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Human capital and innovation in Sub-Saharan countries: a firm-level study

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ABSTRACT
This paper contributes to the scarce literature on the relationship between human capital and innovation at the firm-level. In this paper we examine whether human capital endowments, such as the general level of schooling within a firm, and practices of firms, such as formal training and employee slack time, have a positive relationship with the innovative output of firms. We contribute by using a more sophisticated approach and analyse how different combinations of human capital elements affect innovation. We study this relationship in Sub-Saharan countries where the general level of human capital is lower compared with developed countries. The results illustrate that internal mechanisms that spur human capital are of particular importance for innovative output in this context. In addition, our results indicate that specific combinations of human capital elements can even have negative effects. In particular, for firms in the manufacturing sector that offer employee slack, the effect of employee schooling actually turns negative, while the combination of training and slack time does not have a significant effect.

1. Introduction
Innovation is widely believed to be a key factor for economic growth (Schumpeter, 1934; Solow, 1956). It is therefore important to understand the determinants of innovation at the country level. However, it is also critical to understand innovation at the level where it is actually developed, namely the firm. The main factor driving innovation in firms is knowledge (Barney, 1991; Kogut & Zander, 1992). Knowledge is pivotal, because innovation can be seen as the outcome of a problem solving process in which an organization ‘defines problems and then actively develops new knowledge to solve those problems’ (Caloghirou, Kastelli, & Tsakanikas, 2004, p. 30). Knowledge to solve those problems can be accumulated by R&D conducted within the firm, absorbed from the environment or can be derived from the skills and abilities of employees (Zahra & George, 2002). The latter source has often been labelled as human capital.
Human capital can be studied at different levels. In this study, we specifically focus on the role of human capital at the firm-level. Human capital is conducive for the development of new knowledge (Smith, Collins, & Clark, 2005) and supports the ability of firms to absorb knowledge (Cohen & Levinthal, 1990). Studies at the national level highlight, among others, human capital as a driving force for innovation (e.g., Dakhli & De Clercq, 2004). At the firm-level, however, this determinant of innovation has received less attention (Schneider, Günther, & Brandenburg, 2010; Teixeira & Tavares-Lehmann, 2014). Most firm-level studies about innovation have focused on the role of R&D activities, technology acquisition, firm size and age as determinants of innovation (Hirsch-Kreinsen, Jacobson, & Laestadius, 2005; Shefer & Frenkel, 2005). In previous studies that focused on human capital, the relationship between human capital and other performance indicators was studied. However, the effect of human capital on innovation has scarcely been studied.1

Moreover, in most studies there is an implicit assumption that if a certain factor spurs innovation, more of that specific factor will lead to higher innovative output (Anderson, Potocnik, & Zhou, 2014). Yet, different combinations of factors may result in heterogeneous outcomes (Jiang, Lepak et al., 2012). For example, Jiang, Lepak et al. (2012) show in a meta-analysis that three dimensions of a human resource system (skills-enhancing, motivation-enhancing and opportunity-enhancing) have a different impact upon financial performance and mediate each other’s effect.

We consider three different elements of human capital. The first element is the human capital endowments of firms, which relates to the level of schooling within a firm. Second, we use two firm-level practices that can improve human capital within the firm. The firm-level practices that we consider are training and the time given to employees to work on their own ideas (employee slack time). In line with Jiang, Lepak et al. (2012), we argue that different combinations of human capital may have an idiosyncratic effect on innovation. As such, in this paper we analyse how distinct combinations of these firm-level elements of human capital relate to innovative output. We examine whether the combination of employee schooling and slack time, and training and slack time have a favourable effect on innovation or whether the combination of these practices has a disadvantageous result. Our results indicate that it depends on the context in which they are applied.

In addition, we add an important dimension to the literature on human capital and innovation. The few studies that have considered the role of human capital as a key factor fostering innovation at the firm-level have mostly taken place in developed countries (Beugelsdijk, 2008; Leiponen, 2005; Vinding, 2006; Schneider et al., 2010; Teixeira & Tavares-Lehmann, 2014). This is striking, because fostering innovation is pivotal in developing countries (Crespi & Zuniga, 2011; Lee & Kang, 2007; Robson, Haugh, & Obeng, 2009). and human capital is a salient factor to spur innovation. By focusing on Sub-Saharan Africa as our research context, a different perspective on the role of human capital for innovation could be generated (George, Corbishley, Khayesi, Haas, & Tihanyi, 2016). One of the major innovation constraints in a developing context, is the availability of human capital (George et al., 2016). Stimulating education levels and building human capital is the cornerstone of many development initiatives and policies in developing countries (UNCTAD, 2014). However, the general infrastructure for human capital is still not well developed compared with developed countries (George et al., 2016). This makes it more difficult to have access to employees that fit within the firm and we expect that internal mechanisms to spur human capital are even more important. Hence, in developing countries, training and providing
employees with slack time might be more beneficial compared with searching for highly educated employees. As such, these firm-level practices could fill the gap between the general human capital supplied by the basic infrastructure within a country and the specific human capital required by the firm.

