ERASMUS UNIVERSITEIT ROTTERDAM
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BACK TO BASICS

HRM and Innovation in Developing Countries

Master Thesis

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ABSTRACT

Development economics has failed to provide a policy framework that effectively initiated the catching up process in the developing world. As a consequence, technological innovation as driver behind growth and development has received increasing attention. This paper attempts to uncover the relationship between adept Human Resource Management and innovation generation in developing countries. I present a consistent theoretical framework that allows for the derivation of four key proposition about the effect of a *Corporate Culture* that encourages exploration, *Rewarding Long-Term Success*, excessive *Termination* and employee *Empowerment* on firm-level innovation generation. I then proceed to empirically test theoretical predictions, combining data form the World Bank Enterprise Survey and the Innovation Follow Up Survey for more than 23,000 enterprises in 18 developing countries. Empirical findings for product innovation perfectly mirror theoretical predictions. Estimation results suggest a strong and significant, positive relationship between my measures for *Corporate Culture, Rewarding Long-Term Success* and *Empowerment* and firm-level product innovation generation. An inverse relationship is identified for *Termination* and my product innovation measure. I further identify a strong, positive and significant relationship between *Corporate Culture* and process innovation generation. An inverse relationship is established for *Rewarding Long-Term Success*, while no relationship is identified for my *Termination* and *Empowerment* measures.

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"Carrying out innovation is the only function which is fundamental in history "
– Joseph Alois Schumpeter –

1. INTRODUCTION

In an attempt to establish sustainable growth in the developing world, the set of privatisation, liberalisation and deregulation policies established in the "Washington Consensus" has clearly revealed its limitation to this date. Thus, in the course of a widely acknowledge "back to basics" movement among development economists, it has become a fashionable approach to refocus on technological innovation as the core driver behind economic development (Aubert 2005). This new approach closely draws on the Schumpeterian doctrine of the early 20th century. Already in 1912, Joseph Schumpeter defined innovation as "creative destruction" that develops the economy in its core, emphasizing the main role of an entrepreneur as allocating resources to "new uses and new combinations" (Schumpeter 1912). However, in today's knowledge-based economy, the generation of innovation no longer rests on the shoulders of individual characters, but rather requires the strategic cooperation of many actors (Sledzik 2013).

This study attempts to answer the question of how Human Resource Management (HRM) relates to firm-level innovation in developing countries. It has long been established in economic literature that developing countries lag behind in their ability to generate innovation output when compared to their more developed counterparts (Fagerberg, Shrolec and Verspagen 2010). A shortcoming that has been successfully linked to a deficiency in growth and economic development in those countries (Fagerberg and Shrolec 2008). A core obstacle in this respect seem to be insufficiently developed "national innovation systems" (Freeman 1987). From a firm-level perspective, one key purpose of such "innovation systems" is to facilitate the realisation of large-scale R&D projects which have been repeatedly identified as key drivers behind innovation in the developed world (Geroski 1990; Roper, Du and Love 2008). As a consequence, the conventional ways of generating innovation seem severely restricted by external factors for firms in developing countries. Further, a very recent body in innovation and business literature has called for a rethinking of the concept of innovation in the context of developing countries. The principal concern is that the character of R&D centred innovation as promoted in developed countries may not meet the special requirements for innovation in the less developed world (Hobday 2005; Tiwari and Herstatt 2014). This study introduces adept HRM as alternative tool for stimulating innovation apart from conventional R&D focused approaches which may neither be feasible, nor particularly fruitful in developing countries.

Theoretical and empirical evidence on the general importance of HRM for innovation generation is more than scarce and at best inconclusive. Manso (2011) and earlier attempts of modelling Bayesian decision problems known as "Bandit" problem by Roberts and Weitzman (1981) and Battacharya, Chatterjee and Samuelson (1986) as well as work by Holmstrom and Milgrom (1991) on multitask decision problems in a principal-agent framework deliver some theoretical insights in this respect. The key idea is that agents in organisations face a decision-problem involving either the exploitation of well-known, conventional actions or the exploration of new work methods. The different properties of both actions can be exploited by the principal when trying to incentivise exploration and hence innovation. In reality, HRM captures the various tools available to the manager/firm for doing so. Further, empirical evidence from economic literature by Ederer and Manso (2009) support the notion of HRM as a key driver behind firm-level innovation generation. The authors evaluate changes in incentive provision encouraging either exploitation or exploration in a controlled lab experiment. Finally, field research in academic management literature by Shipton et al. (2006) and Bourke and Cowley (2015) delivers strong support for the importance of the (subjective) quality of "HRM systems" for innovation generation.

My main goal is to present a conclusive theoretical framework which allows for the derivation of testable predictions regarding the effect of various HRM practices on innovation output generation.[1] Propositions from economic theory are then tested in a comprehensive empirical analysis. To begin with my underlying theory, I first introduce a single-agent decision problem known as Bandit problem, illustrating the central trade-off between "exploitation" of conventional work methods and "exploration" of new actions (March 1991). Then, I closely follow the modelling in Manso (2011) and integrate the Bandit problem into a principal-agent framework to derive optimal incentive contracts. My demonstration from economic theory allows for the formulation of four key propositions that can be tested using my data:

First, a *Corporate Culture* that encourages exploration has a positive effect on innovation, capturing the effect of firms' loose commitment to promote exploration and hence per definition, innovation. Second, *Rewarding Long-Term Success* positively affects innovation output generation. The key intuition here is that rewarding early success elicits exploitation of conventional methods which have a higher probability of delivering initial success while delaying compensation

[1] The terms innovation, innovation output and technological innovation are used interchangeably throughout this study.

incentivises early exploration to obtain additional information for later periods. In addition to the latter, a stronger *Commitment* to *Rewarding Long-Term Success* increases the positive effect on innovation. Third, *Excessive Termination* (or also: lower job security) has an adverse effect on innovation, because the threat of termination in earlier periods shifts additional incentives towards exploiting conventional actions to minimise the potential wage loss following dismissal. Finally, employee *Empowerment* positively affects firm-level innovation output. Key insights from theory suggest that the agent's inclusion in the decision-making process increases the pool of potential new work methods and consequently the probability of success in optimum.

For my empirical analysis I combine cross-sectional data from the 2013/14 World Bank Enterprise Survey with the 2013/14 Innovation Follow Up Survey. My full sample contains more than 23,000 enterprises from 18 different developing countries in Sub-Saharan Africa and South Asia. The surveys contain questions on HRM practices as well as on firm-level innovation which are used in my key identification strategy to estimate an innovation production function. I use responses on the introduction of new or significantly improved products and processes as two different measures approximating firm-level innovation output. A linear probability model with country, year and industry fixed effects is used to identify correlational effects. I want to stress that I am very much aware of underlying endogeneity issues in this particular area of study. Hence my empirical investigation at no point attempts to make causal inference, but rather constitutes a best practice to uncover underlying relationships in sign and approximate magnitude.

Estimation results deliver four key insights: First, a *Corporate Culture* that encourages exploration is associated with a greater innovation propensity for both innovation measures. The suggested effect is highly significant and astonishingly large in margin. Second, *Rewarding Long-Term Success* is positively related to product innovation generation and inversely related to my process innovation measure. Third, engaging in excessive *Termination* at the firm level is inversely related to the generation of product innovation. No relationship with process innovation is found. Finally, more employee *Empowerment* is associated with a higher product innovation propensity, while no relationship with my process innovation measure is established. In essence, findings for all my HRM practices of interest and product innovation perfectly mirror theoretical prediction, while I find only weak support for my process innovation measure.

My contribution to academic literature is five-fold. First, I engage in academic pioneer work by disentangling firm-level innovation, showing individual association with HRM practices for product and process innovations. Second, this is one of the first studies on HRM and innovation

where methodology and empirical execution are based on consistent theoretical reasoning. Third, I deliver empirical evidence in support of theoretical predictions made by Manso (2011). Fourth, with a total sample size of more than 23,000 firms, this study belongs to the largest in scope in this field of research. Finally, to the best of my knowledge, this is the first study that investigates firm-level HRM and innovation in developing countries on a larger scale.

The remainder of this paper is structured as follows. The subsequent section leads through related literature. Section three introduces the theoretical model. The fourth section presents the data. Section five explains my methodology and identification stagey. Then, in section six I present my key estimation results. Section seven features various robustness checks with respect to modifications in my key regression specification. The following section eight presents a discussion which is divided in two parts. I first discuss key limitations of this study, to then analyse my main findings in the context of developing countries. The final section concludes.

2. RELATED LITERATURE

Joseph Alois Schumpeter (1912, 1934) introduced innovation as "revolutionary change" which is the core factor driving economic development though pushing the economy out of its "static mode". Most studies that try to link cross-country differences in economic development to innovation to this date focus on the comparison of what has early been defined by Christopher Freeman (1987) as "national innovation systems". Abramovitz (1986) suggested that factors such as education level, the capability of financial institutions and the stability of national governments are the key determinants for innovation and hence economic development on a national level. The umbrella term that was later coined for those factors is called "social capabilities" (Fagerberg, Shrolec and Verspagen 2010). In combination with national "technological capabilities" such as defined by Lall (1992) as countries' total R&D effort and FDI volume, the quality of "national innovation systems" can be assessed. Fagerberg and Shrolec (2008) empirically examine the relationship between 115 countries' innovation systems (as defined by 25 indicators determining social and technological capabilities) and economic development in the period from 1992 to 2004. The authors find a very strong, significant and robust relationship between the quality of innovation system and GDP per capita as their measure of economic development.

