The productivity of knowledge mobilisation, knowledge capitalisation and product-related firm transmutation: exploring the case of small-scale garment-makers in Nairobi, Kenya

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Abstract

Highlighting the limitations of R&D, this paper champions design activity as the phenomenon that captures knowledge mobilisation at the firm level, especially amongst small firms in developing countries. Still, knowledge becomes a capital (factor input) proper when employed in production. Volumes of new products sold could suggest the market value of utilised knowledge capital the same way the resale value of plant and equipment often approximates the stock of physical capital. Conversely, shares of sales of new products arguably capture an altogether different phenomenon: product-related firm transmutation. Findings suggest that the deeper utilisation of knowledge has significant productivity effects and supersedes mere mobilisation of knowledge. Further, undergoing transmutation towards the production of more of new products relative to incumbent products has no significant relationship with labour productivity. Firms should therefore prioritise the deeper exploitation of given new knowledge rather than potentially prodigal shifts in production towards new products as such.

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1 Introduction

To survive in their highly competitive local markets, Micro and Small Enterprises (MSEs) in developing countries have to constantly and sometimes frantically metamorphose. Offering new products to the market is one of the key avenues through which such firms pursue change for survival and growth. Yet, while the churn of new products does necessitate searching and employing knowledge that is at least new to the firm, Research and Development (R&D) activity is hardly observed in developing country contexts (Goedhuys 2007). This has made studying innovation in developing countries rather difficult (van Dijk and Sandee 2002; Mytelka 2000). Researchers have thus highlighted the need for alternative approaches to understanding innovation dynamics in such contexts (Forbes and Wield 2008).

As Bogliacino et al. (2012) discuss, one approach that has proved useful in developing countries is to develop surveys that focus less on frontier R&D-based innovation and more on intermediate innovative efforts, adaptation of extant technologies and other more subtle changes in the way production and commerce is carried out (see also, Salazar and Holbrook 2004). While empirical research on innovation and its impact on the performance of (small) firms in developing countries has been notably scant (Lee 2011), Bogliacino et al. (2012) point to recent growth in empirical innovation research in the developing world attributable to the adapted innovation surveys.

Despite such progress, innovation remains inadequately researched in Africa (Goedhuys et al. 2008). In all, there are only a handful of published studies on innovation-related issues in Africa (see for example, on Ghanain MSEs: Obeng et al. 2012; Robson et al. 2009; on Tunisian firms: Rahmouni et al. 2010; on Burundi: Goedhuys and Sleuwaegen 1999; on Tanzania: Goedhuys et al. 2008; Goedhuys 2007; Mahemba and Bruijn 2003; on Ethiopian firms and a review of other African studies: Gebreeyesus 2011; Gebreeyesus and Mohnen 2013; see also, Forbes and Wield 2008, for a comparative study of firms in South

Africa, Tanzania, Koren, India and Mexico). There is a gap, therefore, in our understanding of the ways in which MSEs in less developed contexts obtain the knowledge and novelty embedded in their new products and how such change impacts firm performance.

A key importance of studying developing country phenomena is that the anomalous nature of such contexts may necessitate the development of alternative concepts and theories to understand the pertinent phenomena and dynamics (Forbes and Wield 2008). In the past, for example, the extraordinary ubiquity of MSEs in poor countries has led scholars to rethink how entrepreneurship and its link to economic growth is conceptualised (Reynolds et al. 2001; Rosa et al. 2009; Acs et al. 2008). Similarly, that MSEs with relatively meagre outputs frequently introduce new products or services suggests that extant conceptualisations of innovation, especially the emphasis on R&D, may not afford a useful framework to understand how innovation enhances firm performance. While evaluations along the conventional technology-push and demand-pull dyad may be helpful in understanding innovation amongst more demand-oriented necessity-driven enterprise, recent developments point to more complex interactions and feedback loops between firm competencies and market demands (Di Stefano et al. 2012).

Indeed, the mechanisms of innovation are generally not well understood (Carlsson et al. 2009). Inconclusive findings from studies chiefly in North America and Europe has thus led some to question whether innovation is economically beneficial after all (Rosenbusch et al. 2011), especially for small firms unable to persistently invest in innovation activities (Demirel and Mazzucato 2012). There is much scope, therefore, for findings from innovation research in developing countries, even first approximations from small surveys, to afford alternative insights that may help to instructively extend extant theory and form a basis for application and further development in future research.

Against this backdrop, the object of the present paper is to investigate the relationship between innovation-related phenomena and firm performance, especially amongst small firms in low R&D developing country contexts. The first contribution of the paper is thus to advance a more nuanced conceptual and theoretical understanding of the way in which firms mobilise new knowledge and how they then employ it as a capital towards generating a firm-level revenue-product. We also examine how a further dynamic, the structural transformation that firms may undergo by shifting production to new products, may or may not enhance productivity. In turn, the second contribution is an exploratory empirical investigation into the extent to which the mobilisation of knowledge, the capitalisation of knowledge, and the internal structural transformation of firms are associated with better firm performance amongst MSEs in the garments sector in Nairobi, Kenya. We begin below by revisiting the literature on innovation and its relationship with firm performance. Section 3 presents the data and methods, Section 4 discusses the results, and Section 5 concludes with some implications for research and policy.