Our contributions are threefold. First, we contribute to the innovation literature by showing how human capital relates to the innovative output of firms. Preceding studies mostly focused on the human capital endowments within the firm. We contribute by using a more sophisticated approach towards human capital and showing the role of human capital accumulation via firm-level practices for firm-level innovation. Second, we propose how different configurations of human capital elements affect innovation. Previous studies focused on the link between human capital and innovation, but did not consider the interaction between different elements of human capital, while different configurations could have different impacts. Our results indeed show that combinations of different human capital elements do not have to reinforce each other. For instance, our results indicate that a combination of slack time and higher levels of employee schooling diminish each other’s effect in the services sector. Moreover, used in combination, these elements may even diminish the level of innovative output. Third, we study these relationships in developing countries, where the role of firm-level practices could be even more profound. As indicated above, we expect that it is more difficult to have access to highly educated employees and that internal mechanisms to spur human capital may be more important. As such, human capital practices could bridge the difference between the human capital supplied by the basic infrastructure within a country and the level of human capital required by the firm.

We investigate the relationship between human capital and innovation in 13 developing countries in Sub-Saharan Africa. We conducted preliminary interviews with managers in four companies in Kenya and Tanzania to understand whether our concepts of human capital are recognized in those countries. We chose companies that varied in terms of their innovative output (from very innovative to non-innovative). Subsequently, we used these interviews to illustrate these concepts in our theory section. We use data from the Enterprise Surveys of the World Bank, which are harmonized questionnaires conducted in the manufacturing and services sectors in several developing countries. The latest version consists of data about the innovative output of firms and human capital. We use these data to formally test our predictions.

2. Theory and hypotheses
2.1. Innovation in developing countries

Innovation has been defined as the introduction of new solutions to certain problems with the use of new, advanced technology, resulting in for instance products that are new to the world (Fagerberg, Srholec, & Verspagen, 2010). Innovation in developing countries increasingly receives attention from scholars, and more and more data collection efforts are undertaken to understand innovation in developing countries. Firms in those countries operate below the technological frontier (Goedhuys, Janz, & Mohnen, 2008), which means they can catch up by technological acquisition and imitation (Amman & Cantwell, 2012; Bell & Pavitt, 1993; Katz, 1986). As such, innovations will spur firm-level growth and productivity, even if only a small percentage of them are new to the world innovations (EBRD,
2014). In developing countries, innovations that are new to the local market are considered to be as important as innovations that are new to the world (EBRD, 2014).

To give an indication about what innovation actually means to firms in developing countries, we took some examples from a recent Innovation survey conducted by the World Bank in Kenya, Tanzania and Uganda and our conducted interviews. Examples of innovations that were considered as new to the local market included ‘the introduction of recycled garbage paper as toilet paper’ and ‘introduction of mobile medical tents’. During our preliminary interviews, other examples of innovations were given as well. For instance, we interviewed a very innovative telecommunications company that has introduced a new mobile banking payment system. In a pharmaceutical company in Kenya, we observed an innovative and state-of-the-art production plant that produced a series of sterile water solutions for nose and eye drops. However, some firms mentioned innovations that were new to the firm, which we did not consider to be actual innovations, such as the introduction of ‘cookies’, or ‘introducing a pool table at our restaurant’. We decided not to include these types of innovation in our study. As such, we considered innovations that are new to the local market as a minimum requirement to be marked as an innovation. Hence, innovative firms are firms that introduced innovations that are new to the world and/or new to the local market. Innovations that are only new to the firm are not included. This is in line with previous studies considering innovation, which have focused on incremental and radical innovations.

2.2. Human capital and innovation

In general, it has been argued that human capital is an important source of competitive advantage for firms (Dakhli & De Clercq, 2004; Gimeno, Folta, Cooper, & Woo, 1997). Research about human capital predominantly considered the role of systems of human capital (Chowhan, 2016). Such a system consists of several components, which have been considered all together as having an impact on firm performance. Recently, scholars objected to this proposition and proposed a rationale for the interaction amongst different practices that may impact the outcome differently (Jiang, Lepak et al., 2012). Hence, it is important to identify how different elements of human capital interact with each other, which has remained largely unclear. As such, we consider three different elements of human capital and the interaction between them. As mentioned earlier, we focus upon on the level of schooling of employees and two firm-level practices: training and slack time. Thus, human capital is a latent concept and in this study we focus on three underlying factors. The percentage of schooled employees within the firm is a human capital endowment of a firm on which a firm can build. The firm-level practices are geared towards the development of human capital within the firm. These practices enhance the skills of employees, which fosters the human capital of the firm (Jiang, Wang et al., 2012). We consider the role of practices like formal training and providing employees with slack time as firm-level practices that improve the level of human capital within the firm and, in turn, the innovative performance of firms. As mentioned in the introduction, an important contribution of our study is that it assesses the relationship between different combinations of elements of human capital. Therefore, we theoretically and empirically analyse how combinations of employee slack time and formal training/employee schooling influences innovation.

All three elements are discussed at the firm-level. As Felin and Hesterly (2007) pointed out, the locus of knowledge resides fundamentally at the individual level. However, we focus
on the firm-level because innovations mainly contribute to the firm as a whole instead of a single individual. Firms can utilize the collective human capital available within their boundaries as a resource to spur innovation. Therefore, we aggregate our human capital concepts to the firm-level.

2.3. Schooling

The level of schooled employees refers to the basic knowledge that is available within the firm, which is sometimes conceptualized as the general human capital of the firm (Teixeira & Tavares-Lehmann, 2014). We focus specifically on the percentage of employees within a firm that completed secondary education or higher. A higher level of schooled employees within the firm enhances the ability to understand, create and process information quicker compared with individuals without education (Nelson & Phelps, 1966). This is conducive for innovation, because innovation is a knowledge-based activity for which a certain knowledge base is required.

