurveys.org). Taking into account that the IFS covers a period of three years (i.e., 2010 to 2012), it can be argued that while innovation activities may require a long gestation period, incremental innovations are likely to precede the emergence of radical innovations (Shalley et al., 2015), and this is particularly applicable in the context of developed countries (Ács and Audretsch, 2005).

The Global Innovation Index (GII), a leading reference for innovation, reports on the innovation capabilities and performance of about 141 economies (www.globalinnovationindex.org). In addition to the GII measuring the innovation capacity across countries, it also presents a comparative analysis of innovation performance that sheds light on factors accounting for differences in innovation performance. Figure 1 shows GII 2015 scores for countries in SSA. Being aware of the role that geographical and institutional proximity play in innovation outcomes (Boschma, 2005), marked cross-country variation in innovation performance is observed. Innovation performance for virtually all SSA countries falls below 40%. Of more interest is the fact that in some instances LICs, such as Rwanda and Malawi, outperform lower middle and upper middle-income countries such as Ghana and Angola. The GII 2015 reports that some of the factors accounting for the strong performance of LICs include the removal of obstacles to innovation, such as poor access to capital, poor linkages to innovation systems, a weak human capital base, and weak institutions. Kenya has a high GII score relative to a majority of SSA countries. The GII 2015 report attributes Kenya's relatively strong performance to indigenous entrepreneurial innovation.

Figure 1: Global Innovation Index scores, 2015



Source: Cornell University, INSEAD and World Intellectual Property Organisation, 2015.

Problem statement

This study focuses on examining how corruption and transaction costs affect innovation. The previous discussion demonstrates that the business environment in SSA is characterised by a high degree of corruption. Additionally, countries in SSA exhibit weak innovation performance. Weak institutions, as evidenced by a high degree of corruption, have an increase in transaction costs that impedes innovation at the firm level, which in turn adversely affects aggregate development (Goedhuys and Srholec, 2015). Hence, to fully understand innovation, it is essential that we examine the macro and micro linkages in the innovation process arising from institutions, such as corruption. Furthermore, investigating asset specificity as the most dominant dimension of transaction costs is crucial to understanding innovation in the context of developing countries. This is because contrary to what TCE postulates, high asset specificity is likely to minimise transaction costs and increase innovation performance in firms in the context of developing countries. Asset specificity includes physical asset specificity, which is the acquisition of specialised machinery or equipment for developing innovation, and human asset specificity, which entails specialised training of workers to acquire skills for the production of innovation or hiring workers for the development of innovative products. Both types of asset specificity are important determinants of innovation, especially in the context of developing countries because they encompass essential innovation inputs that enhance the likelihood of innovation at the firm level. However, corruption in the business environment is likely to influence the degree of asset specificity in a firm. There are virtually no empirical studies examining the nexus between corruption, transaction costs and innovation in the context of SSA. In addition, there is a dearth of literature examining how transaction costs mediate the relationship between corruption and innovation in Africa. This has been attributed to a lack of comprehensive innovation data for developing countries (Goedhuys and Veugelers, 2012), which has been unavailable until recently.

Research objectives

The general objective of this study is to examine factors affecting innovation in the context of developing countries in SSA. The specific objectives of the study are to: (1) examine the relationship between corruption and innovation; and (2) investigate how transaction costs mediate the relationship between corruption and innovation.

Significance of the study

Institutions, transaction costs, and innovation play a key role in promoting firm performance; it is therefore important that we gain an understanding of how corruption and transaction costs influence innovation in developing countries, and more so in Africa, which is characterised by endemic corruption and sub-optimal innovation performance. The New Institutional Economics (NIE) strand of research posits that institutions and transaction costs are linked in important ways. Nevertheless, this link has been scarcely explored. Hence, this study fills this knowledge gap by providing pertinent information that promotes the understanding of how corruption and transaction costs affect innovation in developing countries in Africa. Apart from examining the main effects of corruption on innovation, this study also investigates how asset specificity, the principal determinant of transaction cost, mediates the relation between corruption and innovation. In particular, the study investigates the mediation effects of physical asset specificity and human asset specificity in the context of developing countries in SSA. Therefore, our study makes two significant contributions. First, it explains the relationship between corruption and innovation in manufacturing firms in developing countries in the context of Africa. Second, by examining how different dimensions of asset specificity, including physical asset specificity and human asset specificity, mediate the relation between corruption and innovation, this study deepens the understanding of how the institution-transaction cost relationship influences innovation outcomes in developing countries.