From a microeconomic perspective, research that tries to explain firm-level differences in innovation generation can be roughly divided in studies on "firm characteristics" and studies on firms' "business environment". Starting with the former, R&D activities are commonly identified as the most important factor determining innovation. In an attempt to model the "innovation value chain" Roper, Du and Love (2008) try to identify the exact origin of product and process innovations by estimating parameters of a comprehensive innovation production function (cf. Geroski 1990; Harris and Trainor 1995). Using a panel of Irish firms between 1991 and 2002 (about 1800 observations), the authors find a relationship between in-house R&D propensity and product innovation that trumps the suggested effect of any other factor by at least 15 percentage points. Other studies following a similar approach identify firm-size (Bourke and Cowley 2015, Roper, Du and Love 2008), state- or private ownership (Jefferson et al. 2003; Xu and Zhang 2008; Li and Xia 2008; Choi and Williams 2011) and firm age (Hansen 1992; Huergo and Jaumandreu 2004) as crucial firm characteristics determining innovation output.

In addition to firm characteristics, a large body in academic literature emphasises the importance of firms' business environment for innovation generation. Audretsch and Feldman (1996) for their study of about 8000 innovations registered in the US in 1982 find that geographic occurrence of innovation is spatially clustered and can be linked to local agglomerations of skilled labour, university research or industry R&D spending. Thus, the authors infer the prevalence of local labour market spill-over effects as important driver behind innovation output. In a closely related manner, McCann and Simonen (2005) show the importance of (local) face-to-face inter-firm interactions for innovation by analysing inter-firm R&D cooperation and its relationship with firm-level innovation output for Finnish high-tech firms in the 1990s. Finally, Aghion et al. (2005) in an extensive theoretical and empirical analysis find strong support for the importance of product market competition for firm-level innovation generation. In a widely acknowledged theoretical reasoning, the authors identify an inverted U-shaped relationship between competition and innovation. The finding is then confirmed by empirical evidence for a panel of 311 UK firms between 1973-1994.

Studies on HRM and innovation generation are scarce and have to be clearly distinguished from existing studies on firm performance. For instance, conclusive economic theory suggests a close relationship between performance sensitivity of compensation systems and output generation. Empirically, Lazear (2000) shows in his study of a US auto glass installer in 1995 and 1996, that a shift from hourly wages to piece-rate pay leads to an average increase in output per worker by

about 44 per cent. Shearer (2004) in a randomised field experiment with Canadian tree planters confirms the substantial positive effect of performance pay identified by Lazear. However, insights from research in psychology suggest caution when trying to transfer those findings to labour task involving experimentation and creativity. McGraw (1978) and Kohn (1993) present a summary of studies in this respect. Essentially it is found that pay for performance encourages the repetition of well-known activities at the expense of experimentation consequently creativity.

Holmstrom (1989) from an agency perspective studies the phenomenon that small firms seem to be responsible for a disproportionally large share of innovation research. He argues that pay for performance is hostile to innovation generation because measures for innovation are noisy, making performance pay more costly. Holmstrom concludes that optimal incentive schemes fostering innovation have to be less sensitive to performance and in this respect show some tolerance to early failure. Ample literature in industrial organisation focuses on the trade-off between exploiting known, conventional actions and exploring new actions (March 1991). Most of those studies take the form of single-agent Bayesian decision problems known as Bandit problems. Highly regarded examples are Roberts and Weitzman (1981), Battacharya, Chatterjee and Samuelson (1986) and Moscarini and Smith (2001). All those studies apply some sort of Bayesian decision problem where learning from experimentation is involved, to model the innovation process. Closely related research studies the incentive provision in multitask principal-agent frameworks. Holmstrom and Milgrom (1991) deliver some groundwork in this respect, showing that increasing compensation for one task where performance measures are available may be suboptimal because it leads to a reallocation of effort away from other tasks.
Manso (2011) delivers the key theoretical foundation for my study. He embeds a Bayesian Bandit problem with exploration and exploitation into a principal agent framework to deliver key insights on the optimal incentive provision. Manso (2011) shows that in his framework, the optimal contract incentivising exploration and hence innovation either rewards early failure or consecutive, long-term success.

There are only very few empirical studies that can be interpreted in the light of Manso's (2011) model predictions. Probably in closest proximity, Ederer and Manso (2009) conduct a controlled lab experiment studying the choice of participants between explorative and exploitative (computer simulated) business strategies under different incentive schemes. The authors find that indeed schemes that tolerate early failure and promote long-term success best promote explorative activities. Francis, Hasan and Sharma (2011) study the CEO compensation of S&P

400, 500 and 600 firms. The authors find that long-term incentives in the form of options as well as golden parachute arrangements are associated with more innovation output in the form of patents. Further, Azoulay, Graff Zivin and Manso (2011) compare funding streams within academic life sciences and find that funding policies which tolerate early failure and evaluate performance on long time horizons promote creativity in academic research. Finally, Archarya, Baghai-Wadij and Subramarian (2009) study changes in dismissal laws in the US, the UK, Germany and France and find that a higher job-security though more stringent dismissal laws is related to greater innovation output.

In academic management literature, the link between HRM and innovation is often described as "black box" (Laursen and Foss 2003). Hence, popular approach is to group together "systems" of HRM practices and create scores along lines of what is considered "good management" at the time. For instance, Bourke and Crowley (2015) for a cross section of about 1000 firms in Eastern European transition countries create a score for "good management" that is based on i.) high performance incentive provision and ii.) employees' inclusion in the decision-making process. The authors find a strong positive and significant relationship between their HRM score and innovation output. Work by Laursen and Foss (2003), Shipton et al. (2006) and Sidorkin (2015) follows a similar approach.

It is not unfair to say that scarce empirical research on HRM and innovation usually either focuses exclusively on one particular target group, so that a generalisation of results is hardly possible; or lacks any theoretical foundation when defining "good" HRM practices. Finally, to the best of my knowledge there exists no empirical study that tries to test theoretical prediction in the context of developing countries.

3. THEORY

The following section introduces a consistent theoretical model, outlining the incentive issues behind firm-level innovation in the course of a principal-agent framework. This section provides the key theoretical insights to derive testable predictions for my subsequent empirical analysis. In essence, I show that HRM practices motivating innovation differ widely from standard pay-for-performance schemes. For the most part, my framework reproduces the work by Manso (2011). I restructure his extensive game-theoretical analysis with an individual focus on

incentivising "moderate" exploration in a principal-agent framework where exploitation constraints are binding for the agent. Further, own extensions will add additional insights with respect to *Corporate Culture* as well as employee *Empowerment* and innovation. Theoretical propositions derived in the following are at no point specific for developing countries, ensuring the comparability of potential following empirical studies drawing on this framework.

The structure reads as follows: First I elaborate on the relationship between exploration and innovation and the role of *Corporate Culture*. Then, I introduce the two-armed Bandit problem, illustrating the individual decision problem between exploration and exploitation. Third, I show how the individual decision problem can be embedded in a principal-agent framework. Within this framework I then finally examine how exploration can be incentivized though *Rewarding Long-Term Success (RLTS), Termination* and *Empowerment.*

3.1 Exploitation, Exploration and Innovation

Exploitation and exploration are the two concepts at the heart of my theoretical analysis. There is ample academic literature relating the two terms to innovation in various, often quite inconsistent ways (for an overview see Li, Vanhaverbeke and Schoenmakers 2008). However, it was the seminal work by March (1991) that set the groundwork for how to use both concepts in organisational literature to this date. He relates exploitation to terms such as refinement, selection and implementation, whereas exploration is related to activities that are risk-taking, experimenting, flexible and innovative. March (1991) inseparably associates the exploration of new possibilities and untested actions with the Schumpeterian definition of technological innovation as "new combination/allocation of resources (Schumpeter 1912), opposing the exploitation of well-known, "old certainties" supporting the status quo.

Naturally I infer that firms who commit to encourage exploration should show higher innovation output. I capture such loose commitment with the term *Corporate Culture.* My first proposition resulting from purely definitory reasoning can be seen as lemma for the further analysis.

Proposition 1: *A Corporate Culture that encourages exploration has a positive effect on innovation*

3.2 Single-Agent Decision Problem

Having established the relationship between exploration and innovation, I now move to examine the tension between exploration and exploitation in a single-agent decision problem. The decision problem is best modelled by a two-armed Bandit model with one unknown arm. The

use of multi-armed Bandit problems to illustrate the tensions between exploitation vs. exploration dates back to Robbins (1952) and since then found application in various fields, also aside from innovation literature. The general model reads as follows:

An agent lives for two time periods, where in each time period, he can take action $i \in \mathcal{I}$. Taking action i produces output S (success) or F (failure). The probability of producing S when taking action i is p_i and may be unknown. The probability of producing F is $1 - p_i$. The agent learns about p_i in the second period after taking action i in the first period. Nothing is learned about p_i from taking action $j \in \mathcal{I}$ and vice versa, for $j \neq i$.