A firm does not only use and build on knowledge that is available within a firm, but also on external knowledge that can be beneficial for innovation. For instance, interactions with suppliers, buyers and universities provides knowledge inputs useful for the production process and potential innovations (Lundvall, 1999; Moulaert & Sekia, 2003). In order to use this knowledge, a firm should be able to absorb and transform this knowledge. A firm that has a certain percentage of schooled employees is better able to absorb, transform and exploit this knowledge compared with a workforce without any schooling (cf. Cohen & Levinthal, 1990), resulting in more innovation.

In developing countries in particular, higher levels of schooled employees within a firm are conducive for innovation and allow firms to exploit new technologies (Baptist & Teal, 2014) because firms in those countries partly upgrade their products by learning and imitation of other firms (Amman & Cantwell, 2012; Kim & Nelson, 2000). A higher percentage of schooled employees spurs this absorption and transformation, which eventually should result in more innovative output. If a firm has a lower percentage of schooled employees, it will be more difficult to innovate. For instance, a textile company we interviewed clearly indicated that they could not find and hire personnel with a certain knowledge background, which hampered innovation.

Therefore, we propose the following hypothesis:

H1: The higher the percentage of schooled employees within a firm, the higher its probability to produce innovative output.

2.4. Firm-level practice: formal training

We consider formal training as another crucial element that is conducive for the development of human capital within a firm. Formal training refers to the extra training that employees receive, it is a practice conducted by a firm to develop human capital within the firm. This increases the level of human capital in a firm by updating the knowledge and capabilities of employees (Cohen & Levinthal, 1990). The reason why firms offer training and why it could contribute to innovation is twofold. First, the knowledge that employees have might become obsolete, because the knowledge retained during secondary education depreciates quickly in a changing environment (Bauernschuster, Falck, & Heblich, 2009). The purpose of formal training is then to update knowledge. Second, it can be the case
that for certain aspects within the company, specific knowledge is needed. Formal training provides employees with this specific knowledge because many skills are not learned during general education but through on-the-job training (Arrow, 1962). These two reasons loosely relate to the distinction that Becker (1964) made between general and specific training. General training is training that upgrades the capabilities of the whole workforce and does not relate to capabilities specific for the firm, while specific training relates to training that improves the specific knowledge related to that specific firm.

We expect that both types of training are useful when introducing an innovation, because both types of training will update the employees' knowledge. This enhances the ability of employees to absorb knowledge and transform knowledge into successful innovations (Freel, 2005). Formal training is even more important for firm-level innovation in developing countries, because training is one of the first steps a firm in an emerging or developing country should undertake in order to create innovative capabilities (Bell & Figueiredo, 2012). Training gives employees the opportunity to acquire skills and know-how, which enhances the innovative capability of firms (Shipton, Fay, West, Patterson, & Birdi, 2005; Shipton, West, Dawson, Birdi, & Patterson, 2006). Furthermore, formal training of employees can compensate for the lower degree of education of employees in developing countries.

For instance, the manager of the telecommunications company indicated that there was a gap between the knowledge that employees obtained during their schooling and the knowledge necessary to develop new innovative products. Therefore, specific training modules were designed, because they 'noticed that coding and talent and developing a great idea is a bit weak. So we have a facility called [firm name] Academy, which is something we set-up in partnership with [name] University'. According to this manager, this would fill 'a gap within the community. So, we thought, if we feed in the gap, they will start innovating'. The pharmaceutical company offered training to its employees as well, but the goal of the training was to teach their employees specific knowledge related to guidelines and procedures: 'Training and retraining over and over ... reinforcing them the need what they are doing ... and how it can affect the product'. The training by the telecommunications firm relates more to general training to update employees' general knowledge, while the training offered by the pharmaceutical company is a specific training to learn certain procedures and guidelines. These two different types of training will both result in an increase of knowledge by their employees, which should positively impact on their innovative output. However, studies about training and innovation show mixed results. For instance, Freel (2005) does not find a significant relationship, while two other studies show a positive relationship (Beugelsdijk, 2008; Laursen & Foss, 2003) in developed countries. Some studies in developing countries take training as a control variable, but do not find a significant relationship with innovation (Goedhuys, 2007; Robson et al., 2009), while we expect that, especially in developing countries, training will be pivotal. Hence, we propose the following hypothesis:

H2: A firm that provides formal training to its employees has a higher probability to produce innovative output compared with firms that do not provide formal training.

2.5. Firm-level practice: employee slack time

Employee slack time, another firm-level practice to develop human capital, is the time that employees can spend on other explorative activities instead of their daily activities (Bourgeois, 1981). The effect of slack resources on innovation is still a point of discussion
(Anderson et al., 2014). Some find an inverted U-shape relationship of slack resources on innovation (Herold, Jayaraman, & Narayanaswanny, 2006; Nohria & Gulati, 1996), while others find a negative relationship (Latham & Braun, 2009) or do not find a significant effect (Alpkan, Bulut, Gunday, Ulusoy, & Kilic, 2010; Mousa & Chowdhury, 2014). We focus on employee slack in particular, because it is an element of building human capital within a firm. In a context where other resources are limited, providing slack time could be an informal way of conducting R&D.