2 The impact of innovation on firm performance: a critical review

2.1 The shortcomings of R&D

In the past, research focused largely on the development of new knowledge through R&D, especially in high technology sectors (OECD 1997). Emphasis was on “technological innovation proper” (Archibugi 1988; Fagerberg and Verspagen 2009). Hall et al. (2010) summarise the theoretical approaches used to evaluate the returns to R&D and adduce extant empirical evidence to affirm that in general R&D has strong positive private returns and even higher social returns. Crespi and Zuniga (2012), studying firms in six Latin American countries, also find that investing in R&D enhances technological innovation which in turn helps improve productivity thereby enabling developing country firms to perform better and the wider exconomies to catch up.

Notwithstanding such evidence, Hall et al. (2010) submit that the link between investments in R&D and economic performance is complex and difficult to accurately establish (See also: Audretsch and Keilbach 2008; Ejermo and Kander 2006; Carlsson et al. 2009). Amongst other things, knowledge development through R&D is highly uncertain and "untidy" (Arthur 2007). This means that the resourcefulness of R&D is highly dependent on serendipity. Thus, since large investments may yet produce little useful knowledge, R&D intensity may not be necessarily proportionate to useful stocks of knowledge.

A further problem is that there are many protracted and unpredictable lags that R&D has to go through before a palpable output is realised. These include lags between the R&D exercise and an actual prototype, especially where development entails basic scienctific research, then lags between a ready protype and a commercialised product (Hall et al. 2010). Indeed, firms may be in possession of market-ready knowledge but elect to cache it rather than immediately cash in on it (Acs et al. 2009; Bloom and Van Reenen 2002) and many good ideas may moulder in furtive hoards thus (cf. Hossain 2012). Certainly, regardless of its potential, hoarded knowledge does not yield a revenue-product. In all, therefore, estimating the returns to observed R&D *per se* without considering the degree of exploitation of the knowledge is highly mistaken.

For such reasons, the implementation of innovations has become the focus of contemporary innovation research and policy (OECD 2005). Yet, R&D continues to play an important role in the new approach. In what has come to be known the CDM methodology following Crepon, Duguet and Mairesse (1998), much of the contemporary empirical research considers R&D to be innovation inputs in a knowledge production process. In turn, deriving from such past R&D inputs, innovation outputs represent knowledge capital that is assumed to be employed as a factor of production and therefore partly responsible for the firm's present output as a factor of production. Innovation outputs are usually observed as shares of sales attributable to new products. This structural multi-stage innovation inputs-outputs framework is argued to allow the effect of knowledge capital on performance to be investigated more robustly with productivity returns to past R&D estimated recursively (see also, Lööf and Heshmati 2006; Roper et al. 2008).

As Bogliacino and Pianta (2012) document, however, rather than the linear approach theorised by the CDM approach, circular and cumulative feedback loops also play a significant role: R&D begets innovation, which enhances profitability, with such profits in turn sustaining further R&D efforts. The effect of such feedback loops is to protract the spiral process. At the same time, profits will be attracting new entrants and complex demand dynamics that may encourage or discourage innovative enterprise will also be in play. Bogliacino and Pianta (2012) thus argue that such key innovation dynamics may be better understood at the industry rather than the firm level.[1]

A further problem with firm-level R&D is that in line with Cohen and Levinthal's (1989, 1990) two sides of R&D thesis, such efforts may only enhance the firm's absorptive capacity. While this improves the firm's productive capabilities, no new products may be generated. Hence, the effects of such R&D will not be observable via the shares of sales of new products. Rather, should the knowledge be employed in other unobserved ways, e.g. sundry efficiency improvements, certain productivity gains may be directly imputed to R&D. This is especially the case where innovation activities also address the modalities of the physical production of the new product. Here, the firm may learn and implement subtle but highly productive changes in extant production processes with or without the new product.

[1] Many thanks to the reviewer for highlighting this point.

Griffith et al. (2004) have thus argued that conventional research not considering the two faces of R&D underestimates the true productivity returns to such efforts.

Further importance of the relationship between capabilities and R&D intensity has been highlighted by Bogliacino and Cardona (2014) with arguably low capability low and medium technology industries found to have low R&D intensity. Yet new products are frequently observed in such industries, the services sector and amongst SMEs despite the relatively low incidence of R&D (OECD 2005). Indeed, it is in part the fact that innovation in these highly prevalent sections of the economy can have a substantial impact on economic growth that led to the redefinition of innovation to focus on the implementation of new methods in all production activities and not just in the R&D intensive high technology sectors (OECD 2005). Notwithstanding this, there may be spill-over effects at the industry level should firms not carrying out R&D take advantage of knowledge developed by other firms to either enhance their absorptive capacities or actually bring new products to the market (Bogliacino and Pianta 2012).

The observation of R&D is thus neither a necessary nor a sufficient condition for the realisation of new products, processes or organisational methods at the firm level. Indeed, as highlighted by Dosi (1988), while various forms of innovation affect all sectors of economic activity, the nature of innovative activities varies widely by sector. Pavitt (1984) also observes that sources of knowledge, type of user and means of appropriation also differ by industry and firm-size. Other factors that affect innovation but may differ by sector include the level of industry competition (Castellacci 2011), and the scope for complementarity in innovation (Arora and Gambardella 1990).