In the specific model, it is assumed that the agent in each period can either take action 1 and exploit a conventional, known work method or take action 2 and explore a new work method. The probability of success of the conventional method p_1 is known and not affected by the outcome in period one: $p_1 = E[p_1|S,1] = E[p_1|F,1]$. However, the new work method has an unknown probability of producing S such that:

$$E[p_2|F,2] < E[p_2] < E[p_2|S,2]$$

Additionally it is assumed that:

$$E[p_2] < p_1 < E[p_2|S,2],$$

implying that when experimenting with the new work method, the agent has a lower probability of success than when applying the conventional method in the first period. In contrast, updated beliefs about action 2 after a success in period one are higher than the known probability of success of the conventional work method.

Finally, the agent is assumed to be risk-neutral, maximizing his expected payoff R by choosing action plan $\langle i_k^j \rangle$, where $i \in \mathcal{I}$ is the first period action, $j \in \mathcal{I}$ is the second period action after success in the first period and $k \in \mathcal{I}$ is the second period action after a failure in the first period.
Action plan $\langle 1_1^1 \rangle$ denotes exploitation as choosing the conventional work method in both periods independent of success or failure in period one. Action plan $\langle 2_1^2 \rangle$ describes exploration as choosing the new wok method in the first period and changing to the conventional work method in the second period only after a failure in the first period. Hence:

$$R(\langle 2_1^2 \rangle) = \{E[p_2]S + (1 - E[p_2]F\} + E[p_2]\,\{E[p_2|S,2]S + (1 - E[p_2|S,2)F\}$$
$$+(1 - E[p_2])\{p_1 S + (1 - p_1)F\}$$

is the expected payoff from exploration and:

$$R(\langle 1_1^1 \rangle) = 2p_1S + 2(1-p)F$$

is the expected payoff from exploitation.

Therefore, in the single-agent decision model, the agent engages in exploration if:

$$R(\langle 2_1^2 \rangle) \geq R(\langle 1_1^1 \rangle)$$

$$E[p_2] \geq p_1 - \frac{p_1(E[p_2|S,2] - p_1)}{1 + (E[p_2|S,2] - p_1)} \quad (1)$$

I derive three major insights from (1). First, even if the initial expected probability of success of the new work method $E[p_2]$ is lower than p_1, the agent may choose action 2 over action 1 in the first period. The second term on the right-hand side in equation (1) shows a premium v_2 [2] the agent is willing to pay in period one for additional information about p_2 in period two. Second, the higher the expected success of the new work method $E[p_2]$, the more likely the agent engages in exploration. Finally, the agent is willing to forego a higher premium $v_m > v_2$ in the first period by experimenting with the new work method if he lives for multiple periods. Each additional period that the agent enters with knowledge about p_2 adds to the premium on the right-hand side of (1) and hence makes exploration in period one more likely.

3.3 Exploration in a Principal-Agent Framework

In the following, I present how the two-armed Bandit problem can be embedded in a principal-agent framework and consequently how exploration can be incentivized in a game with two players. This step represents Manso's (2011) novel contribution to existing academic literature.
The principal-agent framework builds on the assumptions from the single-agent decision problem. Yet, in addition to exploiting and exploring, the agent can also engage in shirking. Costs $c_1 \geq 0$ incurred when exploiting and $c_2 \geq 0$ when exploring can be avoided by shirking, yet at the cost of a lower probability of success $p_0 < E[p_i]$ for $i = 1, 2$. Now I assume that a risk-neutral principal offers an agent with limited liability a wage contract $\vec{w} = \{w_F, w_S, w_{SF}, w_{SS}, w_{FF}, w_{Fs}\}$, depending on the agent's performance path (performance in period one and two). The principal's

[2] $v_2 = \frac{p_1(E[p_2|S,2] - p_1)}{1 + (E[p_2|S,2] - p_1)}$

main objective is to maximise her expected profit $\Pi(\langle i_k^j \rangle)$, depending on the action plan chosen by the agent. Exploration is preferred over exploitation if $\Pi(\langle 2_1^2 \rangle) > \Pi(\langle 1_1^1 \rangle)$.

$W(\vec{w}, \langle i_k^j \rangle)$ is the agent's total wage income with:

$$W(\vec{w}, \langle 2_1^2 \rangle) = E[p_2]w_S + (1 - E[p_2])w_F + E[p_2]E[p_2|S,2]w_{SS} + E[p_2](1 - E[p_2|S,2])w_{SF}$$
$$+(1 - E[p_2])p_1 w_{FS} + (1 - E[p_2])(1 - p_1)w_{FF}$$

denoting the income after exploration. Together with the total costs $C(\langle i_k^j \rangle)$ incurred by the agent and:

$$C(\langle 2_1^2 \rangle) = c_2 + E[p_2]c_2 + (1 - E[p_2])c_1,$$

the expected costs after engaging in exploration, we can describe the agent's net utility as $\Delta\left(W(\vec{w}, \langle i_k^j \rangle), \mathrm{C}(\langle i_k^j \rangle)\right)$. The net utility after exploration is:

$$\Delta\big(W(\vec{w}, \langle 2_1^2 \rangle), \mathrm{C}(\langle 2_1^2 \rangle)\big) = E[p_2]w_S + (1 - E[p_2])w_F + E[p_2]E[p_2|S,2]w_{SS} +$$
$$E[p_2](1 - E[p_2|S,2])w_{SF} + (1 - E[p_2])p_1 w_{FS} + (1 - E[p_2])(1 - p_1)w_{FF}$$
$$-(c_2 + E[p_2]c_2 + (1 - E[p_2])c_1)$$

3.4 Incentivizing Exploration in a Principal-Agent Framework

Building on the analysis so far, a contract that incentivizes exploration satisfies the following incentive compatibility constraints (ICs):

$$\Delta\big(W(\vec{w}, \langle 2_1^2 \rangle), \mathrm{C}(\langle 2_1^2 \rangle)\big) \geq \Delta\left(W(\vec{w}, \langle i_k^j \rangle), \mathrm{C}(\langle i_k^j \rangle)\right). \quad \left(IC_{\langle i_k^j \rangle}\right) \tag{2}$$

This is a system of equations with 27 (3^3) constraints and six unknowns. Two assumptions are introduced that facilitate the solving process for (2) and further allow for the interpretation of results in the light of my subsequent empirical analysis.

Assumption 1: Incentive compatibility constraints associated with exploitation are binding. This means situations where exploitation is too costly relative to exploration and the principal only considers ICs related to shirking are not considered.

Assumption 2: The likelihood of two consecutive successes relative to the likelihood of a failure in the first period is higher for exploration than for exploitation.[3] This is a technical assumption, restricting the solution space in the following. Manso (2011) calls this situation *moderate exploration* because the likelihood of failure of the new method in the first period is relatively moderate compared to the likelihood of failure of the conventional method.

Under these assumptions, the optimal wage contract has the following properties:

- $w_S = w_{SF} = w_{FF} = 0$

From (2) it can be demonstrated that $w_S = w_{SF} = w_{FF} = 0$. Suppose that $w_S > 0$ and $\vec{w}'$ is similar to $\vec{w}$ except that $w'_S = 0$ and $w'_{SS} = w_S + E[p_s|S,2]w_{SS} - \varepsilon$. It can be shown that there always exists an $\varepsilon > 0$ such that all $IC_{\langle i^j_k \rangle}$ in (2) are satisfied. The explanation for w_{SF} and w_{FF} follow a similar logic.[4] Intuitively, an interplay of three concepts explains these findings: First, rewarding success in period one incentivizes the agent to employ the conventional work method because $p_1 > E[p_2]$. Second, failure in period two is not rewarded because it incentivizes the agent to shirk. Third, delaying compensation provides additional information about actions taken in period one (through updated beliefs about p_2).

- $w_{FS} = \frac{c_1}{p_1 - p_0}$

From $w_S = w_{SF} = w_{FF} = 0$ it can be shown that out of the initial 27 ICs, only 4 are binding (see Manso 2011, Appendix for an elaboration). Those are: $IC_{\langle 2^2_0 \rangle}$, $IC_{\langle 0^0_1 \rangle}$, $IC_{\langle 0^1_1 \rangle}$ and $IC_{\langle 1^1_1 \rangle}$. As apparent, the first three ICs are associated with shirking whereas the last one concerns exploitation. From:

$$(p_1 - p_0)w_{FS} \geq c_1 \qquad \left(IC_{\langle 2^2_0 \rangle}\right)$$

it follows that $w_{FS} = \frac{c_1}{p_1 - p_0}$. Hence, a compensation of success in the second period, even after failure in period one is necessary to prevent the agent from shirking.