Slack time gives employees the resources to work on their own ideas and it gives them a certain amount of freedom in their work, which encourages creativity (Amabile, 1996). In addition, it has been shown that slack time increases the development of tacit knowledge, which enhances knowledge creation and eventually creativity (Richtnér & Åhlström, 2010). As ‘innovation is the successful implementation of creative ideas within an organization’ (Amabile, 1996, p. 1), providing employees with slack time to work on their own ideas will increase the chance of being innovative.

There is some case study evidence about the company 3M, where employees spend 15% of their working time on a self-chosen project. This 15% rule has been identified as one of the key characteristics of the company that fosters innovative output (Garud, Gehman, & Kumaraswamy, 2011). During the interviews, some firms indicated that they provide slack time to their employees, while other firms said that they needed all the manpower to keep the business going. For instance, at a chemical company, there was one employee who was given time to come up with new ideas. Companies that developed new clothes designs indicated that designers got the freedom to do what they want: ‘Actually, we mostly allow them to work on their own ideas. We try as much as possible not to be a dictator company because creatives are very self; they have their own style’ (stated by a manager from a furniture company). The CEO of a food company indicated that the person who was given slack time was expected to come up with:

- Proposals for a new product to meet a need in the market, to come up with a new product to meet an unmet need in the market or to improve on available product to meet or to come up with a process that can help us access the market better or that can help us produce the product at a lower cost.

A textile company was aware of the fact that slack time could spur creativity, but ‘It is usually hard because mostly what happens is that every day … you have to have something on the line so sometimes we, they usually don’t have that time to think about something new you know’. These quotes indicate that some firms do provide slack time to their employees to spur creativity and innovation, sometimes as an informal way to conduct R&D, but not all firms are able to provide slack time to their employees due to time and resource constraints.

Especially in low- and medium-technology industries, creativity is one of the drivers of innovation instead of technological knowledge, because in those industries innovation is mostly based on the general knowledge stock of the firm and the creativity to transform such a stock, instead of scientific research (Santamaría, Nieto, & Barge-Gil, 2009). Most developing countries have a comparative advantage in low- and medium-technology industries (Goedhuys, Janz, & Mohnen, 2014), which indicates that creativity is an even more important factor in those countries. Slack time increases individual creativity (Amabile, 1996) and should therefore stimulate innovation. Hence, we formulate the following hypothesis:

H3: A firm that gives slack time to its employees has a higher probability to produce innovative output compared with firms that do not give slack time to their employees.
2.6. Schooling and employee slack

The percentage of schooled employees within a firm provides a certain knowledge base for the firm and employee slack time gives employees the opportunity to develop their skills and come up with innovative ideas. We propose that these two different elements of human capital will reinforce each other’s effect on innovation, for two reasons.

First, in order to come up with new ideas there needs to be a certain base level of knowledge to build on (Smith et al., 2005). Therefore, a certain level of schooled employees within the firm will be conducive for the development of new ideas during slack time. Furthermore, a certain percentage of schooled employees will increase the chance of using this basic knowledge in new circumstances (Kyriakopoulos & de Ruyter, 2004), which could spur the innovative output during slack time. Therefore, the combination of those two elements will result in an even higher innovative output.

Second, we argued that a higher percentage of schooled employees results in a higher ability of transforming information. The ideas generated during slack time, will not automatically result in successful innovation, but these ideas have to be transformed into successful innovations within the firm. Thus, the ideas will more often be transformed into successful innovations when a firm has a higher percentage of schooled employees. This results in the following hypothesis:

H4: The higher the percentage of schooled employees within a firm, the stronger the influence of employee slack time on innovative output.

2.7. Formal training and employee slack

The slack time that employees receive to develop themselves and come up with innovative ideas is based on the assumption that some spare time will enhance creative thinking and result in new ideas (Amabile, 1996). Next to slack time, firms could provide extra training to employees to improve the level of human capital within the firm. We expect that these two different mechanisms will have a reinforcing effect on each other.

Training serves to reduce the complexity of the problem to solve and clearly signals the goals of the company, which could stimulate creativity (Hirst, Van Knippenberg, & Zhou, 2009). Training could improve the implementation of new ideas within the firm and improve the knowledge base of the firm (just as human capital endowments) and it could indicate that the firm is open for new approaches. In a study in Chinese firms, Jiang, Wang et al. (2012) empirically showed that training positively correlates with creativity. However, in their structural equation model, the effect turns insignificant. In our preliminary interviews, training offered by the telecommunications company was partly geared towards the development of new ideas. Moreover, a firm that offers training to it employees, spurs the implementation of ideas. Training will update the employees’ knowledge. This enhances the ability of employees to absorb knowledge and transform knowledge into successful innovations (Freel, 2005), because it will increase the understanding of complex products (Bauernschuster et al., 2009). In order to come up with radically new ideas, creative skills are required (Bauernschuster et al., 2009). Giving employees slack time will spur this creativity. Hence, the combination of training with slack time will accelerate the innovative output.

This is because, first, ideas developed during slack time are easier to implement. Second, training spurs the development of knowledge, which could provide a good starting point
to develop new ideas during slack time. Third, slack time spurs the creativity necessary to come up with something radically new, which in combination with training will be even more likely. Hence, we formulate the following hypothesis:

H5: The effect of providing slack time on innovative output is greater for firms that also provide formal training as compared with firms who do not.