For example, Pavitt (1984) found innovating textile firms to be relatively small, to engage in relatively low knowledge production activity, but to rely on equipment suppliers for process innovation. Raustiala and Sprigman (2006) further observe that despite the absence of entitled appropriation rights under the present Intellectual Property (IP) Law, and with imitation thus rampant, the garments industry produces a huge variety of creative goods at a rapid clip the world over. Relaxing the integrality of R&D, and related IP issues, to innovation therefore allows studies of innovation amongst small firms in low technology sectors such as textiles to also constitute bona fide innovation research. While findings thereof may be unique to such sectors, they would arguably still advance new insights towards the understanding the mechanisms and dynamics of innovation and firm performance more generally.

2.2 Rethinking implementation: Knowledge capitalisation versus structural transmutation

Despite the shift in focus to knowledge implementation (OECD 2005), findings from studies employing the structural inputs-outputs approach have been largely inconclusive and the inferences thereof rather muddled (for a review, see Mairesse and Mohnen 2010). A reconsideration of this approach is thus warranted. From a methodological perspective, a probable suspect that has not been duly interrogated is the potential mismatch between the construct of interest and its operationalisation. A largely overlooked issue is that the share of sales of new products is necessarily a function of the magnitude of the sales of the firm's incumbent products. One may argue, therefore, that the variable captures very little about the capacity of the new knowledge in and of itself. For that reason, it is subject to highly insidious ambiguities.

Indeed, a firm that has prematurely shifted all its production to a new product but only managed meagre sales would class as a high knowledge business. Similarly, high market cannibalisation would count as an indicator of successful innovation regardless of the extent to which this entails mere displacement of existing revenues.[2] In particular, while developing country MSEs in highly competitive sectors will usually manifest high shares of sales of new products as they frequently and sometimes frantically metamorphose to survive, that this signifies a case of high stocks of knowledge may be questioned. Strictly speaking, in fact, the share of sales of new products describes the composition of the firm's revenues at a given time in terms of the relative representation of new products. In other words, "how important the innovation(s) were overall for the firm in question" (Hall 2011, p6). The variable thus captures the structural make-up of the firm's production; the degree to which the firm has within itself mutated towards the production of new products. To avert the ambiguity associated with innovation generally, we term this particular phenomenon *product-related transmutation*. Undoubtedly, the internal transformation of entities is conceptually different from the notion of stocks of employed knowledge capital.

From this perspective, studies employing the sales shares variable inadvertently estimate a phenomenon quite different from the intended evaluations of the returns to knowledge capital as a supplementary factor in an augmented production function. The resultant empirical work is thus likely to yield results that appear to be inferentially absurd. It is imperative, therefore, that other proxies of knowledge capital are considered. A suitable alternative is the volume of sales of new products. To the extent that producing and selling more of the new products constitutes the deeper utilisation of the knowledge embedded in such a product, intrinsically, the volume of sales of the new products more reasonably approximates the degree to which the respective knowledge has been substantively employed in production. In a recent study, Bogliacino et al. (2015) also employ the innovative sales volume variable as a proxy for innovative performance of firms. They find that innovative performance does in fact significantly impact overall economic performance.

[2] Although a firm may self-cannibalise in the hope that it may gain a first-mover advantage should the demise of the old products affect the whole market, this is an altogether different question and is hardly the dynamic that is theorised in the pertinent innovation literature.

To be sure, besides the intensity of successful exploitation of knowledge embedded in new products, the volume of sales of such goods will also reflect other factors that impact product prices in the market more generally. These include, the cost of associated intermediate inputs, industry concentration, being a foreign firm, the presence of foreign firms, state control, etc. Indeed, using the Herfindal index, Bogliacino et al. (2015) find that industry concentration significantly impacts the volume of innovative sales. While it is important to acknowledge and account for such potential influences, the volume of sales of new products arguably still approximates the market value of the knowledge employed in producing such products in a way that is similar to the market (or replacement) value of plant and equipment as frequently utilised in evaluations of firm-level returns to physical capital.

Sales of new products can thus be said to represent *knowledge capitalisation* in three ways: capitalisation in the sense of making knowledge a capital input proper, i.e. an actively employed factor input; capitalisation in terms of the extent to which the firm has capitalised on new knowledge, i.e. how extensively the new knowledge has been exploited; and capitalisation in the sense of the market value of the knowledge the firm has employed in production in the period in question.

In this vein, by not using variables that proxy the "units" of actively employed knowledge capital, much of the extant innovation research can be said to invoke the production function incorrectly. Seemingly, while some technical methodological issues such as endogeneity have received much attention in the literature (for a review, see Mairesse and Mohnen 2010), other more basic research issues have been neglected with at least two key consequences. First, with invalid constructs, inferences drawn from the findings are incorrect and incoherent since there is a mismatch between what is referred to and what is observed in reality.