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[3] $\frac{E[p_2]E[p_2|S,2]}{p_1^2} \geq \frac{1 - E[p_2]}{1 - p_1}$

[4] See Manso (2011, Appendix)

- $w_{SS} > w_{FS} > 0$

We can solve the remaining programme consisting of $IC_{\langle 0_1^0 \rangle}$, $IC_{\langle 0_1^1 \rangle}$ and $IC_{\langle 1_1^1 \rangle}$ for w_{SS} and obtain

$$w_{SS} = \alpha + \frac{p_1 - p_0}{E[p_2]E[p_2|S,2] - p_0\, p_1} \cdot \frac{p_1(1 + E[p_2])c_1}{E[p_2]E[p_2|S,2] - p_1^2} \cdot \left(\frac{c_2}{c_1} - \beta\right)$$

with:

$$\alpha = \frac{1 + E[p_2]c_2 - p_0 c_1}{E[p_2]E[p_2|S,2] - p_0 p_1} + \frac{(E[p_2] - p_0)p_0 c_1}{(E[p_2]E[p_2|S,2] - p_0 p_1)(p_1 - p_0)}$$

$$\beta = \frac{(E[p_2]E[p_2|S,2] - p_0 p_1) + E[p_2](p_1 E[p_2|S,2] - p_0 p_1)}{(p_1^2 - p_0 p_1) + E[p_2](p_1^2 - p_0 p_1)}$$

We find that $w_{SS} > w_{FS} > 0$. In addition to preventing the agent from shirking, the principal has to provide incentives through w_{SS} that keep the agent from exploiting in period one (and period two after success in period one). Following the analysis, the latter incentives are exclusively provided through rewarding two consecutive successes. Manso (2011) points out that if *Assumption 1* does not hold and the likelihood of two consecutive successes is relatively low, failure in the first period may serve as better signal for the agent's exploration activities and hence it is cheaper for the principal to incentivize exploration through w_F. Yet, for practical reasons with view to my empirical analysis, I stick with my assumptions so far and infer: $w_F = 0$.

I conclude that to incentivize exploration in a principal agent setting, first period (short-term) success is not rewarded. Instead, it is optimal to provide incentives solely thorough rewarding consecutive (long-term) success.

***Proposition 2**: Rewarding Long-Term Success has a positive effect on innovation*

3.5 Commitment

In the analysis so far, I assumed that the principal can credibly commit to her reward structure of choice. Such commitment can be of explicit (i.e. stock options) or implicit (i.e. employer reputation) nature. In the basic model, a lack of commitment to rewarding consecutive success calls for the introduction of short-term contracts instead (rewarding performance after each period). Two scenarios are possible:

If $\frac{c_2}{c_1}$ is relatively high, it can be shown that there is no short-term contract that incentivises exploration. The key intuition here is that rewarding short-term success always results in exploitation because the conventional method comes with a higher probability of success.

Whereas rewarding failure results in shirking because it is not only cheaper but also has a higher probability of failure.

If $\frac{c_2}{c_1}$ is relatively low, there exists a short-term contract that incentivizes exploration. However, this contract is always more expensive to implement for the principal. The key intuition here is that the principal misses out on information about the first period action if she cannot wait for the agent's second period choice before rewarding.

Proposition 2.1*: Commitment to rewarding long-term success increases the positive effect on innovation*

3.6 Termination

In the following, the principal has the possibility to terminate the agent after failure in the first period. This is an extension of the basic principal-agent framework introduced above. The agent now chooses his action plan with termination $\langle i_t^j \rangle$ with respect to the compensation plan $\vec{w}^t$. When trying to implement exploitation, termination comes in handy for the principal. As suggested by ample academic literature, termination serves as additional tool to elicit effort in a standard work-shirk model and hence lets the principal implement exploration at smaller costs (cf. Stiglitz and Weiss 1983).[5] The case is different when trying to incentivise exploration:
Action plan $\langle 2_t^2 \rangle = \langle 2_0^2 \rangle$ constitutes exploration with termination, assuming the agent's outside wage after termination is zero.[6] Hence the optimal contract has to satisfy the following IC programme:

$$\Delta\big(W(\vec{w}, \langle 2_0^2 \rangle), \mathrm{C}(\langle 2_0^2 \rangle)\big) \geq \Delta\left(W\big(\vec{w}, \langle i_k^j \rangle\big), \mathrm{C}\big(\langle i_k^j \rangle\big)\right) \tag{3}$$

As in the basic model, I assume that exploration is moderate and further that exploitation constraints are binding.

Hence the optimal wage contract has the following properties:

- $w_{FF} = w_{FS} = w_s = w_{SF} = 0$

To begin with, $w_{FF} = w_{FS} = 0$. Resulting from the very definition of termination, the agent will not receive a payment after failure in the first period. Second, the reasoning for $w_s = w_{SF} = 0$ closely follows the reasoning from the basic framework.

[5] Assuming the cost of termination for the principal is marginally small
[6] And hence is the same as his expected income after shirking

- $w_{SS}^{t} > w_{SS}$

The analysis for w_{ss}^{t} is similar to the analysis for w_{SS} in the basic model. Yet under my baseline parameter assumption we find that $w_{SS}^{t} > w_{SS}$ (see Derivation 1, Appendix). Intuitively, the agent faces additional incentives to exploit the conventional method in period one because of the threat of termination after failure and the following wage loss in period two. Additionally, incentivizing exploration through w_{FS} becomes unavailable for the principal. Consequently, incentives are shifted towards exploitation and have to be counteracted by the long-term compensation plan incentivizing exploration through rewarding consecutive success, making exploration with termination relatively more expensive. In this sense, Manso (2011) shows that the optimal compensation plan promoting innovation under my baseline parameter assumptions abstains from excessive termination.

Proposition 3: *Excessive Termination has an adverse effect on innovation.*

I find it important to stress that all my inferences so far result from an analysis under my baseline assumptions. While all previous propositions hold even when loosening the grip of such assumptions,[7] the case is different for the analysis of termination. In fact, it can be shown that if exploration is relatively cheap and hence shirking constraints (as opposed to exploitation constraints) are binding, excessive termination provides additional incentive fostering first period exploration (instead of shirking) and hence innovation (see Derivation 2, Appendix).

3.7 Empowerment

In a final step, I want to present the theoretical implications of employee empowerment for my basic model outcomes. The following analysis extends Manso (2011) and naturally builds on the model so far. In organisational literature there already exist various different theoretical frameworks modelling empowerment. A common example is the task-involvement theory. It suggests that empowerment implies involving the agent more in the task he is performing. Task-involvement increases intrinsic motivation, which can be modelled as a lower disutility of effort when performing the task (Staw 1989, Murdock 2002).

I use a more straightforward interpretation of empowerment in the light of my baseline parameters. Following Cunningham, Hyman and Baldry (1996), I define empowerment as inclusion of lower-tier employees in the decision-making process in a way that workers "become

[7] Yet requiring a more comprehensive analysis which does not add any valuable insights for my reasoning.

active problem solvers". In the context of my model, empowerment encourages the agent to choose a new work method out of a set of possible new actions, while the conventional work method is defined as before. The agent chooses $n \in \aleph$ with $\aleph \subseteq \mathcal{I}$. This is an extension of my baseline situation, which can be thought of as a principal presenting the agent with the new work method (action 2), initiating the agent's decision problem.

I first analyse empowerment in the single-agent decision problem. With the new work method as endogenous choice parameter, the agent's exploration payoff function reads as follows:

$$\max_{n\in\aleph}(R\langle n_1^n\rangle) = \{E[p_n]S + (1 - E[p_n]F\} + E[p_2]\,\{E[p_n|S,n]S \\ +(1 - E[p_n|S,n)F\} + (1 - E[p_n])\{p_1S + (1 - p_1)F\} \qquad (4)$$

I further assume relative consistency in ranked probabilities – for the expected probability of success and updated beliefs, such that if $E[p_n] \geq E[p_2]$ then $E[p_n|S,n] \geq E[p_2|S,2]$ and vice versa. This does not necessarily need to be the case in practice. However, I consider it a quite reasonable assumption, that further facilitates the reasoning in the light of my model so far. Resulting from (4) and with respect to equation (1) it can be shown that $E[p_{n^*}] \geq E[p_2]$ and/or $E[p_{n^*}|S,n^*] \geq E[p_2|S,2]$. The former expression naturally shows that under empowerment, the likelihood of exploration increases. The latter expression indicates that empowerment increases the premium v_{n^*}[8] ($\frac{\partial v_n}{\partial E[p_n|S,n]} > 0$) the agent is willing to forego in period one and consequently in turn also the likelihood of exploration.

For the principal-agent model I assume that the cost of experimentation is independent of the specific new work method n chosen by the agent and hence: $c_2 = c_{n^*}$. It is easily shown that $\frac{\partial w_{ss}}{\partial E[p_2]} < 0$ and $\frac{\partial w_{ss}}{\partial E[p_2|S,2]]} < 0$. It follows that $w_{SS}^{n^*} \leq w_{ss}$ and $w_{FS} = w_{FS}^{n^*}$. Therefore, empowerment facilitates the principal's incentive provision for exploration.