3. Research methods

3.1. Data

The quantitative data that we use to test our theoretical ideas stems from the Enterprise Surveys conducted in Kenya (2013), Tanzania (2013), Uganda (2013), Ghana (2013), Congo (2013), Djibouti (2013), Malawi (2014), Namibia (2014), Nigeria (2014), South Sudan (2014), Sudan (2014), Zambia (2013), Ethiopia (2011). We chose these countries because it is a relatively coherent group of countries in Sub-Saharan Africa. Moreover, in these countries, similar surveys have been conducted within a similar time span. The Enterprise Surveys have been developed by the World Bank to collect harmonized data among developing countries. Since 2002, the World Bank has conducted interviews with top managers and business owners of 130,000 firms in 135 economies. The goal of the survey is to get an overview of a broad range of topics, such as finance, corruption, infrastructure, crime, competition and performance. In recent surveys a new section has been included about innovation. This gives us the opportunity to relate human capital measures with innovation measures in developing countries. In line with the method used in the OECD’s ‘Oslo Manual’ the Enterprise Surveys include questions about innovation outputs. This makes the survey very suitable for analysing the relationship between human capital and innovation – especially because other traditional measures for innovation, such as patenting, are not common among developing countries.

The World Bank uses stratified random sampling as sampling methodology. The strata have been based on firm size, business sector (manufacturing and services) and geographic region within a country. This resulted in a representative sample for the countries and industries involved. In total 8223 firms have been surveyed in our sample.

3.2. Dependent variable

Traditionally, innovation has been measured using R&D expenditures and patents. Yet, R&D is an input measure in the innovation process and patents only refer to innovations that are sufficiently new, and may not be introduced (Mairesse & Mohnen, 2010). Therefore, we operationalize a firm’s innovation outcomes using self-reported measures of innovativeness that were developed according to the Community Innovation Survey (CIS) (Brouwer & Kleinknecht, 1996). Specifically, to measure whether companies are innovative we used two sequential questions. First, respondents were asked, ‘Did you introduce new or significantly improved products or services to the market in the last three years?’ A three-year period was chosen to avoid bias resulting from measuring accidental or one-off innovation. Respondents answering in the affirmative to this question were subsequently asked ‘Was this new or significantly improved product or service also new to your main market?’ Companies answering ‘yes’ to both questions were coded with a ‘1’, all other companies
with a ‘0’. This measurement is in line with generally accepted definitions of incremental and radical innovation and prior research has shown that this perception-based measure of innovation outcomes is highly reliable and correlates heavily with other (objective) measures of innovation outcomes (Hagedoorn & Cloodt, 2003).

### 3.3. Independent variables

**Human capital endowments**

A proxy that is often used for the human capital endowments of a firm is the level of schooling of employees (De Winne & Sels, 2010). We measured the human capital endowments of a firm by the share of employees that completed high school. The level of education of the employees was measured by asking the respondents ‘What percentage of your full-time workers has completed their high school?’ The resulting variable ranges between 0 and 100 by design.

**Formal training**

The presence of formal training practices within the company was assessed by asking ‘In the last fiscal year did your company offer formal training programs to your full-time permanent employees?’ Companies answering ‘yes’ to this question were coded with a ‘1’ all other companies with a ‘0’.

**Employee slack**

The presence of the practice of giving employees slack time to work on creative new ideas was measured by asking ‘During the last three years, did your establishment give employees time to work on new ideas?’ Companies answering ‘yes’ to this question were coded with a ‘1’ all other companies with a ‘0’.

### 3.4. Control variables

**Size**

We control for the size of the company as generally bigger companies have more resources at their disposal and can more easily free up personnel and resources for innovative activities (Hansen, 1992). The size of the company was measured by the natural log of the number of full-time permanent employees of the company.

**Age**

We control for the age of the company as it is often argued that older companies are more inert and less flexible and will therefore be less likely to innovate (Hansen, 1992). A company’s age was determined by asking for the year of establishment of the company and subtracting this from the year in which the survey was performed (i.e. 2013).

**Subsidiary**

We also control for whether the company is an independent economic unit or part of a larger organizational entity. We do so by asking the question ‘Is your establishment part of a larger firm?’. Companies answering ‘yes’ to this question were coded with a ‘1’ all other companies with a ‘0’.
Foreign presence or foreign owned
We used a question about the percentage of the company that is owned by private foreign individuals, companies or organizations to construct two control variables. First, for any company that answered with any value greater than 0% to the above question we coded the control variable ‘foreign presence’ as ‘1’ and ‘0’ otherwise. Second, for any company that answered any value greater than 50% we coded the control variable ‘foreign owned’ as ‘1’ and ‘0’ otherwise. We control for foreign presence and foreign ownership because firms in emerging economies often highly benefit from the technological knowledge available from their international headquarter and research labs (Isobe, Makino, & Montgomery, 2000).

Previous studies pointed out that strategic activities have an effect on human capital and performance (Chowhan, 2016). Therefore, we control for two strategic activities, namely conducting research and development and if the firm is active in the international market by exporting.

R&D
A firm’s internal capacity to generate and process knowledge is also likely to impact on its innovation outcomes (Cohen & Levinthal, 1989). As such, we included a dummy variable that took the value ‘1’ if the responding firm indicated that in the last three years it had spent any money on formal R&D activities and ‘0’ in all other cases.