2. Theoretical background

This study is grounded in the TCE theory of the firm propounded by Coase (1937), which is a branch of NIE. NIE literature relates transaction costs to the institutional environment. Institutions exist to mitigate costs associated with transactions, which is crucial for economic performance. Transaction costs provide a means by which the efficiency of different institutional arrangements in achieving economic outcomes in political and economic environments can be measured. Essentially, transaction costs are the medium through which institutions influence firm performance. Thus, corruption as an institution can enhance or diminish firm performance via transaction costs. NIE consists of two levels: the micro and the macro level (Williamson, 2000). The macro level focuses on the institutional environment, which affects the behaviour and economic performance of actors such as firms. The institutional environment comprises a set of political, social and regulatory rules that govern production, economic exchange, and distribution. The micro level, also referred to as the institutional arrangement, relates to institutions of governance at the firm level (Williamson, 1996). These comprise hierarchical production in a firm, and markets, which are alternate institutions of governance for organizing economic activity in a firm (Arrow, 1974).

Williamson (1981) argues that where new sets of technological capabilities are necessary for production, transaction costs will arise when a product or service is transferred from one stage of production to the next. The TCE theory of the firm suggests that firms weigh up the internal bureaucratic costs of undertaking hierarchical production in the firm against external transaction costs arising from sourcing on the market. Hence, decision makers select the governance structure that minimizes the total cost of a transaction. There are three distinct dimensions of transactions, i.e., asset specificity, frequency of transactions, and uncertainty (Williamson, 1981), which are discussed in the context of vertical integration that occurs when a firm internalizes production processes as opposed to sourcing from the market (Vannoni, 2002). Empirical studies use these characteristics as proxies for measuring transaction costs indirectly (see Dyer, 1997). Williamson (1981) describes asset specificity as the extent to which an investment for a particular transaction relates to that individual transaction. Asset specificity is the key determinant when minimizing transaction costs. In the event of the transaction failing, the investment would be less valuable in another venture. In such a situation, two issues arise. First, buyers are not able to easily turn to other suppliers and are "locked into" the transaction. This is known as the hold-up problem. Second, suppliers are exposed to opportunistic behaviour and therefore must safeguard themselves by implementing, monitoring and enforcing contractual agreements (Boudreau et al., 2007). This is known as the safeguard problem. Vertical integration offers a solution to both problems. Thus, firms will prefer hierarchical production where there are high levels of asset specificity. Rindfleisch and Heide (1997) argue that uncertainty mainly arises from environmental variability and behavioural uncertainty.

Environmental variability may arise from technological uncertainty, which is difficult to anticipate, making it difficult to write complete contracts. Thus, re-negotiation and adaptation are necessary for dealing with the contractual gaps that emerge, which increases transaction costs. Behavioural uncertainty refers to the difficulty of monitoring and evaluating the performance of a transaction partner. Hence, with a high degree of uncertainty, firms opt to produce internally as opposed to sourcing from the market. Measuring the degree of uncertainty concerning future relations presents difficulties and, as such, asset specificity has been used as a measure of transactions cost in most empirical studies (Shelanski and Klein, 1995). The TCE theory of the firm asserts that frequency of transactions affects transaction costs and production costs (Boudreau et al., 2007). Firms will have an incentive for internalizing production with increasing frequency of transactions (Williamson, 1987). This transactions characteristic has received far less attention compared to asset specificity and uncertainty (Rindfleisch and Heide, 1997; Geyskens et al., 2006).

Whilst transaction costs have been extensively studied in NIE, there is no consensus on the definition and measurement thereof. Direct measures of transaction costs relate to the economic value of resources used in locating, negotiating and executing transactions. In addition, transaction costs can be directly measured by the difference between the price paid by the buyer and the price received by the seller (Wang, 2007). Notwithstanding this, the direct measurement of transaction costs heavily relies on the availability of quantifiable micro-data from the successive stages encountered in carrying out transactions. Transaction costs comprise the cost of doing business such as the time, effort and resources spent in obtaining business permits and licenses, and bribing government officials. We argue that transaction costs largely pertain to corruption in the context of SSA. In contrast, indirect measures of transaction costs, as employed by Williamson (1980), encompass the use of proxies such as asset specificity, uncertainty and frequency of transactions as measures of transaction costs. This study focuses on indirect measures of transaction costs that entail firms selecting the form of economic organization that minimizes transaction costs (Wang, 2007). Asset specificity is the most critical indirect measure of transaction costs (Williamson, 1981). Firms may acquire equipment and machinery, or human capital as innovation inputs specific to the needs of the innovation outcomes. Consequently, transactions costs as indicated by high asset specificity can result in opportunistic behaviour encompassing moral hazard and adverse selection, which can only be minimised by institutions evolving. Hence, transaction costs and institutions are inextricably linked in shaping innovation outcomes at the firm level. Institutions are humanly devised constraints that shape human interaction. Institutions structure political, social or economic incentives in human exchange (North, 1990). Various studies find that institutions accounting for control of corruption, enforceability of contracts, perception of a predictable and effective judiciary system, public administration transparency, and market-friendly regulations, play a significant role in fostering entrepreneurial activity and innovation in a business environment (North, 2005; Tebaldi and Elmslie, 2013). Furthermore, the level of transaction costs may vary depending on the effectiveness of institutions, which relates to the degree of corruption in the context of this study. Thus, corruption and transaction costs are two dominant factors that influence innovation at the firm level.