Proposition 4: *Empowerment has a positive effect on innovation*

[8] $$v_{n^*} = \frac{p_1(E[p_{n^*}|S,n^*] - p_1)}{1 + (E[p_{n^*}|S,n] - p_1)}$$

4. DATA

For my empirical analysis I use survey data from two sources: The 2013/14 Enterprise Survey (ES) and 2013/2014 Innovation Follow Up Survey (IFS) conducted by the World Bank.[9]

The World Bank Enterprise Survey provides firm-level data for more than 135,000 establishments in 139 countries.[10] Multi-topic firm-level survey data is collected to create more than 100 indicators, benchmarking the business environment for firms around the globe. Important for my study, the ES contains a section where nine questions related to innovation activities are asked in the style of the OECD Community Innovation Survey (CIS).[11]

Most countries are visited in a 3 to 4 years cycle. To enable comparison across countries and years, a universal methodology is used when conducting the ES. The firm samples are selected using stratified random sampling by firm-size, sector and location to obtain a representative sample of a country's formally registered, non-agricultural and non-mining economy. The surveys are usually answered by business owners and top managers. Typically, about 1,200 - 1,800 interviews are conducted for large economies and about 360 (150) for medium (small) sized economies. The key business sectors of interest are the manufacturing and service sector, where formally registered firms with more than 5 employees are the key target group. A histogram of my full firm sample with respect to firm size (micro, small, medium and large) can be found in Figure A 1. Fully state-owned enterprises are excluded from the ES.

I use a cross section of the 2011-2014, survey data on more than 23,000 enterprises in 18 different developing countries, namely: Bangladesh, Congo DRC, Ethiopia, Ghana, India, Kenya, Malawi, Namibia, Nepal, Nigeria, Pakistan, Rwanda, South-Sudan, Sudan, Tanzania, Uganda, Zambia and Zimbabwe. India (9,281), Nigeria (2.664) and Bangladesh (1,442) account for more than half of all observations in my ES sample.

In all those countries in 2013/14[12], some firms were revisited in the course of the World Bank Innovation Follow Up Survey to obtain more detailed information on innovation and innovation related activities. The IFS counts over 11,100 enterprises in total. The firms were randomly selected based on geography and industry weights in the ES.[13] Furthermore, questions in the

[9] For a small subsample of ("pilot"-) countries, the Innovation Follow Up survey was conducted already in 2011, which is why in those cases I also use the preceding 2011 Enterprise survey.

[10] For more information visit: http://www.enterprisesurveys.org

[11] For more information visit: http://ec.europa.eu/eurostat/web/microdata/community-innovation-survey

[12] The pilot-countries Ethiopia, Rwanda and Zimbabwe are revisited in 2012.

[13] Fort Ethiopia, Rwanda and Zimbabwe, the three pilot-countries surveyed already in 2011, the sampling strategy is different and the IFS dataset here is not nationally representative.

Innovation Follow Up Survey are asked for two different, consecutive time periods preceding the survey date. The IFS for all countries (except the three 2011 "pilot" – countries Ethiopia, Rwanda and Zimbabwe) in addition to a catalogue of questions on innovation activities contains a "Management" section, where business owner and managers of firms with 20+ employees (medium and large enterprises) are asked to elaborate on firm-level HRM practices. A description of all variables generated from ES and IFS responses can be found in Table 1.

My data situation is subject to obvious limitations along three dimensions. First, disadvantages accompanying the use of survey data such as errors in subjective responses have to be taken into account in the subsequent empirical analysis. A critical view on this issue can be found in the Discussion section. Further, the use of survey questions to approximate theoretical predictions requires sound and consistent economic reasoning preceding the generation of my key dependent and independent variables. The Methodology section outlines my best attempt in this respect. Third, using naturally occurring data, the variation in incentive schemes is not exogenous and hence the coefficient estimates are likely inconsistent. This matter has to be addressed with the utmost care throughout the entire empirical analysis.

Table 1. Variable Descriptions

Dependent Variables – Innovation Output	
Product Innovation (ES)**	= 1 if firm introduced new*** or significantly improved product or service in last 3 years preceding ES, 0 otherwise
Product Innovation (IFS)	= 1 if firm introduced new or significantly improved product or service in last two financial years preceding IFS, 0 otherwise
Process Innovation (ES)	= 1 if firm introduced new or significantly improved i.) method of manufacturing product / offering service or ii.) logistics, delivery or distribution method for inputs, products and services in last 3 years preceding ES, 0 otherwise
Process Innovation (IFS)	= 1 if firm introduced new or significantly improved i.) method of manufacturing product / offering service or ii.) logistics, delivery or distribution method for inputs, products and services in last 2 financial years preceding IFS, 0 otherwise
Independent Variables – HRM Practices	
Corporate Culture (ES)	= 1 if during last three years, establishment gave employees some time to try out/develop new ideas/approaches about products/services/processes, 0 otherwise
Time-Frame / RLTS (IFS)	Time frame of production targets*
	1. Long-term = RLTS = 1 if more than one year, 0 otherwise
	2. Short-term = 1 if one year or less, 0 otherwise
	3. Combinational = 1 if combination of long- and short-term, 0 otherwise
Bonus (IFS)	= 1 if firm uses performance bonus based on production targets
Termination (ES)	Ability to dismiss reluctant workers x number of permanent employees/total employees in first quintile
Empowerment (IFS)	Log. number of employees reporting directly to top manager*
Hierarchy (IFS)	Log. layers of direct reporting from top manager to lowest level employee
Independent Variables – Auxiliary Controls	
R&D (ES)	= 1 if firm has invested in Research and Development in the past 3 years, 0 otherwise
R&D (IFS)	= 1 if firm has conducted internal or external R&D in last 2 financial years preceding IFS, 0 otherwise
Employees (ES)	Log. total number of (permanent + temporary) employees
State-owned (ES)	= 1 if firm is partly state-owned, 0 otherwise
Multi-plant (ES)	= 1 if establishment is part of larger firm, 0 otherwise
Distress (ES)	Firms output as proportion of maximum capacity utilization*
City (ES)	Population of locality
	1. Small = 1 if population < 50,000
	2. Medium = 1 if 50,000 ≤ population < 250,000
	3. Large = 1 if 250,000 ≤ population < 1m
	4. Metropolitan = 1 if population ≥ 1m
	5. Capital = 1 if city is official capital city
	6. Business = 1 if city is main business city
Industry (ES)	Main product/service 4-digit ISIC code
Country (ES)	Country in which establishment resides
Year (ES/IFS)	Year the ES/IFS was conducted

* During preceding financial year

** Origin of survey responses denoted in parenthesis

*** New here means new to the establishment, not necessarily new to the market

Table 2. Summary Statistics: Innovation and HRM Measures

VARIABLES	N	Mean	SD	Min	Max
Product Innovation (ES)	23,270	0.476	0.499	0	1
Product Innovation (IFS)	11,100	0.483	0.500	0	1
Process Innovation (ES)	22,512	0.572	0.495	0	1
Process Innovation (IFS)	11,094	0.499	0.500	0	1
Corporate Culture	23,152	0.430	0.495	0	1
RLTS (Long-Term Prod. Targets)	4,898	0.283	0.450	0	1
Short-term Prod. Targets	4,898	0.277	0.448	0	1
Combinational Prod. Targets	4,898	0.440	0.496	0	1
Performance Bonus	4,895	0.255	0.436	0	1
Termination	9,074	0.146	0.353	0	1
Distress	12,791	76.77	20.46	0	100
Empowerment	5,439	2.023	0.869	0	8.007
Hierarchy	5,352	1.587	0.599	0	6.989

5. METHODOLOGY

The next section leads through the key methodological framework and is organised as follows: First, I introduce the groundwork for my identification strategy. This is followed by an elaboration on the two dependent variables of interest, product and process innovation. Then I present an extensive discussion on special characteristics and methodological peculiarities for each individual HRM practice. Finally, I describe the set of control variables used across all specifications.

My identification strategy exploits variation in survey responses with respect to HRM practices and relates it to differences in reported innovation output. Estimating an innovation production function (cf. Geroski 1990; Harris and Trainor 1995), I apply a linear probability model (LPM) of the following form:

$$I_i = F_i + E_i + \beta HRM_i + sic_i + c_i + y_i + \varepsilon_i$$

where I_i captures my innovation output measure and HRM_i denotes the HRM practice of interest for firm i. F_i and E_i represent my auxiliary control vectors for firm characteristics and external business environment. Further $isic_i, c_i$ and $y_i$denote industry, country and year fixed effects (FE) and ε_i is the error term. For the ease of interpretation, I use an LPM as opposed to a conditional

logit specification (cf. Hellevik 2007). A discussion on the implications of this choice can be found in the Robustness section. Further, to account for heteroscedasticity in LPMs, I use robust standard errors across all specifications and cluster at the industry level (cf. Long and Ervin 2000). Finally, I condition on country, industry and year fixed effects. [14]

5.1 Dependent Variables

My empirical examination features a novel coverage of innovation output by separately analysing the effect of HRM practices on product and process innovations. In academic research, the OECD Oslo Manual (2005) constitutes the primary, international basis for identifying, assessing and classifying innovation at firm level (Gunday et al. 2011). The ES as well as the IFS follow the definitions suggested by the Oslo Manual, which allows me to classify my innovation measures in accordance with academic standards.