Export
Export measures the percentage of sales that was exported directly. It indicates how active a firm is in the international market.

We also control for the coordination with suppliers and customers, which has been indicated as a strategic activity by Chowhan (2016). The variable email measures if a firm communicates with its suppliers and customers by email. It is a dummy variable that took the value of ‘1’ if a firm communicates with email and ‘0’ otherwise.

We control for the recruitment and selection bottlenecks as an indicator of how difficult it is to find the right employees. In particular in developing countries, this could be a major obstacle to hire employees that fit within the firm’s strategy. The variable is measured as a dummy variable coded as ‘1’ if an inadequately educated workforce is a major or severe obstacle to the current operations of the firm and ‘0’ if it is no, minor or a moderate obstacle.

Country, sector and industry dummies
Finally, we include dummy variables to control for differences between countries (Uganda being the reference category), between sectors (services being the reference category) and between industries (food being the reference category).

3.5. Analyses
Our dependent variable has a discrete distribution. We therefore employed logistic regression analysis to estimate the effects of our independent variables on the likelihood of a firm being innovative. The basic form of a logistic regression equation is represented in equation (1). To make this function estimable it is transformed into equation (2).

\[ y = \frac{e^{b_0 + b_1 x_1 + b_n x_n}}{1 + e^{b_0 + b_1 x_1 + b_n x_n}} \] (1)
As is evident from equations (1) and (2), logistic models are highly nonlinear. Therefore, formal hypothesis tests using logistic regression models have to take into account that the strength and direction of the effects depend on the values of all other variables in the model. We follow recommendations of Hoetker (2007) and estimated average marginal effects across all observed values for the other variables in the model. This approach improves on the common practice of setting all other variables at their mean. The latter can be problematic because the mean ignores the actual dispersion of values. In addition, in the case of categorical variables, the mean tends to be a value for which the variable is not defined.

While estimating the logistic regressions, we used probability weights as indicated and presented by the World Bank. This allows us to make inferences on the population of non-agricultural private firms in our 13 countries. We used the improvement of overall model fit to identify appropriate models for hypothesis tests based on log-likelihood ratio tests (Long & Freese, 2006). For our formal hypothesis tests, we report conditional effect-specific relevant values of the independent variables (Bowen & Wiersema, 2004; Long & Freese, 2006). In addition, we provide graphs that show their effects across the full range of observed variable values.

4. Results

Table 1 reports pooled descriptive statistics and correlations. The descriptive statistics indicate that 36% of the firms in our sample report to be innovative. Only 23% of the firms performed any formal R&D in the last three years. However, a surprisingly large share of 40% of the firms formally offer their employees time to work on new and creative ideas. As such, it seems like a large part of the R&D is done informally. Finally, 28% of the companies offered formal training to their personnel and for the average firm about 57% of the personnel at least holds a high school degree.

Table 2 reports the results of the binary logistic regressions performed to test our hypotheses. Models 1 through 3 are hierarchical logistic regressions. Model 1 is the baseline model including only the control variables. Model 2 adds to direct effects of the three independent variables to the model, whereas model three adds to interaction effects between employee slack and the two other independent variables. Models 4–5 and 6–7 are identical to models 2 and 3 except that models 4 and 5 include only manufacturing firms, whereas models 6 and 7 include only service firms.

With regard to the control variables most results are as expected. Firm size has a positive effect on the likelihood of being innovative, as well as R&D. Marginal effect analyses reveal that the difference in the likelihood of being innovative between firms that do perform R&D and firms that do not is only 11%. Compared with the effect sizes of one of the human capital variables we will discuss later, this effect is modest indeed. This further underlines the notion that formal R&D is relatively unimportant as a driver of innovation in developing countries.

The main effects of our independent variables are highly similar across all models. With regard to the interaction effects, comparing model 3 with model 2 reveals that the full model (model 3) has a superior model fit. However, comparing models 4–5 and 6–7 reveals that
Table 1. Descriptive statistics and bivariate correlations.

<table>
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<tr>
<th></th>
<th>Mean</th>
<th>St. Dev</th>
<th>Min</th>
<th>Max</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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<th>9</th>
<th>10</th>
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<th>12</th>
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<tbody>
<tr>
<td>1</td>
<td>Innovation</td>
<td>0.35</td>
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<td>0</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
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<tr>
<td>2</td>
<td>Ln size</td>
<td>2.66</td>
<td>1.17</td>
<td>0</td>
<td>8.99</td>
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<td>-</td>
<td>-</td>
<td>-</td>
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<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Ln age</td>
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<td>0</td>
<td>7.58</td>
<td>0.07</td>
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<td>-</td>
<td>-</td>
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<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
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</tr>
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<td>0.02</td>
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<td>0.08</td>
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<td>-</td>
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<tr>
<td>6</td>
<td>Foreign owned</td>
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<td>0.08</td>
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<td>7</td>
<td>Recruit ment obstacle</td>
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<td>0.37</td>
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<td>1</td>
<td>0.05</td>
<td>0.02</td>
<td>0.01</td>
<td>-0.03</td>
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<td>13</td>
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<td>0.04</td>
<td>0.07</td>
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<td>0.04</td>
<td>0.06</td>
<td>0.16</td>
<td>0.41</td>
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### Table 2. Logistic regression results.