Second, notwithstanding that the theoretical production function framework may be employed incorrectly in the first place, empirical models regressing firm productivity on the shares of new products and then recursively on R&D will yet be mis-specified since the pertinent constructs and their theorised relationships may be formulated in a way that is at odds with the true relationship that the variables could still have. For example, R&D amongst straggling firms in competitive industries may be towards learning, adapting or combining technologies developed elsewhere. In line with Arora and Gambardella (1990), complementarity effects in certain industries may mean that relatively low investments yield productivity improvements that are higher than those accruing to firms commercialising completely new and independent technologies. Indeed, Castellacci (2011) finds that in less concentrated industries, rather than a cumulative effect where frontier firms increasingly grow their lead in the shares of sales of new products, it is follower firms that achieve greater shares of innovative sales as they exploit existing knowledge to catch-up.

Despite the inclusion of various knowledge sourcing activities and extensive controls, studies not considering such nuances frequently report a sizable residual in estimates of knowledge capital, when operationalised as new products sales shares. Here, what is argued to capture unobserved “innovativity” (Mohnen et al. 2006) in analogy to Total Factor Productivity (TFP) (Mairesse and Mohnen 2002), is likely a residual attributable to invalid constructs and specification errors. As we have argued, the sales share variable more pertinently approximates product-related transmutation of the firm rather than knowledge capital. The residual here can thus be seen to pertain not to highly fecund latent innovativity but to residual mutativeness. While firms may shift production towards new products because they are more rewarding, we have argued that ostensibly large shares of sales of new products may yet be the result of prodigal or precipitous lurches. Indeed, large shares of low absolute sales may falsely suggest relatively high knowledge capital in a case where a small firm dealing in low volumes discontinuously changes to a frivolous new product but sees no real change in its revenue-product.

It would appear, thus, the relationship between the magnitude of change in the structural make-up of the firm and firm output may not be theoretically or empirically similar to that expected of standard factors of production. In contrast, knowledge capitalisation would be straightforwardly in line with the classic diminishing marginal returns framework. Thus, firms with higher new knowledge capitalisation would be expected to have a higher output. In contrast, a small firm with a majority of its low absolute sales from a frivolous new product will yet have low new knowledge capitalisation and therefore a low output attributable to such new knowledge inputs.

2.3 The prompt productivity of design-related activities

Despite their proximity to actual production, "design" activities have been largely overlooked as the role of R&D has yet been promininent in CDM-based innovation research. As a concept, design has its own definitional imprecisions, including the connotation of exceptional ingenuity. Generally, however, design involves "the creative visualisation of concepts, plans and ideas; and the representation of those ideas (as sketches, blueprints, models or prototypes) so as to provide the instructions for making something that did not exist before or not in quite that form" (Walsh 1996, p513). According to Freeman (1983), "design is crucial to innovation in that it is the domain of creativity where ideas are devised but also where the 'coupling' occurs between technical possibilities and market demands or opportunities" (Walsh 1996, p514).

In this light, unlike mere R&D whose utility is subject to a high degree of abstractness, serendipity, hoarding and lag issues, design entails the mobilisation of knowledge, at the stage immediately preceding production, to formulate models that can be readily implemented. Design activity may therefore be more plausibly associated with a higher probability of such new ideas being employed in production, whether as new products or other changes in production. Hence, the returns to design will accrue more promptly. In some industries, higher design activity may also more accurately capture the scale of readily exploitable knowledge, both in notional quantity and/or quality, the firm has in hand. Indeed, Walsh (1996) finds that design is usually housed in production and marketing departments, and is thus more proximate to physical production.

Whilst extant research seemingly treats it as a mere ancillary to R&D, design can be seen to play an integral and integrative role in the fruition of any innovation. Further, conceptually, other more mundane activities, such as the development of simple prototypes or modest improvements as well as devising new-to-the-firm concepts through reverse engineering also entail aspects of design. To be sure, in cases such as contract manufacturing, the product design function would be relatively limited with focus more on production processes and quality control in line with the design specifications supplied by the client firm. Indeed, as compellingly illustrated by Stan Shih’s (2005) famous “smiling curve”, although ostensibly producing new products, strictly speaking, contractor firms’ chief inputs are traditional labour and physical capital with relatively low value-added overall. One therefore needs to be more discerning both in acknowledging the firm’s industrial and market context that may determine the role in-house design plays, and also in identifying and attributing the various design activities undertaken by the firm.

Still, Walsh (1996) observes that almost all firms and industries and across a variety of countries, including contexts where more technical R&D is low, do undertake design activities of some form. The consideration of design as a key and unique component within the broader process of innovation can thus not be overemphasized if we are to not only understand the process more comprehensively but also enhance the scope of innovation research beyond R&D and R&D-related contexts.

The review above gives rise to three key empirical questions:

1) Given the proximity of design activities to production, do firms engaging in more intensive knowledge mobilising design activity perform better?
2) Is deeper knowledge utilisation (through higher volumes of new products sold) related to greater firm performance?
3) Is more extensive product-related transmutation of the firm (through higher shares of sales of new products) associated with higher firm performance?

3 Data and methods

To empirically address the above questions in a developing country context, we employ data from a small survey of micro and small enterprises in the garments industry in Nairobi, Kenya that was conducted in 2010. As Bulmer and Warwick (1993) have documented, research contributions from developing countries are often unforthcoming as data collection in such contexts is fraught with many challenges, not least the absence of secondary data, lack of suitable sampling frames, and practical difficulties in the administration of questionnaires. With limited resources, the present survey collected data mainly via researcher-administered questionnaires targeting the garments sector in Nairobi.