The distinct examination of product and process innovation in the following is of crucial importance, because based on my theoretical model I suspect that for some HRM practices, different workers may face different incentive constraints depending on the type of innovation, affecting magnitude and even sign of the identified relationship.

Aside from differences between my two innovation measures, I also want to draw attention to potential differences across the two surveys. First, as presented in Table 1, the survey responses cover slightly different time periods depending whether they are obtained from ES or IFS data. Additionally, considering that in the course of the IFS, some countries were visited as late as one year after the ES took place, the different time periods covered by both surveys diverge even more. Second, while both surveys follow the exact wording of the OECD Oslo manual, asking for "new or significantly improved" products/processes, there is still reason to believe that respondents answers may differ in one or the other context. One possible factor is survey fatigue in the ES, where the innovation question appears about half way through a catalogue of 190 questions in total. [15] In comparison, in the IFS the question concerning innovations appears at the very beginning of the, relatively short questionnaire. Further, even though in about 80% of cases, the same individual answers to the ES and the following IFS, the remaining 20% may have different views on what the "right" answer to the question is. This of course is reinforced by the highly subjective character of such a statement. Table A 2. suggests that responses indeed differ

[14] Reference year will be either the year the ES or the IFS was conducted, depending on the source of the HRM measure of interest.

[15] cf. Bertrand and Mullainathan 2001

in one or the other survey context, at least to some extent. I decide that an adequate matching of time-periods covered by survey responses trumps the convenience of greater comparability through uniform origination and hence use the survey response that matches the source of the HRM measure of interest to generate my innovation measure for each specification. In addition, this way I group responses on innovation and HRM practices from the same respondents. Summary statistics of all dependent variables can be found in Table 2.

The product innovation measure denotes whether a firm has introduced any new or significantly improved products or services. This is the most commonly used and widely accepted concept for measuring firm-level innovation output (OECD 2005, Griffith et al. 2008, Masso and Vahter 2008, Roper, Love and Du 2008). The idiosyncrasy of this measure with respect to my theoretical framework is twofold: First, product innovations are usually subject to relatively long time horizons due to underlying research and testing periods. Second, I expect expertise about success or failure of product innovations to be mainly found in research departments and or middle/top management levels as opposed to for instance low-tier production levels, naturally assuming that availability and evaluation of data on past success and failure is indispensable for building up such expertise. Findings by Roper, Du and Love (2008) about the knowledge utilisation capacity within companies support this view. The authors find a significant and positive relationship between employing more workers "with degree" and "having an R&D department" and product innovation. No such relationship is identified for employees "with no qualification".

Process innovation is my second innovation output measure and defined as a new or significantly improved way of manufacturing products/offering services or a new or significantly improved logistics or distribution method. The study of process innovation output has been widely neglected by economic literature (cf. Rosenberg 1982, Reichstein and Salter 2006). Process innovation has long been considered the "dull and unchallenging cousin of the more glamorous product innovation" (Reichstein and Salter 2006), despite its undisputable importance for firm-level productivity and growth (Cabral and Leiblein 2001). Compared to product innovations, process innovations should be implementable on shorter time scales because time consuming test phases and bureaucratic obstacles do not apply here to the same extend.[16] Further I expect development of process innovation to require both, the expertise of low-tier production workers and management level employees. Again, findings by Roper, Du and Love (2008) deliver some

[16] Such as product registration or (for the most part) patent applications.

empirical support for this assumption. In contrast to product innovation, the authors do not identify a significant relationship for "having an R&D department" and process innovation. Furthermore, and vey interestingly, the authors find a significant inverse relationship between employing more workers "with degree" and process innovation.

5.2 Independent Variables – HRM Practices

In the following I will elaborate on how I construct my key independent variables from survey responses and how those variables are used to identify the relationship between HRM practices and innovation.

Throughout the analysis, I consider responses for time periods closest to the actual survey date. This mitigates response biases but of course comes at the expense of ignoring potential lagged impacts. Summary statistics for all variables introduced in the following can be found in Table 2. It is important to note that two of my HRM measures are sourced from ES and two from ISF responses. As mentioned in the Data section, this implies different minimum firm sizes for ES (all sizes) and IFS (20+ employees) data. For the sake of exploiting the maximum variation in survey responses while obtaining the largest possible samples for my estimations, I deliberately decide against restricting my firm samples to firms with 20+ employees. A discussion on this matter can be found in the Robustness section.

The groundwork of my analysis is taking a broad perspective on HRM and innovation, examining whether a *Corporate Culture* that fosters exploration promotes firm-level innovation output. This will be followed by a more nuanced analysis of the underlying drivers derived from theory. First, I apply insights from the basic model and investigate the effect of *Rewarding Long-Term Success* on innovation. Then, *Termination* and *Empowerment* are introduced as two extensions of the basic framework.

Corporate Culture (ES)

The key presupposition of my theoretical framework states that exploration leads to innovation. Hence, I set the foundation for my further analysis by investigating whether firms that claim to directly encourage exploration show higher innovation output. The ES provides me with a question, asking whether the establishment "gives employees time to develop or try out new approaches or ideas about product/services or business processes". Survey responses here serve as an excellent approximation of what I define as a *Corporate Culture* that encourages or discourages exploration.

Corporate Culture in general can be defined as a "pattern of shared values and beliefs that helps people understand […] the norms for behaviour in the organisation" (Déshpandé and Webster 1989). Manso (2017) states that a *Corporate Culture* that fosters exploration "gives employees freedom and time to develop new ideas".

My estimation strategy is very straightforward. I include *Corporate Culture* as dummy variable for both innovation measures separately, while conditioning on my full set of auxiliary control variables.

Reward Structure (RLTS) (IFS)

My theory section suggests that *Rewarding Long-Term Success (RLTS)* is a key distinctive feature for incentivizing exploration and hence innovation. I use IFS responses about the time frame of firm-level production targets to create my *RLTS* dummy variable indicating the application of long-term (more than one year) production targets (as opposed to short-term / a combination of long-term and short-term targets). Further, in accordance with economic theory, I assume a strong commitment to rewarding target achievement to increase the effect associated with time frames for production targets. Hence, from IFS responses I create an indicator denoting whether firms apply a performance bonus system which is based on production targets.

The first regression specification includes the RLTS dummy as HRM practice of interest and treats firms with short-term or combinational targets as baseline. Consequently, assuming some commitment to rewarding the achievement of production targets, I identify the relationship between rewarding long-term (consecutive) success and innovation output.

In a second specification, an interaction term – for *RLTS* x performance bonus – is added to the estimation framework. In doing so, it is investigated whether a self-reported commitment to actually reward target achievement (short- or long-term) alters the identified relationship.

Termination (ES)

Following my theoretical model, early *Termination* of an employment contract can be seen as an additional tool to incentivize or disincentivize exploration and hence serves as an extension of the basic framework. ES responses allow for the construction of a proxy variable determining "excessive *Termination"* (Manso 2011) along two dimensions: First, I use survey responses indicating whether or not firms "are able terminate or fire" workers if they "feel like those employees are redundant". – This question only appears in the 2013/2014 ES questionnaire for India, which restricts my empirical analysis of *Termination* to the subsample of 9,281 Indian firms.

Second, I use the permanent (as opposed to temporary) to total number of employees ratio to approximate not only firms' perceived ability, but also their practical application of early *Termination.* The total number of employees is calculated as the sum of temporary plus permanent, full-time employees. A temporary employee is defined as a full-time worker who is "being payed short term (i.e. less than a year)" with "no guarantee of renewal of contract employment". I create a binary variable indicating excessive *Termination* if i.) firms are able to terminate employees they perceive as redundant, whilst ii.) firms' permanent employee ration is below the first quintile of the probability distribution across my full sample of firms. The Robustness section will feature a discussion on different thresholds for the permanent employee ratio. As apparent from my definition of excessive *Termination*, "low job security" could be used as terminology interchangeably.

In addition to the suggestion from my theoretical model, I construct my *Termination* variable following Acharya, Baghai-Wadij and Subramanian (2013) who find that stringent labour laws that restrict the dismissal of employees encourage innovation. Further, Ederer and Manso (2013) in a laboratory experiment find that subjects facing threat of dismissal in case of early failure engage less in exploration activities.

Naturally, an important factor that determines *Termination* and hence might bias my estimation is the degree of financial distress a company finds itself in during the surveyed period. Hence, I create an approximation from ES responses, denoting firms' output as proportion of the maximum possible capacity utilisation. Indeed, correlational evidence shows that my *Termination* dummy is negatively related to firm's capacity utilisation ($Corr. \approx -0.08$), suggesting a within group comparison.

My key specification then separately regresses the two innovation measures on the *Termination* dummy variable, conditioning on financial distress and my full set of auxiliary control variables.