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<tr>
<th>Variables</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
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<tr>
<td>Size (ln)</td>
<td>0.0828***</td>
<td>0.0386</td>
<td>0.0391</td>
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<td>0.0110</td>
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<td>Subsidiary</td>
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<td>−0.0833</td>
<td>−0.0811</td>
<td>−0.0772</td>
<td>−0.0683</td>
<td>−0.1304**</td>
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<td>Foreign presence</td>
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<td>0.1871</td>
<td>−0.1727</td>
<td>−0.1928</td>
<td>0.4257***</td>
<td>0.4268</td>
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<td>−0.2634*</td>
<td>−0.2611*</td>
<td>0.0577</td>
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<td>Labor force obstacle</td>
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<td>0.2398***</td>
<td>0.3945***</td>
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<td>0.6262***</td>
<td>0.6298***</td>
<td>0.5175***</td>
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<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
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<tr>
<td>Industry dummies</td>
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<td>Schooled employees (H1)</td>
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<td>0.0015</td>
<td>−0.0025**</td>
<td>0.0002</td>
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<td>0.4689***</td>
<td>0.5223***</td>
<td>0.4548***</td>
<td>0.5576***</td>
<td>0.4979***</td>
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<td>Employee Slack (H3)</td>
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<td>1.3611***</td>
<td>1.2005***</td>
<td>1.5389***</td>
<td>1.1336***</td>
<td>1.2401</td>
<td>1.1367</td>
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<td>Schooled employees * slack(H4)</td>
<td>−0.0032**</td>
<td>−0.0052*</td>
<td>−0.0052*</td>
<td>−0.0052*</td>
<td>−0.0013</td>
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<td>Formal Training * slack (H5)</td>
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<td>−0.1705</td>
<td>−0.1705</td>
<td>−0.098</td>
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<tr>
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<td>3344</td>
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<td>Log-likelihood</td>
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<td>−4601.86</td>
<td>−4598.7</td>
<td>−1900.14</td>
<td>−1896.56</td>
<td>−2658.11</td>
<td>−2657.6</td>
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<tr>
<td>$\chi^2\Delta$Log-likelihood</td>
<td>562.68***</td>
<td>6.32**</td>
<td>-</td>
<td>7.16**</td>
<td>-</td>
<td>1.03</td>
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</tr>
</tbody>
</table>

Robust standard errors in parentheses.

$^p < 0.10$.

$^{*} p < 0.05$; $^{**} p < 0.01$; $^{***} p < 0.001$. 
this superior model fit is completely driven by a better model fit for the manufacturing firms. For the service firms, the interaction effects are insignificant. As such, we will be interpreting the interaction effects separately for both industries.

Employee schooling has a marginally significant effect on a firm’s likelihood of being innovative in the manufacturing industry. Moreover, the effect is very small and negative. Marginal effects analyses reveal that a one standard deviation increase in employee schooling decreases the likelihood of being innovative by about 1 percentage point. So we find some statistical evidence for a small negative effect and we conclude that employee schooling is a relatively unimportant determinant of firm innovation. Hence, Hypothesis 1 is not supported.

We find very strong support for our hypothesis that formal training is of influence on a firm’s innovativeness (Hypothesis 2). The size of the effect of this variable is depicted in Figure 1. Having a formal training program makes the likelihood of a firm being innovative increase from 20% to 30%.

The same conclusion holds for firms that offer their employees slack time to work on new and creative ideas. Figure 1 reveals that the size of this effect is even more profound than that of formal training. Offering employees slack time results in an increase in the likelihood of being innovative from 23% to 46% and 43% in manufacturing and services respectively. These findings offer strong support for Hypothesis 3. It also indicates that firm-level practices are indeed of importance to stimulate human capital levels within firms for innovative output. In comparison with schooling, firm-level practices have a more profound relationship with innovation in developing countries.

In Hypothesis 4 we predicted that having more educated employees and offering employee slack would reinforce each other’s positive effects. We find evidence of the opposite, but only in the manufacturing industry. Effect size analyses reported in Figure 2 reveal that for firms that offer employee slack the effect of employee schooling actually turns negative. This is an intriguing finding to which we will get back in detail in the discussion section. However, it is important to note that, for any value of employee schooling, offering employee slack will increase a firm’s likelihood of being innovative (i.e. the black line is always above the grey line in Figure 2). However, for firms that already offer employee slack, a strategy of hiring more educated employees might have negative consequences for the innovativeness.

Figure 1. R&D, employee slack, formal training and innovation.
In Hypothesis 5 we predicted that offering both formal training and employee slack would reinforce each other’s effect as formal training might induce individual creativity, which employee slack relies on. We do not find support for this hypothesis, as indicated by the insignificance of the interaction coefficient in Table 2. The effect size analysis reported in Figure 1 clearly reveals that the combination of slack and formal training results in a higher innovative output, but that the confidence intervals overlap.