The sector was deemed a particularly interesting industry to study for a number of reasons. Firstly, the fashion and garments industry is inherently characterised by swift innovation cycles (Raustiala and Sprigman 2006). This means that the aspects of innovation the study identifies as key, i.e. design-related activities and sales of new products, can be readily observed in economic contexts where data on innovation is usually difficult to obtain. More generally, the textile and garments industry is also especially important within the context of a developing country due to its significance in promoting industrialisation and international trade (Gereffi 1999; Naumann 2006).

In Kenya, the textile and garments industry is given special policy attention due to its economic potential across the entire supply chain; from land and labour utilising cotton farming, through capital intensive yarn-spinning to labour intensive garment-making (Government of Kenya 2001). Also, in an economy where the small scale sector is dominated by retail and other services (Ronge et al. 2002), MSEs in the garments industry account for about 15 per cent of all MSEs in Kenya and over 30% of manufacturing MSEs in Kenya (McCormick et al. 2007). Garments MSEs are therefore a considerably important part of the Kenyan economy. In turn, the capital city, Nairobi accounts for about 43% of the Kenya's urban workers, and generates over 45% of national GDP (da Cruz et al. 2006).

A sampling frame of garment-makers in Nairobi was constructed using a database comprising about 160,000 businesses that the City Council of Nairobi issued with an operating licence in 2006. Because the original purpose of the database is local government revenue collection, and not formal registration, the businesses are not adequately categorised by industry or standard activity. Thus, textile and garments firms were obtained by sifting through all the entries selecting firms whose business name or business description suggested textile and garment production. A total of 9,030 firms were identified thus. The City Council licence fee was in turn used to stratify the sample to ensure that it represented the garments industry in the City of Nairobi.

Around 300 questionnaires were then issued, mostly by hand-delivery, to owner-managers of small firms and Managing Directors or General Managers of larger businesses. Out of these, 167 were returned with a majority researcher-administered upon follow up. Although the survey did not initially target MSEs as such, only a handful of medium and large firms responded. These were subsequently dropped to mitigate outlier issues and to limit the study to within the definition of MSEs as firms with less than 50 employees, the definition adopted by the Kenyan Government (Ronge et al. 2002) and internationally

(UNIDO 2004; European Commission 2003). In the end, 122 cases were found to have been satisfactorily completed and were employed in the analysis that follows.

In acknowledging the well documented challenges afflicting survey data from developing countries (Scheyvens and Storey 2003; Bulmer and Warwick 1993), some caveats are in order. First, our low response rate poses the risk of non-response bias, including item non-response, even within the sub-sample of MSEs considered. Hence, while drawn variously from the garments MSE sector in Nairobi, the final sample is not strictly random and may thus not be representative of garments MSEs in Nairobi. Besides, idiosyncrasies characterising the garments sector and Nairobi City itself potentially introduces further bias. Second, our cross-sectional data may be compromised by simultaneity and other endogeneity problems. Third, while techniques to control for such biases exist, our small sample severely limits the extent to which robustness measures can be implemented to enhance analytical rigour and validity. What we present here, therefore, are indicative patterns observed amongst a selective group of small urban garment-makers in a developing country context that nevertheless contribute novel and instructive insights to a growing body of knowledge about how various aspects of innovation affect firm performance.

3.1 Variable definitions

The dependent variable in the present study is labour productivity. Although a variety of methods towards measuring productivity as output that is unexplained by the variability in inputs have been proposed (for example, Van Beveren 2012; Van Biesebroeck 2007), we employ labour productivity as a simple and useful indicator of the relative economic performance of firms in standardised per-worker terms. To empirically observe this, value-added was worked out as the firm's total sales in 2009 net of material purchases. Labour productivity was then calculated as value-added per full-time worker. However, since not all workers were full-time employees and we were unable to obtain the man-hours equivalent of labour, the labour variable was adjusted to reflect units of labour equivalent to full-time work. This adjustment was advised by discussions with a selection of respondents during the survey. In general, owner-managers tended to work late and weekends and were therefore assumed to put in 20% more labour than full-time workers. Part-timers were assumed to work half as much as their full-time colleagues, apprentices a third, and unpaid family and friends' worked roughly the equivalent of 25% of full-time work.

To operationalise knowledge mobilisation, we observe design intensity as the average number of hours per worker per week devoted to all research, design and development (RDD) activities. This included regularised activities such as in-house fashion design, as well as visiting fashion shows and upmarket shopping malls to survey the trends in the garments market, and/or taking apart and attempting to reverse-engineer fashionable brands the artisans will have purchased from a chic shop or in imported second-hand markets. Lessons thereof would then be used to develop replica products, make improvements to existing products, or sometimes advise changes to the process of producing existing products.