Empowerment (IFS)

My second extension of the basic framework considers employee *Empowerment* as an HRM practice encouraging innovation through the inclusion of employees in the decision-making process. I use the logarithm of IFS responses on "the number of employees who report directly to the establishment's top manager on a regular basis" to approximate firm-level *Empowerment*. This definition captures two important characteristics of *Empowerment* emphasised by academic literature. Lashley and McGoldrick (1994) state that *Empowerment* as a strategic HRM practice should be focused on those workers in closest proximity to the market outlets (usually lower-

level employees). Additionally, Cunningham, Hyman and Baldry (1996) specify that *Empowerment* implies the inclusion of a broader range of workers, encouraging the input of "everybody" in the decision-making process. The latter definition closely resembles the character of employee *Empowerment* as introduced in my model section.

Additionally, from IFS data I create a variable approximating firm-level *Hierarchy*, capturing the logarithm of "the layers of direct reporting […] from the top manager down to the lowest-level of employee". Considering *Hierarchy* in the context of *Empowerment* and innovation is interesting for two reasons. First, the hierarchical structure in an establishment naturally determines employee *Empowerment*, calling for a within-group comparison. Second, I expect more "layers of direct reporting" to indicate a situation with less employees per supervisor and consequently a higher level of monitoring. Even though not specifically highlighted in the Model section, insights about the relationship between innovation and monitoring as well as its joint determination with *Empowerment* nicely extend and lend additional support to findings in this section.

The final specification then separately regresses the two innovation measures on my *Empowerment* variable, conditioning on firm-level *Hierarchy* and the full set of control variables.

5.3 Auxiliary Control Variables

In my estimation framework, I consider auxiliary firm characteristics determining innovation output, namely R&D propensity, ownership, size, age and whether or not the establishment belongs to a multi-plant firm. All firm-level characteristics are obtained from ES responses. I expect all control variables (except for R&D propensity) to be very consistent over time, which is why I do not hesitate to use them across specification, independent of the source of my HRM measure. R&D propensity is additionally obtained from the IFS and used, matching the source of my HRM and innovation measures interchangeably. Summary statistics of all auxiliary controls can be found in Table A 1.

First, a firm's propensity to invest in R&D intuitively constitutes a crucial innovation input and finds ample coverage in academic literature (cf. Crépon, Duguet and Mairesse 1998; Mairesse and Mohnen 2005; Roper, Du and Love 2008). Second, establishments that are part of a firm with multiple plants are expected to face different cost structure when it comes to the adaption of new technologies, compared to single-plant establishments (Stoneman 1983, Jensen 2004). Third, state-ownership has been proven to play a significant role in determining innovation output, yet with conflicting theoretical and empirical evidence (cf. Aghion, Van Reenen and Zingales 2013;

Jefferson et al. 2008; Li and Xia 2008). Fourth, following suggestion by Huergo and Jaumandreu (2004) and Bourke and Cowley (2015), I include the years since a firm started business as well as the logarithm of total full-time employees to approximate the impact of firm age and firm size on innovation generation.

The local business environment vector controls for external inputs in my innovation production function. Audretsch and Feldmann (1996) as well as McCann and Simonen (2005) suggest that local labour market spill-overs, particularly knowledge-sharing and R&D spill-overs substantially drive firm-level innovation output. Therefore, I include a variety of dummy variables capturing the characteristics of a firm's local business environment in my estimation frameworks, such as city size dummies, whether or not the city is a capital city and whether or not the city is the country's main business city.

Table 3. Estimation Results – HRM and Innovation

VARIABLES	(1) Product Innovation (ES)	(2) Product Innovation (IFS)	(3) Product Innovation (IFS)	(4) Product Innovation (ES)	(5) Product Innovation (IFS)
Corporate Culture	0.231***				
	(0.00840)				
RLTS		0.0298*	0.0420**		
		(0.0153)	(0.0184)		
RLTS x Bonus			-0.0478		
			(0.0362)		
Bonus			-0.0107		
			(0.0222)		
Termination				-0.0552***	
				(0.0186)	
Empowerment					0.0385***
					(0.0129)
Hierarchy					-0.0134
					(0.0160)
R&D	0.196***	0.188***	0.182***	0.333***	0.176***
	(0.0120)	(0.0167)	(0.0176)	(0.0216)	(0.0165)
Constant	0.268***	0.482***	0.264***	-0.0401	0.457***
	(0.0682)	(0.0858)	(0.0763)	(0.0592)	(0.0843)
Observations	20,985	4,378	4,005	6,942	4,742
R-squared	0.198	0.199	0.210	0.218	0.196
Distress	No	No	No	Yes	No
Aux. Controls	Yes	Yes	Yes	Yes	Yes
Country, Year, Industry FE	Yes	Yes	Yes	Yes	Yes

VARIABLES	(6) Process Innovation (ES)	(7) Process Innovation (IFS)	(8) Process Innovation (IFS)	(9) Process Innovation (ES)	(10) Process Innovation (IFS)
Corporate Culture	0.342***				
	(0.0103)				
RLTS		-0.0321**	-0.0348**		
		(0.0131)	(0.0157)		
RLTS x Bonus			0.00318		
			(0.0369)		
Bonus			0.00170		
			(0.0198)		
Termination				0.0226	
				(0.0304)	
Empowerment					0.0127
					(0.0101)
Hierarchy					0.0204
					(0.0158)
R&D	0.160***	0.141***	0.131***	0.382***	0.132***
	(0.00968)	(0.0182)	(0.0180)	(0.0179)	(0.0156)
Constant	0.458***	0.788***	0.439***	0.356***	0.658***
	(0.0696)	(0.0864)	(0.0634)	(0.0582)	(0.0863)
Observations	20,339	4,375	4,003	6,937	4,739
R-squared	0.287	0.222	0.228	0.245	0.207
Distress	No	No	No	Yes	No
Aux. Controls	Yes	Yes	Yes	Yes	Yes
Country Year Industry FE	Yes	Yes	Yes	Yes	Yes

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 Linear probability estimation results. Standard errors clustered at industry level. Data: World Bank Enterprise Survey (ES); World Bank Enterprise Survey – Innovation Follow Up Survey (IFS). Estimation Results for firms of all sizes (Corporate Culture, Termination) and 20+ (RLTS, Empowerment) employees. RLTS = Reward for Long-Term Success. Bonus = Performance bonus based on production targets.

6. RESULTS

The following section leads through my key estimation results. Table 3 presents a summarised overview. Results for each individual estimation with the full set of control variables can be found in the Appendix Table A 4 - A 10. This section is structured as follows. First, I introduce estimation results for each individual HRM measure of interest. Second, I analyse the joint determination of *Corporate Culture* and *Termination*, my two HRM measures sourced from ES responses, as well as *Reward Structure* and *Empowerment*, the measures obtained from IFS responses. Finally, a subsequent paragraph introduces estimation results for my auxiliary control variables.

6.1 Key Estimation Results

Corporate Culture (ES)

Table 3, Column 1 and 6 indicate a positive relation between *Corporate Culture* and innovation. Column 1 suggests that giving employees time to develop or try out new ideas or approaches increases the likelihood of having introduced a new or significantly improved product/service by 23.1 percentage points. The suggested effect is significant at the 1 per cent level. Further, Column 6 indicates a correlational effect of *Corporate Culture* on process innovation of 34.2 percentage points, which is also significant at the 1 per cent level. Based on magnitude and statistical significance of the estimates identified, I infer that my estimation results provide strong, consistent support for *Proposition 1.*

However, neither the sign nor the statistical significance should be very surprising at this point. What is astonishing however is the actual economic magnitude of the identified relationship, especially when putting it in relation with other key determinants of innovation generation. Table 3 suggest a significant effect of R&D propensity on innovation of 19.6 percent points for product, and 16 percentage points for process innovation. Hence committing to a *Corporate Culture* that fosters exploration trumps the suggested effect of investing in R&D by 3.5 ($p = 0.05$) and 18.2 ($p = 0.00$) percentage points respectively. This means that for generating product innovation, *Corporate Culture* appears to be more, and for process innovation more than twice as important as investing in R&D. Considering the vast academic literature that identifies R&D investment as indisputable, most important innovation input (cf. Love and Roper 1999; Bhattacharya and Bloch 2004; Vega-Jurado et al. 2008), my estimation results for *Corporate Culture* certainly put HRM back in the spotlight in this respect.

A key concern that calls the findings so far into question arises from the binary character of my R&D propensity variable. If firms that conduct R&D differ in the extent to which they invest in R&D, and the R&D volume is correlated with *Corporate Culture*, then my estimate may simply pick up the effect of large R&D spending. For a small subsample of 2,125 firms I obtain data on the volume of inhouse R&D spending from IFS responses. I find that estimation results using R&D volume remain effectively unchanged,[17] lending additional support to my reasoning in this section.

In a final step I want to argue that a comparison of estimation results for product and process innovation perfectly reflects my theoretical narrative so far. I find that the suggested effect of *Corporate Culture* on process innovation exceeds the effect on product innovation by about 11.1 percentage points. With my theoretical model in mind, this can be explained by the two fundamental definitory differences between my two innovation measures.