In the context of developing countries, transaction costs largely pertain to the role of government institutions in the business environment. Tybout (2000) claims that a weak rule of law, uncertainty about government policies and corruption hamper operations of the firm. Thus, the effectiveness of state institutions in regulating the business environment plays a critical role in fostering economic freedom and firm growth. In addition, economic theory suggests that institutions provide firms with incentives to innovate. Therefore, good governance is expected to stimulate innovation. For example, a corruption-free economic system is vital for ensuring that effort and competence are rewarded. Previous studies from Kenya and Uganda show that corruption arising from bribery of government officials and informal payments dampen firm performance in manufacturing firms (Kimuyu, 2007; Fisman and Svensson, 2007). Yet, the extant literature shows that corruption has divergent effects on firm growth. Sequeira and Djankov (2014) argue that corruption may be classified as cost-reducing “collusive” corruption or cost-increasing “coercive” corruption. Hence, corruption has ambiguous effects on entrepreneurial activity. Positive effects of corruption may manifest where private agents engage in acts of corruption to overcome bureaucratic red tape and regulatory inefficiency. Furthermore, acts such as bribery may provide public officers with an incentive to perform their duty. The negative effects of corruption arise from the distortion of private agents’ decisions that increase the costs of corruption.

3. Hypotheses

The preceding discussion highlights the importance of institutional environment for entrepreneurial activity. In sum, institutions foster innovation. Based on this, this study develops hypotheses relating to the effect of corruption on innovation in this section. Specifically, the hypotheses investigate the direct and indirect relationship between corruption and innovation.

Corruption and Innovation

The institutional environment within which a firm operates may incentivize or constrain entrepreneurial innovation (Baumol, 1990; Nee, 1996). The vulnerability of firms to corruption may arise from innovation activities, involving obtaining permits for the construction of additional features in plants, installation of communication infrastructure, acquisition of equipment, importation of new products, or the registration of trademarks. These activities increase contact with public officials that are in a position to extort the firm (Murphy et al., 1993). It therefore follows that firms engaging in innovation activities are more likely to make informal payments to government officials than non-innovating firms (Ayyagari et al., 2011). Institutions such as corruption also influence a firm's decision to direct resources to more or less productive activities (Licht and Siegel, 2008). Furthermore, key considerations when selecting an economical form of governance for a transaction include the transaction's characteristics, alternative forms of governance structures and the institutional environment (Dyer, 1997). Using cross-country data and the instrumental variable approach to examine the link between innovation and institutions, Tebaldi and Elmslie (2013) find that control of corruption is positively associated with increased rates of innovation. Similarly, Chadee and Roxas (2013) find that a high degree of corruption has a negative impact on innovation in Russia. Additionally, Mahagaonkar (2008) finds that corruption has a negative effect on innovation in the context of SSA. Nevertheless, Nguyen, et al. (2016) show that corruption has positive effects on innovation in Vietnam. The authors argue that the competing "sand-the-wheels" and "grease-the-wheels" hypotheses relating to the effects of corruption on economic growth also apply in the case of corruption and innovation. Similarly, Krammer (2017) finds that corruption has a positive effect on innovation in Central Asia and Eastern Europe. Thus, empirical literature on the effects of corruption on innovation is mixed, and it can be argued that corruption is likely to have ambiguous effects on innovation in the context of Africa. The following hypothesis is formulated:

H1: Corruption and innovation have a significant relationship in SSA.

Mediated corruption-innovation effect

Transaction costs are generally positioned as a mediator in the corruption-innovation relationship (Chadee and Roxas, 2013; Goedhuys and Srholec, 2015). Transaction costs involve economic resources required for facilitating innovative activities in a firm. The innovation process comprises various stages, with successive stages involving transaction costs. Transactions costs and strategic implications are key factors in determining whether to "make or buy" a technology (Tidd et al., 2001). Armour and Teece (1980) argue that a high degree of vertical integration positively impacts innovation performance. However, asset specificity, frequency of transactions and uncertainty increase transaction costs in an innovative environment (Wolter and Veloso, 2008). It has been suggested that in addition to there being a likelihood of transactions recurring in a business environment, some degree of uncertainly is always likely to be present. Hence, asset specificity is the principal factor contributing to high transaction costs. Contrary to what the TCE theory of the firm suggests, this study argues that transaction costs do not always increase with greater asset specificity. In fact, Dyer (1997) shows that greater asset specificity implies low transaction costs and that is likely to result in increased innovation. It is likely that firms may make firm-specific investments because of the incentives of coordinating innovation activities within the firm. For example, physical asset specificity involving the purchase of new equipment and machinery is likely to promote innovation, particularly in an environment with a low degree of corruption. Similarly, a low degree of corruption is likely to promote human asset specificity involving workers acquiring special skills from specialised training for developing specific innovations, which in turn increases the likelihood of innovation. Hence, in the context of innovation in developing countries, asset specificity is likely to encompass investment in innovation inputs that significantly lowers transaction costs and increases the likelihood of innovation in an environment with strong institutions. It is hypothesised that:

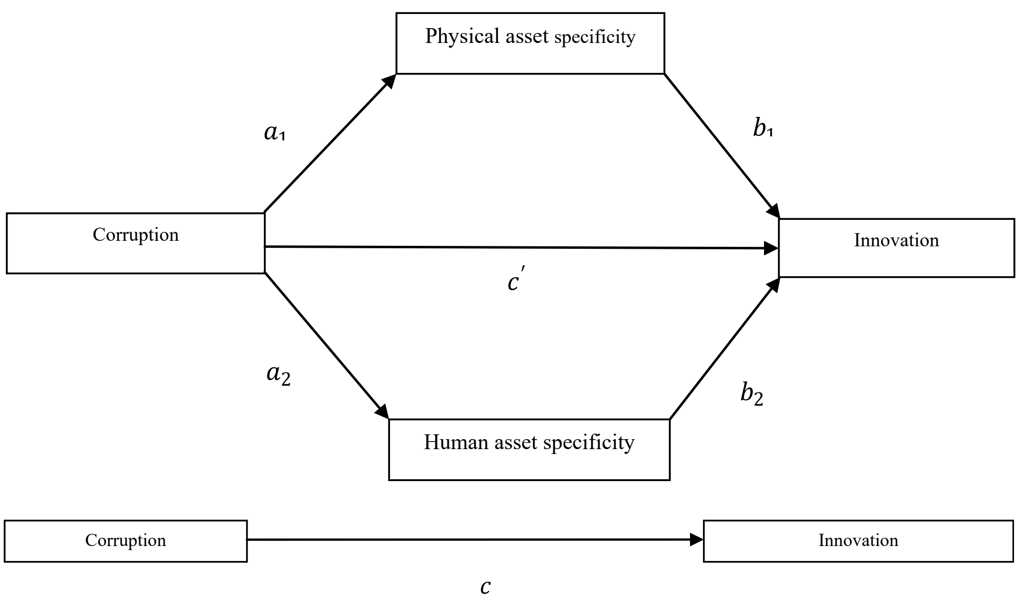
H2: The relationship between corruption and innovation will be mediated by asset specificity.

4. Data and methods

Conceptual framework

While extant literature shows that a direct relationship exists between corruption and innovation, understanding the mechanism by which this relationship occurs is important. Mediation analysis goes a step further to uncover the mechanism underlying the causal relationship. This study seeks to explain the underlying mechanism of the relationship between corruption and innovation by including transaction costs as a mediating variable. Figure 2 displays the single-step multiple mediator model that illustrates the hypothesized relationships. The relationship between corruption and innovation includes the direct effect and mediated effects, in which corruption affects innovation through transaction costs comprising physical asset specificity and human asset specificity.

Figure 2: Single-step multiple mediator model showing the effect of corruption on innovation via transaction costs



Model specification

Traditionally, mediation models are implemented by estimating a series of separate regressions for the causal pathways (Baron and Kenny, 1986). Mathematically the relationships set out in Figure 2 are expressed using the following set of logistic models:

$$\Pr(Y = 1|X) = \frac{\exp(\alpha_1 + cX + \varepsilon_1)}{1+\exp(\alpha_1 + cX + \varepsilon_1)} \Pr(Y = 1|X) = \frac{\exp(\alpha_1 + cX + \varepsilon_1)}{1+\exp(\alpha_1 + cX + \varepsilon_1)} \quad (1)$$

$$\Pr(M_1 = 1|X) = \frac{\exp(\alpha_2 + a_1 X + \varepsilon_2)}{1+\exp(\alpha_2 + a_1 X + \varepsilon_2)} \Pr(M_1 = 1|X) = \frac{\exp(\alpha_2 + a_1 X + \varepsilon_2)}{1+\exp(\alpha_2 + a_1 X + \varepsilon_2)} \quad (2)$$

$$\Pr(M_2 = 1|X) = \frac{\exp(\alpha_3 + a_2 X + \varepsilon_3)}{1+\exp(\alpha_3 + a_2 X + \varepsilon_3)} \Pr(M_2 = 1|X) = \frac{\exp(\alpha_3 + a_2 X + \varepsilon_3)}{1+\exp(\alpha_3 + a_2 X + \varepsilon_3)} \quad (3)$$

$$\Pr(Y = 1|X, M_1, M_2) = \frac{\exp(\alpha_4 + c' X + b_1 M_1 + b_2 M_2 + \varepsilon_4)}{1+\exp(\alpha_4 + c' X + b_1 M_1 + b_2 M_2 + \varepsilon_4)} \quad (4)$$