Knowledge capitalisation is observed as the natural log of the sales of new products per worker in 2009 and product-related firm transmutation is proxied by the natural log of the percentage share of sales of new products in the firm's total sales in 2009. In line with other research on the performance of small firms, other variables included as controls include owner-manager's gender, education level, the resale value of the firm's capital equipment, and the firm's networking activity (Biggs and Shah 2006; Nichter and Goldmark 2009; Rosenbusch et al. 2011; Sleuwaegen and Goedhuys 2002; van der Sluis et al. 2005; Westhead and Birley 1995). Table 1 below gives the list of variables employed in the present study, their empirical definitions and descriptive statistics.

[Table 1 about here]

3.2 Estimation considerations

Although the variability in raw labour productivity is rather large, a Skewness/Kurtosis test finds no evidence that the log transformed data is not normally distributed (joint *p-value= 0.278).* Without immediately apparent distributional issues with the dependent variable, this study elected to employ Ordinary Least Squares (OLS) multiple regression analysis technique due to its ease of implementation in the present exploratory study. We assume that logged variables have a linear relationship even as the raw variables may not. Further tests and measures were however undertaken to establish the suitability and robustness of OLS estimates in line with other Gauss-Markov assumptions. In this study's principal estimation (Table 3, Model 3), the mean of the residuals was found to not be significantly different from zero (*p-value= 1.000*) although residual errors were not strictly normally distributed (joint Skewness/Kurtosis test *p-value= 0.025).* A Breusch-Pagan / Cook-Weisberg test also found no evidence of significant heteroscedasticity (*p-value= 0.731).* Nevertheless, recognising the potential for unobserved heterogeneity amongst sampled firms, standard errors were clustered in the regression analysis by allowing firms in the same licence category - the variable used to stratify the sample – to have 'within group' similarities that may be significantly different from other groups.

As Table 2 further shows, apart from sales of new products and shares of sales of new products, there are no instances of high correlation between the variables used in the analysis; tests of multicollinearity following regression estimates also found no variable to have a variance inflation factor greater than two. Besides their binary relationship, however, the sales of new products and share of sales of new products are based on revenue values that are also used to calculate the firm's labour productivity. This presages an endogeneity bias in estimates of labour productivity. Following Davidson and MacKinnon (1993), a Durbin-Wu-Hausman augmented regression test was therefore carried out to examine the issue. Here, residuals from a first stage regression of per worker sales of new products were not significantly associated with labour productivity (*p-value = 0.290*). This lends statistical support for the absence of an endogeneity bias with the sales of new products variable. The same was however not established for the shares of sales of new products variable. Because the percentage shares are censored between zero and 100, the variable lends itself to a Tobit model. However, Tobit residuals predicted using a linear approach may be biased because the model is strictly speaking not a linear estimator. Endogeneity bias can thus not be ruled out in present estimates of the relationship between product-related transmutation and labour productivity.

[Table 2 about here]

4 Analysis and results

Results from the controls equation (Table 3, Model 1) are largely in line with expectations and extant research on SME performance in Africa (Biggs and Shah 2006; Nichter and Goldmark 2009). Amongst garments MSEs in Nairobi Kenya, returns to education are statistically significant and increase along levels of education, firms with greater capital per worker perform significantly better, there is some evidence that dynamic networks are munificent, and no significant gender effects are detected.

As pertains our variables of interest, estimates from Model 2 show that garments MSEs that mobilise knowledge by intensively engaging in design activities perform better; a 10% increase in the number of hours per worker per week devoted to design-related activities is associated with a 0.7% increase in labour productivity. However, besides the rather small direct effect on labour productivity, knowledge mobilisation can be seen to be integrally embedded in or associated with other knowledge related variables already accounted for. This is because the effects of education and dynamic networking predicted in the controls equation

(Model 1) diminish to a degree once knowledge mobilisation is included in the equation. Indeed, the inclusion of our knowledge mobilisation variable improves the ability of the model to explain the variability in firms' labour productivity only very slightly (from an R-squared value of .49 to .50).

In contrast, in Model 3, knowledge capitalisation appears to improve the R-squared value by five percentage points. The variable can thus be said to be substantively important in the understanding of the variability in labour productivity. The results predict that increasing knowledge capitalisation by 10% is associated with a 1.3% increase in the firm's labour productivity; doubling the extent to which given new knowledge is employed in production is associated with around 10% increase in firm performance. Microeconomics of innovation suggest that although complementary factors such as labour and capital will have cost implications, using given knowledge more than once entails zero marginal costs (see for example, Shapiro 2008). By the same token, our results suggests that capitalising on new knowledge more intensively, by pursing higher volumes of sales of new products incorporating such knowledge, can be a considerably productive endeavour.

Notably, design intensity is no longer significant once knowledge capitalisation is directly accounted for. Thus, although it brings forth some effects on MSE productivity discretely attributable to the mobilisation of knowledge that are otherwise largely captured by education and networking, our results affirm that it is the material exploitation of knowledge that is more substantively productive, the source of such knowledge notwithstanding. Still, that the design effect disappears once exploitation is directly considered further confirms that the proximity of design to production heightens the likelihood that knowledge will be promptly employed in production, and that such exploitation is in fact more directly associated with the output than mere mobilisation; it is not implausible that not all designs are implemented. There is thus a more straightforward practical and theoretical relationship between the extent of knowledge exploitation and observed output than there is between mere knowledge mobilisation (without indication of actual employment) and an observed economic output.