5. Discussion

This paper aimed to contribute to the literature about the relationship between human capital and innovation in developing countries. We find that human capital, and especially firm-level practices to improve human capital, play an important role for innovation in developing countries. In addition, the combination of certain elements of human capital can have an adverse relationship with innovation. We conduct our empirical analysis in 13 Sub-Saharan countries and combine qualitative and quantitative data to support our claims. Overall, our results point to the direction that firm-level practices, even more than the human capital endowments, seem to be pivotal for innovation in developing countries. Moreover, these results indicate that human capital practices have a more profound relationship with innovation than traditional factors, such as schooling and R&D. This suggests that previous studies have paid too much attention to these traditional factors, while – especially in developing countries – other factors should be taken into account when studying innovation. This is in line with a point made in previous research that in non-high-tech industries or innovations that are not based on scientific research, other factors should be considered as well (Santamaría et al., 2009; von Tunzelmann & Acha, 2005). We do not state that traditional factors do not play a role at all, but that one should not overlook other factors that relate to innovation.

When considering the utilization and development of human capital within a firm, we found that the portfolio of certain elements of human capital matters for innovation. Our study indicates that different combinations relate differently to innovative output. This contradicts the implicit assumptions in most previous studies that if one factor relates to innovation, an increase in this factor is always desirable (Anderson et al., 2014; Chowhan,
We suggest that one should consider a portfolio approach towards different elements of human capital.

Furthermore, it seems that it depends on the context in which these combinations are deployed (manufacturing or services sector) what the relationship will be with innovation. Thus, future studies should consider the context in which these combinations are implemented and further investigate this issue. For instance, the combination of employee schooling and employee slack time in the manufacturing industry diminishes each other’s effect, while we did not find this result for the services sector. This result is surprising because it contradicts our hypothesis that the combination of these two elements would reinforce each other. This could imply that employees who did not attend secondary education have other characteristics that are even more beneficial in combination with employee slack time, such as job experience (Marvel & Lumpkin, 2007; Tierney & Farmer, 2002), this is because instead of going to school they started working. This could result in more job expertise and enhance creativity (Amabile, 1996) and therefore the effect of slack time could be higher for employees without secondary schooling. Unfortunately, we did not have data about job experience, but this result indicates that future studies should include other characteristics of employees as well.

In general, this result indicates that the assumption in most previous studies that an increase in one factor is always desirable to improve innovation is not supported. In this case, it could be better not to increase the percentage of employees with secondary schooling when providing them with slack time. Hence, this result supports the idea highlighted in previous studies (Anderson et al., 2014; Chowhan, 2016; Jiang, Lepak et al. 2012; Lepak & Snell, 1999) that a portfolio approach is of major importance. As such, it contributes to the literature by providing evidence showing that certain combinations of human capital have different relationships with innovative performance.

Similarly, the combination of training and employee slack time also did not reinforce each other’s effect. Although the results are insignificant, this could imply that countervailing forces are at play. A firm that offers training to its employees could limit the creativity within the firm, because employees are provided with similar knowledge and information, which diminishes the amount of perspectives within a firm. A less heterogeneous population of employees will have adverse effects on creativity (Perry-Smith & Shalley, 2003), because individuals are not exposed to different approaches and views anymore. Moreover, if employees are more homogeneous, it results in more confirmative behaviour which leaves little room for autonomy and creative behaviour (Amabile, 1996; Perry-Smith, 2006). In addition, training may constrain people’s feeling of autonomy, which reduces the intrinsic motivation of employees and results in less creativity (Caniëls & Rietzschel, 2015; Shalley, Zhou, & Oldham, 2004). Furthermore, training can result in more formalized structures and rigidities within a firm, which can limit creativity as well (Klijn & Tomic, 2010). Thus, it could be that the training given in these firms diminishes the creativity used during slack time to come up with new ideas. Future research, with more information about the type of training could shed more light on this issue.

Managers and policymakers could use these results to stimulate investments in formal training and employee slack time, because this may be more beneficial for innovative output than policies focusing on R&D expenditures. Furthermore, policymakers and managers should consider the portfolio of factors that they would like to introduce, because some combinations of elements of human capital are more favourable than others. They should
also consider the sector in which the firm is active, because some of the combinations have a more beneficial relationship with innovation in one sector compared with the other. This implies that policies should not be too generic, but should target specific combinations in specific sectors.

**Limitations**

From a methodological point of view, our study has some limitations. First, only cross-sectional data are available, which makes it difficult to establish causality. Future research using panel data could empirically investigate the direction of causality. This problem could also be solved if instrumental variables were available. Second, slack time and training are both measured as dummy variables, which does not give very rich information about these variables. If more information is available, future studies could use information such as time and money spent on these firm-level practices, to gain a more in-depth understanding. Moreover, we only know whether a firm offers training to its employees in a given year. We do not know to which employees specifically or if these employees stay within the company or whether employees leave after the training. This could also influence the results. Finally, other studies about human resources included more specific information, which is not available in our database. Future data collection efforts could include other variables related to human resources, such as motivation incentives, for example bonuses, or information about opportunities, for example variables about information sharing and job design. Moreover, the strategic activities of a firm could influence the results (Jiang, Lepak et al., 2012). We included some variables about firm strategy, but other factors could play a role as well. This could bias our results by overestimating the effects, due to omitted confounding variables. Future research could consider these points to improve our understanding of the relationship between human capital and innovation. Furthermore, future studies could replicate this study in other countries (when data are available) to check the robustness and generalizability of the results.

**Notes**

1. Two notable exceptions are Beugelsdijk (2008) and Laursen and Foss (2003) who relate human resource practices to innovation.
2. For more information about the methodology and sampling see www.enterprisesurveys.org.
3. See www.enterprisesurveys.org

**Acknowledgements**

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