where Y represents the probability of innovation occurring, X represents institutional quality, M_i represents the two mediators comprising physical asset specificity and human asset specificity, and ε_i represents the idiosyncratic error terms. There are two indirect effects in the model. The first indirect effect passes through mediator M_1 and is calculated as the product of a_1 and b_1. Similarly, the second indirect effect passes through mediator M_2 and is calculated as the product of a_2 and b_2. Hence, the total indirect effect is given as the sum of the two indirect effects, $a_1 b_1 + a_2 b_2$. When used as predictors in logistic regressions mediating variables have a different scale from when they are outcome variables. This issue is addressed by standardizing the regression coefficients before estimating the indirect effects (Winship and Mare, 1983) by means of the product of coefficients approach (Sobel, 1982). The product of coefficients approach is appropriate for this study given that we have a sufficiently large sample and reasonably expect an approximately normal sampling distribution (Preacher and Hayes, 2008). Furthermore, we use bootstrapping techniques (Bollen and Stine, 1990; Shrout and Bolger, 2002) to test for the significance of the indirect effects. Bootstrapping is recommended when testing for indirect effects in multiple mediator models (Preacher and Hayes, 2008). This study reports 95% percentile intervals, and bias-corrected (BC) bootstrap confidence intervals (CI). Indirect effects are significant when the CIs do not contain zero.

Data types and sources

The hypotheses of this study are tested using WBES and IFS data from 2,981 firms from Ghana, Kenya, Tanzania, Uganda, and Zambia. The WBES collects data relating to an economy's business environment and investment climate. Since 2005, data collection by the World Bank have been centralised and data collection instruments standardised for comparability across countries. The IFS, launched in 2011, reports on innovation and innovation-related activities within firms. The WBES administers firm-level surveys to a representative sample of firms in the non-agricultural formal sector in an economy, consisting of firms in the manufacturing, service and retail sectors. In addition, the WBES is stratified according to the sector of activity, firm size and geographical location of the firm. WBES respondents comprise business owners and managers. Similarly, respondents for the IFS include business owners and managers from 720 firms in Ghana, 549 firms in Kenya, 543 firms in Tanzania, 449 firms in Uganda, and 720 firms in Zambia. The IFS respondents are a subset of the original WBES sample and were randomly selected to constitute 75% of the WBES respondents (www.enterprisesurveys.org). As the WBES and IFS datasets comprise the same firms, this study merges the two datasets by means of the unique firm identifiers used in both surveys to create a dataset for our empirical analysis. Table 1 provides the definitions and measurement of variables used in the analysis.

Table 1: Definition and measurement of variables

Variable	Definition and measurement
Dependent variable	
Innovation	1 if firm introduced new or significantly improved product or service; 0 if otherwise
Independent variables	
Corruption	0= not an obstacle, 1=minor obstacle, 2=moderate obstacle, 3= major obstacle, 4= very severe obstacle
Mediation variables	
Transaction costs	
Physical asset specificity	1 if firm invested in equipment, machinery or software for developing innovations; 0 if otherwise
Human asset specificity	1 if firm provided formal training for the development of innovation; 0 if otherwise

continued next page

Table 1 Continued

Variable	Definition and measurement
Control variables	
Age	Age of firm in years
Size	1 if firm has at least 20 employees; 0 if otherwise
Internal R&D	1 if firm conducts internal R&D; 0 if otherwise
Access to credit	1 if firm has a line of credit, loan or overdraft facility; 0 if otherwise
Human capital	Percentage of employees with high school education
Managerial experience	1 if manager has worked at least 10 years in a sector; 0 if otherwise
High-tech industry	1 if firm is classified as high-tech; 0 if otherwise
Medium-tech industry	1 if firm is classified as medium-tech; 0 if otherwise
Low-tech industry	1 if firm is classified as low-tech; 0 if otherwise
Ghana	1 if country is Ghana; 0 if otherwise
Kenya	1 if country is Kenya; 0 if otherwise
Tanzania	1 if country is Tanzania; 0 if otherwise
Uganda	1 if country is Uganda; 0 if otherwise
Zambia	1 if country is Zambia; 0 if otherwise

5. Results

Table 2 shows the descriptive statistics for the variables used in the estimations. About 35% of the firms in the sample reported product or service innovations. Furthermore, it is observed that about 36% of the firms reported the purchase of new machinery and equipment for developing innovations (physical asset specificity). Contrastingly, only about 24% of the firms formally trained their workers specifically for the development of innovations (human asset specificity). This implies that firms in SSA rely on physical assets for innovation. It is also noted that the mean average of corruption is markedly low, which suggests that corruption is generally not perceived as an impediment to business operations. Furthermore, about 71% of managers in the sample have at least 10 years of experience in their respective sectors. It can also be seen that about 63% of employees in the sample possess high school education. Lastly, more than 80% of the firms in the sample belong to the low-tech industry.