In Model 4, we evaluate the relationship between labour productivity and product-related transmutation. For garments MSEs in Nairobi, no significant association between the two is detected. Although suspected endogeneity may have biased the estimate towards zero, our results suggest that while the increased production and sale of new products enhances firm performance, there is no evidence that bare shifts in production and sales towards new products engenders higher labour productivity. In this light, policies and strategies seeking to improve firm performance through innovation should emphasize the deeper exploitation of new knowledge by intensifying the production and sales of new products in and of themselves and not the mere shift in production towards new products away from incumbent products as such.

[Table 3 about here]

5 Conclusions

This paper has sought to address some of the theoretical and empirical problems that have undermined the applicability and inferential efficacy of conventional innovation research, especially in developing countries. The paper has also carried out an empirical investigation of the relationship between labour productivity and three different aspects of innovation including knowledge mobilisation, knowledge capitalisation and product-related firm transmutation. Based on a small survey within one industrial and geographical developing country context, the empirical work has some validity and generalisability limitations. This study yet heralds the potential for larger innovation studies in Africa and other developing countries. In addition, this paper has highlighted key areas for theoretical and methodological refinements, further empirical application, and nuanced inferential insights for innovation research more generally.

Firstly, following Walsh (1996), we have identified design as an important variable that should be espoused by innovation research and policy more integrally. This is not just because it is widely undertaken in different contexts but also, perhaps more importantly, in recognition of it as a knowledge mobilisation activity that serves as a passport to the implementation of any innovation in actual production.

Second, we have highlighted knowledge capitalisation as the means through which the returns to knowledge actually accrue. The key contribution we posit here is that the extent to which new knowledge has been exploited by a given firm is observable through the *volume* of sales discretely attributable to new products and not the *share* of sales of such new products in the firm's total takings. The later has been argued to represent the transmutation of the firm towards the production of new products. Profoundly, this differentiation allows knowledge capitalisation to be more in line with the way conventional factors of production are theorised and estimated within the standard production function framework as units of such a factor that are employed in production. The proposed approach is therefore more consistent with established economic theory, where interest is in the approximation of the marginal contribution of units of a given factor input. This makes the present approach more inferentially coherent. Hence, future research on the returns to knowledge may wish to espouse and advance this approach further.

To be sure, it is not implausible that selling *more* new products effectively becomes selling *more of* new products relative to incumbents in due course. Indeed, in the present analysis, the two variables have a significantly high correlation. The concept of structural transmutation should however be investigated in its own right in future research. As discussed, a quotient showing relative change in production that is also prone to prodigal and precipitous lurches is out of line with the way factor inputs are traditionally conceptualised. Why structural transmutation should enhance productivity at the margin is therefore less straightforward. From this perspective, the shares of sales of new products and the volumes of sales of new products should not be considered as alternative operationalisations of the same concept.

Furthermore, in terms of the applied aspects of innovation research, unlike percentage shares censored between zero and 100 and often rounded (Mairesse and Mohnen 2010), volumes of sales of new products can be measured as a variable that is more or less properly continuous. This makes the variable better suited to the implementation of standard empirical practices such as log transformations and examinations of endogeneity, for example. Since it is measured in pecuniary terms, the variable can also be employed across a wide range of geographical and industrial contexts straightaway and remain comparatively meaningful. The same cannot be said of firm level percentage shares of sales of new products variable. The espousal of the concept of knowledge capitalisation and its operationalisation can thus not be overemphasized.

In our exploratory empirical study, we find that while knowledge mobilisation through more intensive design activity is positively associated with labour productivity, the intensity of knowledge capitalisation is the more dominant force. The implication here is that while small firms should be encouraged to undertake more knowledge mobilising design activities at the pre-exploitation stage, greater emphasis should be on the actual and more exhaustive exploitation of such new knowledge by expanding the production and sale of products embodying the pertinent knowledge.

Crucially, firms do not necessarily have to give up lucrative cash-cow products, for example, to benefit from innovation. In fact, with product-related transmutation seemingly statistically random, precipitous shifts in production towards new products should be shunned. Rather, in line with classic economic canons of productive and allocative efficiency, business managers, consultants and policy-makers should be sure to emphasize the rational exploitation of the productivity potential of a given piece of knowledge. Structural transmutation of the firm should thus not be directly pursued. Instead, it should be left to be strictly an organic eventuality resulting from the strategic optimisation of knowledge as a factor input.