Table 2: Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
Product innovation	0.35	0.48	0.00	1.00
Physical asset specificity	0.36	0.48	0.00	1.00
Human asset specificity	0.24	0.43	0.00	1.00
Corruption	1.61	1.40	0.00	4.00
Age	16.34	13.39	1.00	132.00
Size	0.39	0.49	0.00	1.00
Internal R&D	0.17	0.38	0.00	1.00
Access to credit	0.21	0.41	0.00	1.00
Human capital	63.69	33.89	0.00	100.00
Managerial experience	0.71	0.45	0.00	1.00
High-tech industry	0.07	0.25	0.00	1.00
Medium-tech industry	0.12	0.32	0.00	1.00
Ghana	0.24	0.43	0.00	1.00
Kenya	0.19	0.39	0.00	1.00
Tanzania	0.18	0.39	0.00	1.00
Uganda	0.15	0.36	0.00	1.00
Zambia	0.24	0.43	0.00	1.00

Using the product of coefficients strategy, the logit-transformed probabilities of Equations 4–7 are tested to test the hypotheses. Table 3 summarises the results of the estimations in models 1–4. Model 1 reports a statistically significant coefficient for corruption implying a significant correlation between corruption and innovation, $r = .063, \rho < .05, 95\%\ CI\ [.004,\ .123]$.In support of the hypothesis that corruption has a significant relationship with innovation (H1), model 1 reveals a positive and significant relationship between corruption and innovation. Models 2 and 3 show the relationship between corruption and transaction costs measured as physical asset specificity and human asset specificity, respectively. In model 2, the coefficient for corruption is positive and significantly correlated with physical asset specificity, $r = .063, \rho < .05, 95\%\ CI\ [.005,\ .121]$. Notwithstanding this, the coefficient for corruption in Model 3 is positive but not significantly correlated with human asset specificity, $r = .042, \rho = .233, 95\%\ CI\ [-.026,\ .110]$. Hence, of the mediators examined by the products coefficient approach, it can be inferred that only physical asset specificity is likely to be an important mediator. Lastly, model 4 reports the results of including physical asset specificity, and human asset specificity as mediating variables, controlling for corruption. The coefficient for corruption remains positive but is no longer statistically significant after controlling for physical asset specificity, and human asset specificity, ($\beta = .048, \rho = .128$). Despite this, physical asset specificity has a positive and statistically significant effect on innovation ($\beta = .958, \rho < .01$). Similarly, human asset specificity has a positive and statistically significant effect on innovation ($\beta = 0.620, \rho < .01$). The standardized specific indirect effects are $a_1 b_1 = .012$ (through physical asset specificity), and $a_2 b_2 = .004$ (through human asset specificity). The total indirect effect is therefore given as $a_1 b_1 + a_2 b_2 = .016$. The total effect coefficient from the sum of the indirect effect, $.016 .016$ and direct effect, $.035$ is $.051$. Therefore, about $^{.016}/_{.051}, 31\%$ of the effect of corruption on innovation is mediated by transaction costs. Nevertheless, the significance of these mediators can be questioned, because these tests of significance are typically applicable in the case of a simple mediation model (i.e., single mediator). We therefore bootstrap the direct and indirect effects of corruption on innovation to test for the significance of the individual indirect effects. Table 4 reports the estimates of 95% CI (percentile, BC). Similar to the results reported from the products of coefficients approach, we find that the direct effect of corruption on innovation is positive and statistically significant. Furthermore, the indirect effects are jointly statistically significant as the CI does not contain zero. Additionally, we find that the only statistically significant mediator is physical asset specificity; this is in agreement with the product of coefficients examination. Hence, human asset specificity does not contribute to the indirect effects above and beyond physical asset specificity. The results from Table 4 provide support for our second hypothesis (H2) that the relationship between corruption and innovation is mediated by transaction costs.

Table 3: Logistic regression coefficients of mediation of effect of corruption on product innovation through physical asset and human asset specificity (n = 2981)

Variables	Model 1		Model 2		Model 3		Model 4	
	Product innovation		Physical asset specificity		Human asset specificity		Product innovation	
Control variables								
Age (log)	-0.020	(0.059)	0.056	(0.060)	0.132*	(0.068)	-0.044	(0.062)
Size	0.208**	(0.089)	0.189**	(0.088)	0.348***	(0.100)	0.128	(0.093)
Internal R&D	1.272***	(0.109)	1.791***	(0.110)	2.004***	(0.109)	0.696***	(0.120)
Access to credit	0.256**	(0.103)	0.367***	(0.101)	0.431***	(0.112)	0.150	(0.106)
Human capital	0.002	(0.001)	0.0002	(0.001)	0.0002	(0.002)	0.002	(0.001)
Managerial experience	0.0750	(0.101)	0.029	(0.101)	-0.186	(0.116)	0.096	(0.105)
High-tech industry	0.104	(0.167)	0.185	(0.168)	0.062	(0.188)	0.084	(0.172)
Medium-tech industry	-0.294**	(0.136)	0.235*	(0.128)	0.114	(0.150)	-0.355**	(0.140)
Ghana	-0.768***	(0.134)	-0.366***	(0.130)	-0.457***	(0.145)	-0.691***	(0.139)
Tanzania	-1.286***	(0.159)	-0.169	(0.141)	-0.433***	(0.159)	-1.289***	(0.164)
Uganda	0.733***	(0.142)	-0.267*	(0.147)	-0.314*	(0.165)	0.879***	(0.147)
Zambia	0.424***	(0.125)	-0.470***	(0.131)	-0.689***	(0.149)	0.631***	(0.131)
Main effects								
Corruption	0.063**	(0.030)	0.0630**	(0.030)	0.042	(0.034)	0.048	(0.031)
Mediating effects: Transaction costs								
Physical asset specificity							0.958***	(0.096)
Human asset specificity							0.620***	(0.108)
Constant	-1.066***	(0.211)	-1.105***	(0.209)	-1.788***	(0.241)	-1.476***	(0.221)

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Table 4: Mediation of the effect of corruption on product innovation through physical asset specificity and human asset specificity (n = 2981)

		Bootstrapping			
Path	Point estimate	Percentile 95% CI		BC 95% CI	
		Lower	Upper	Lower	Upper
Physical asset specificity (a1b1)	0.0117	0.0014	0.0235	0.0014	0.0236
Human asset specificity (a2b2)	0.0045	-0.0030	0.0126	0.0030	0.0125
Total indirect effect (a1b1 + a2b2)	0.0162	0.0020	0.0319	0.0016	0.0314
Direct effect (c' path)	0.0349	-0.0082	0.0795	-0.0077	0.0800
Total effect (c path)	0.0511	0.0049	0.0989	0.0049	0.0989

Note: BC, bias corrected; 5,000 bootstrap samples[1]

Robustness tests

The robustness of the results is tested by using process innovation as the dependent variable. The robustness checks containing the logistic regressions and bootstrapping tests are reported in Table 5, models 5–7 and Table 6, respectively. The results are robust when process innovation is used as the dependent variable. In particular, these results are in agreement with the results reported in the main model, particularly with regard to the direct relation between corruption and innovation, and the mediated effect passing through physical asset specificity to innovation. Thus, these models reveal that the qualitative conclusions remain unchanged.

Table 5: Logistic regression coefficients of mediation of effect of corruption on process innovation through physical asset and human asset specificity (n = 2981)

Variables	Model 5		Model 6		Model 7		Model 8	
	Product innovation		Physical asset specificity		Human asset specificity		Product innovation	
Control variables								
Age (log)	-0.036	(0.062)	0.056	(0.060)	0.132*	(0.068)	-0.074	(0.067)
Size	0.273***	(0.092)	0.189**	(0.088)	0.348***	(0.100)	0.200**	(0.099)
Internal R&D	1.699***	(0.109)	1.791***	(0.110)	2.004***	(0.109)	1.021***	(0.123)
Access to credit	0.388***	(0.106)	0.367***	(0.101)	0.431***	(0.112)	0.270**	(0.114)
Human capital	-0.002*	(0.001)	0.0002	(0.001)	0.0002	(0.002)	-0.003*	(0.001)
Managerial experience	0.153	(0.105)	0.029	(0.101)	-0.186	(0.116)	0.165	(0.113)
High-tech industry	-0.028	(0.175)	0.185	(0.168)	0.062	(0.188)	-0.082	(0.186)
Medium-tech industry	-0.180	(0.137)	0.235*	(0.128)	0.114	(0.150)	-0.297**	(0.147)
Ghana	-0.127	(0.147)	-0.366***	(0.130)	-0.457***	(0.145)	0.043	(0.158)
Tanzania	0.131	(0.155)	-0.169	(0.141)	-0.433***	(0.159)	0.257	(0.167)
Uganda	0.827***	(0.155)	-0.267*	(0.147)	-0.314*	(0.165)	1.113***	(0.168)
Zambia	1.213***	(0.138)	-0.470***	(0.131)	-0.689***	(0.149)	1.670***	(0.154)
Main effects								
Corruption	0.099***	(0.031)	0.063**	(0.030)	0.042	(0.034)	0.084**	(0.033)
Mediating effects: Transaction costs								
Physical asset specificity							1.680***	(0.101)
Human asset specificity							0.505***	(0.113)
Constant	-1.780***	(0.222)	-1.105***	(0.209)	-1.788***	(0.241)	-2.522***	(0.244)

Standard errors in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Table 6: Mediation of effect of corruption on process innovation through physical asset specificity and human asset specificity (n = 2981)

Path	Bootstrapping				
	Point estimate	Percentile 95% CI		BC 95% CI	
		Lower	Upper	Lower	Upper
Physical asset specificity (a1b1)	0.0193	0.0018	0.0378	0.0009	0.0373
Human asset specificity (a2b2)	0.0034	-0.0020	0.0098	-0.0016	0.0103
Total indirect effect (a1b1 + a2b2)	0.0227	0.0023	0.0433	0.0020	0.0431
Direct effect (c' path)	0.0577	0.0140	0.1002	0.0127	0.0996
Total effect (c path)	0.0804	0.0317	0.1283	0.0300	0.1264

Note: BC = bias corrected; 5,000 bootstrap samples.