Table 1: Descriptive statistics and variable definitions

Variable (Operational variable name)	Operational definition	N	Mean	Std. Dev.	Min	Max
Firm performance (Dependent variable)						
Firm's Value-Added	Value Added of the firm in 2009 in PPP$ (PPP$1 = KShs. 37.92)	122	20,950	45,004	316	316,456
Value-Added per worker	Value-Added per worker in 2009 (PPP$)	122	2,333	3,080	165	19,778
Labour Productivity	Value-Added per full-time employee equivalent in 2009 (PPP$)	122	3,220	4,863	200	36,754
Independent variables						
Knowledge mobilisation	Number of man hours per week devoted to Research, Design and Development activities	122	5.91	17.07	0	160
Knowledge capitalisation	Value of sales of new or significantly modified products (introduced between 2005 – 2009) in 2009 (PPP$)	122	19,678	56,716	16	395,965
Product-related transmutation	Percentage share of sales of new or significantly modified products (introduced between 2005 – 2009) in 2009 sales.	122	32	33	0	100
Traditional factor inputs						
Labour	Total number of workers	122	9	9	1	42
Adjusted Labour (FTE)	Adjusted Labour variable [L =(1.2*Owner-Managers) +Fulltime +(0.5*Parttime) +(0.33*Apprentice) +(0.25*UnpaidFamily/Friends)]	122	6	5	1	26
Capital Stock	Total resale value of the firm's fixed assets (Machines, tools, etc, excluding building) in PPP$	122	24,882	92,015	607	922,996
Capital per worker	Capital Stock per worker in PPP$	122	1,783	5,438	178	57,687
Owner/Manager factors						
Gender	Female = 1, Male = 0	122	0.45			
Owner managers education	Up to primary school = 1, 0 otherwise	122	0.14			
	Secondary school = 1, 0 otherwise	122	0.38			
	College qualifications = 1, 0 otherwise	122	0.32			
	University graduate = 1, 0 otherwise	122	0.16			
Dynamic networks	1 = If owner/manager was in an association which had new members joining in the previous year, 0 otherwise	122	0.29			

Table 2: Correlations matrix

	Labour productivity	Sales of new pdts p/worker (log)	Share of sales of new pdts (log)	Weekly design hrs per worker (log)	Primary education	Secondary education	College qualifications	University qualifications	Female	Capital per worker (log)	Dynamic Networks
Labour productivity	1.0000										
Sales of new pdts per worker (log)	0.5311*	1.0000									
	0.0000										
Share of sales of new pdts (log)	0.1914*	0.8196*	1.0000								
	0.0347	0.0000									
Weekly design hrs per worker (log)	0.1164	0.1942*	0.3912*	1.0000							
	0.2015	0.0321	0.0000								
Primary education	-0.1985*	-0.1927*	-0.1804*	-0.2190*	1.0000						
	0.0284	0.0335	0.0468	0.0154							
Secondary education	-0.1674	-0.2148*	-0.1386	-0.0047	-0.3130*	1.0000					
	0.0654	0.0175	0.1279	0.9590	0.0004						
College qualifications	0.0861	0.1759	0.1968*	0.1275	-0.2758*	-0.5333*	1.0000				
	0.3458	0.0526	0.0298	0.1617	0.0021	0.0000					
University qualifications	0.2964*	0.2398*	0.1023	0.0504	-0.1782*	-0.3445*	-0.3035*	1.0000			
	0.0009	0.0078	0.2621	0.5815	0.0496	0.0001	0.0007				
Female	-0.0175	-0.0723	0.0600	0.0935	-0.1267	-0.0251	0.0501	0.0883	1.0000		
	0.8486	0.4290	0.5118	0.3056	0.1643	0.7840	0.5837				
Capital per worker (log)	0.6657*	0.4552*	0.1537	-0.0368	-0.1104	-0.1394	0.0015	0.2839*	-0.0699	1.0000	
	0.0000	0.0000	0.0910	0.6871	0.2261	0.1256	0.9868	0.0015	0.4443		
Dynamic Networks	0.0640	0.2327*	0.2378*	0.0034	0.1111	-0.0447	-0.0462	0.0128	0.0809	-0.0360	1.0000
	0.4840	0.0099	0.0084	0.9705	0.2231	0.6245	0.6135	0.8884	0.3757	0.6940	

Table 3: The correlates of labour productivity

Dependent variable: Natural log of labour productivity (Gross value-added per worker)				
	(1)	(2)	(3)	(4)
VARIABLES	Controls	Knowledge mobilisation	Knowledge Capitalisation	Product-related Transmutation
Knowledge capitalisation: Sales of new products per worker (log)			0.134*** (0.021)	
Product-related transmutation: Share of sales of new products (log)				-0.010 (0.032)
Knowledge mobilisation: No. of hrs p/worker p/week for design activities		0.074*** (0.016)	-0.004 (0.014)	0.079*** (0.022)
Owner-manager's education qualifications				
Secondary school qualification	0.254** (0.091)	0.197* (0.096)	0.114 (0.094)	0.200* (0.101)
College diploma	0.483*** (0.076)	0.405*** (0.075)	0.200** (0.067)	0.415*** (0.064)
University degree	0.621*** (0.135)	0.547*** (0.139)	0.390*** (0.102)	0.554*** (0.135)
Female owner-manager (Dummy)	-0.022 (0.097)	-0.033 (0.091)	0.004 (0.085)	-0.033 (0.091)
Capital per worker (log)	0.588*** (0.029)	0.596*** (0.034)	0.482*** (0.033)	0.598*** (0.033)
Dynamic Networking (Dummy)	0.220* (0.112)	0.215 (0.124)	0.057 (0.051)	0.226* (0.109)
Constant	4.703*** (0.355)	4.757*** (0.435)	4.724*** (0.543)	4.747*** (0.421)
Observations	122	122	122	122
R-squared	0.487	0.497	0.556	0.497

Robust standard errors in parentheses. Reference category for education qualifications is owner-managers that attained primary school education only.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

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