6. Discussion

The findings largely support the study's hypotheses. It was found that corruption has a positive effect on innovation. In particular, the finding is that a high degree of corruption is positively associated with the likelihood of innovation. This finding offers support for the "grease-the-wheels" hypothesis, as shown by previous studies (Nguyen et al., 2016; Krammer, 2017). Additionally, one may argue that the nature of corruption may be cost-reducing "collusive" corruption that relates to overcoming bureaucratic red tape (Sequeira and Djankov, 2014). Hence, a low degree of corruption in a business environment with weak institutions may have an adverse effect on innovation. It is also found that physical asset specificity significantly mediates the relationship between corruption and innovation. This finding supports the argument that greater asset specificity is associated with low transaction costs that foster innovation in firms (Dyer, 1997) in an environment with a high degree of corruption.

It has been argued that asset specificity plays a key role in minimising transaction costs (Williamson, 1981). As such, asset specificity increases the likelihood of innovation in manufacturing firms. Investing in physical assets for the development of innovations encompasses investing in innovation inputs that foster the likelihood of innovation in the context of developing countries. An important theoretical implication arising from this study's findings is that contrary to the transaction costs theory proposition that greater asset specificity indicates high transactions costs, it was observed that greater physical asset specificity implies low transaction costs in the context of developing countries (Williamson, 1981; Dyer, 1997), which increases the likelihood of innovation in the presence of a high degree of corruption. It is argued that greater asset specificity involves the ex ante acquisition of machinery and equipment that results in high overall productivity, and increased innovation. Furthermore, corruption in the face of poorly-functioning institutions is likely to drive the acquisition of assets for innovation purposes that, in turn, increases the likelihood of innovation. This implies that firms opt for hierarchical production as opposed to market transactions that are likely to expose them to corruption. Therefore, it is suggested that firms are likely to engage in corruption pertaining to asset specificity (e.g., obtaining permits for the construction of additional features in plants, installation of communication infrastructure, or acquisition of equipment and machinery) if corruption is perceived as a relatively efficient way of fostering innovation. The conclusion is that corruption is significantly linked to transaction costs and innovation, and that transaction costs mediate the relationship between institutions and innovation in the context of SSA.

Policy implications

In light of the finding that corruption "greases-the-wheels" of innovation, it is proposed that policy makers focus on programmes that foster control of corruption, because a high degree of corruption is likely to exhaust the benefits of corruption for innovation. Additionally, corruption is bound to limit entrepreneurial innovation especially because not all firms will engage in corrupt practices. Corruption may facilitate firm growth by enabling entrepreneurs to circumvent inefficient government regulations and policies in an environment with limited economic freedom. In particular, firms are likely to engage in corruption to overcome restrictive business policies that hamper entrepreneurial activity. It has been argued that corruption mitigates inefficiencies arising from ineffective government institutions. Nevertheless, the benefits of corruption are likely to reduce with institutional improvements. A sound business environment promotes entrepreneurial activity, including innovation. Firms are more likely to devote their resources to productive entrepreneurial activities in an environment with a high degree of institutional quality. Hence, strengthening the institutional environment of business operations is critical in realising increased rates of innovation at the firm level.

Our findings also show that transaction costs partially mediate the relationship between corruption and innovation. Essentially, greater asset specificity plays an important role in increasing the likelihood of innovation in the context of developing countries. It can be argued that greater asset specificity entails the acquisition of physical assets and human assets that are likely to not only increase productivity, but also foster innovation in firms. More importantly, greater asset specificity lowers transaction costs in an environment with strong institutions. Moreover, asset specificity is likely to increase the likelihood of innovation by reducing transaction costs in an environment with strong institutions. Hence, investing in physical assets including equipment, machinery or software for the development of innovative products is critical for increased innovation in the context of developing countries. In light of this, it would be prudent for policy makers to focus on fostering an environment that provides tax incentives for firms investing in physical assets. Focusing on investment tax credits may result in increased rates of investment in physical assets and a reduction in transaction costs related to the acquisition of physical assets.

Further avenues of research include the use of panel data for examining the causal effect of corruption and asset specificity on innovation in Africa. In addition, and subject to the availability of data, examining other measures of transaction costs including uncertainty and frequency of transactions is likely to provide new insights into how different dimensions of transaction costs influence innovation in the context of developing countries.

Notes

1. Preacher and Hayes (2008) recommend that 5,000 resamples are sufficient for that final reporting.

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