First, the type of workers involved in the innovation process: The difference in the identified relationship may reflect the fact that *Corporate Culture* is more effective in incentivising lower-tier production workers (rather involved in process innovation), as opposed to managerial level employees and R&D workers (rather involved in product innovation). This is also supported by the fact that the association between R&D propensity and innovation is substantially larger for product innovation than for process innovation, in absolute terms as well as relative to the suggested effect of *Corporate Culture* (Table A 4). As a consequence, the fit of my model for process innovation ($R^2 = 0.287$) by far outranks the fit of my model for product innovation ($R^2 = 0.198$). The fact that *Corporate Culture* incentivizes lower-tier production workers should not surprise when looking back at the implications from my theoretical model. Foreshadowing insights from empowerment, assuming lower-tier production workers to be more involved in the decision-making process when it comes to process innovation, we can expect them to have a higher expected probability of success about new work methods which facilitates incentive provision for exploration. In addition, Manso (2011) states that a *Corporate Culture* that gives employees freedom to develop new ideas is crucial for overcoming the scepticism of especially the lower-tier workforce, because explicit contracts tied to verifiable innovation measures are often not available for them.

[17] Point estimate *Corporate Culture:* 0.215. $p = 0.000$

My second explanation for the difference in the estimated relationship is the time scale of innovation processes: As mentioned in the description of my dependent variables, I expect process innovations to be implementable on shorter time scales than product innovations. As proposed by my theory section, this facilitates incentive provision for exploration through *Corporate Culture*, and hence explains the different effects suggested by my empirical analysis.

I conclude that *Corporate Culture* shows a strong positive association with both my innovation measures, lending great support to my *Proposition 1.* Additionally, *Corporate Culture* seems particularly related to process innovation.

Reward Structure / RLTS (IFS)

Investigating the relationship between *RLTS* and innovation Table 3, Column 2 and 7 indicate conflictive findings for my two innovation measures. For product innovation, estimation outcomes in Column 2 suggest that applying long-term production targets relates to an increase in the probability of having introduced a new or significantly improved product or service by about 2.98 percentage points. The relationship identified is significant at the 10 per cent level ($p = 0.052$). Hence estimation results suggest an effect that is rather moderate yet by no means neglectable. The findings for product innovation very much confirm *Proposition 2*, suggesting that rewarding long-term success positively affects innovation.

However, estimation results in Column 7 indicate that quite the opposite is the true for my process innovation measure. Here, long-term production targets decrease the likelihood of innovation generation by about 3.21 percentage points ($p = 0.015$). This finding is in stark contrast to predictions from my theory section.

One possible explanation for those seemingly contradictory findings is that as opposed to product innovations, firms have trouble committing to rewarding long-term success when it comes to process innovations. One reason could be the shorter time scales of process innovations, which aggravates the commitment to rewarding a long-term performance path through long-term production targets. Another possibility may be the unavailability of verifiable, long-term performance measures, which makes rewarding lower-level employees particularly difficult (Manso 2011). For those workers, explicit contracts including long-vesting stock options, entrenchment or option repricing may not be available. Either way, due to the lack of commitment and assuming the costs of exploring process innovation for low-tier workers is relatively low, firms would have to swap to short-term contracts when trying to incentivise

innovation. Estimation Results Table A 6 confirm this narrative, suggesting a positive (if anything) effect of short-term production targets and a significant, positive correlational effect of combinational targets, amounting to about 3.9 percentage points ($p = 0.01$).

Table 3, Column 3 and 8 show estimation results for *RLTS,* when tying long-term production targets to a commitment to rewarding target achievement in the form of performance bonuses. Long-term production targets in combination with performance bonuses neither significantly relate to my product, nor my process innovation measure. Therefore, estimation results here do not lend any support to *Proposition 2.1* from theory, suggesting an increase in the positive effect of RLTS on innovation, when firms' commitment to rewarding increases. One possible explanation is that my best attempt to capture commitment is still too narrowly defined. Firms that report to apply performance bonuses merely self-claim to commit to their reward structure. Actual commitment for instance through explicit contracts (i.e. stock options) or implicit contracts (i.e. reputation) is not captured by my definition. Interestingly, when conditioning on my long-term targets x performance bonus interaction term in Column 3, it seems like the correlational effect of applying long-term production targets on product innovation increases. However, I cannot confidently reject the hypothesis that both coefficients, in Column 3 and Column 2 are the same ($Chi^2 = 1.26; p = 0.26$). In another explanation, one could interpret the performance bonus as additional incentive for eliciting effort. In this case the performance bonus does not necessarily alter the relationship identified for long-term production targets.

Another practice for rewarding long-term success could be seen in employee promotion. An intact internal labour market where promotion is either tied to long-term performance or committed to through firms' reputation may serve as a better approximation of a reward structure that is credibly rewarding long-term success. Yet unfortunately, no such measure is available from my survey data.

In conclusion, by identifying a positive association between RLTS and product innovation, I find partial support for *Proposition 2*. Estimation results for process innovation indicate an inverse relationship. Finally, introducing commitment to my estimation framework does not alter the relationships identified and hence leaves *Proposition 2.1* without support.

Termination (ES)

Table 3, Column 4 and Column 9 present estimation results for the relationship between excessive *Termination* and innovation. Engaging in excessive *Termination* is associated with a 5.52

percentage points lower likelihood of having introduced a new or significantly improved product or service. The suggested effect is significant at the 1 per cent level. Further Table 3 shows that its magnitude amounts to about one sixth (or about 17 per cent) of the suggested (positive) effect of R&D propensity on product innovation, indicating a relationship that is not only statistically highly significant, but also economically meaningful. Hence, results for product innovation lend great support to *Proposition 3*, suggesting an adverse effect of excessive *Termination* on innovation. Estimation results for process innovation however are not as conclusive in this respect. Estimates in Table 3 Column 9 do not allow for any inferences about a positive or negative relationship between excessive Termination and process innovation.

In an attempt to explain my findings above, I want to draw attention to one main insight from my theory section. It was stated before that for the case of *Termination*, my theoretical proposition is closely tied to the baseline assumptions of my model. And further, that if exploration is relatively cheap and shirking constraints are binding, excessive *Termination* can have a positive effect on innovation. I think it is fairly reasonable to assume that experimentation with process innovations, especially innovations in logistics and distribution methods is much less cost intensive for the workers than experimenting with new products/services. Consequently, the baseline situation leading to *Proposition 3* may be more closely resembling the situation for product, rather than process innovation. In fact, I would not have been surprised if a positive relationship between my *Termination* dummy and process innovation would have been identified by my estimation framework.

I conclude, my estimation results suggest a substantial, negative effect of *Termination* on product innovation, reflecting the prediction in *Proposition 3.* However, no relationship is identified for process innovation, indicating possible differences in the underlying constraints structure.

Empowerment (IFS)

Employee *Empowerment* is the last HRM practice of interest investigated by my empirical framework. Estimation results for both innovation measures can be found in Table 3, Column 5 and Column 10. I find that increasing the number of employees who report directly to the establishment's top manager on a regular basis by 10 (50) percentage points is related to an increase in my product innovation measure by about 0.385 (1.93) percentage points. The associated effect is significant at the 1 per cent level. The magnitude of the suggested effect identified seems small at best but appears not at all to be neglectable when taking a closer look:

The median value for employees who report directly to the establishment's top manager on a regular basis is 5 ($\ln(5) \approx 1.61$). This means increasing my *Empowerment* measure by 50 percentage points for the median firm would require an increase in the number of employees directly reporting to the top manger by about 6 workers ($e^{(1.5*1.61)} \approx 11.18$). Practically speaking, an increase from 5 to 11 workers does not seem too farfetched and would be related to an increase in my product innovation measure by almost 2 percentage points. Hence estimation results for product innovation support theoretical predictions in *Proposition 4.* As for the *Termination* measure, no relationship can be identified between employee *Empowerment* process innovation.

The finding for process innovation is rather surprising, since from theory I would have expected that especially lower-level employees (responsible for process innovation) respond to higher task involvement, because those are the workers who may have been excluded from the decision-making process before. However, two theoretical and conceptual considerations may explain the findings here. First, the choice of new work methods when it comes to process innovations may quite naturally already rest almost solely on the shoulders of lower-level employees, which makes additional inclusion in the decision-making process as defined by my *Empowerment* measure obsolete. Second, employees reporting directly to the top manager are most likely not the lowest-level production workers (at least for larger firms), but predominantly middle managers (and possibly R&D workers) who, as elaborated on before, I expect to have a relatively higher contribution to product rather than process innovation generation.

Finally, I want to draw attention to the estimation results for my *Hierarchy* variable in Table 3 Column 5 and 10. I do not find any evidence for a relationship between "layers of direct reporting", my *Hierarchy* variable and either one of my innovation measures. Considering the high correlation between my *Empowerment* and *Hierarchy* measure ($Corr. \approx 0.49$), estimation results here reassure that the relationship identified for *Empowerment* is not just picking up differences in for instance monitoring intensity.

I conclude, my estimation results for product innovation suggest a positive effect of employee *Empowerment* as predicted by *Proposition 4.* For process innovation on the other hand, *Empowerment* as defined in my estimation framework does not appear to show any relationship.

6.2 Joint Determination

In the following I will briefly elaborate on estimation results for the joint determination of *Corporate Culture* and *Termination* as well as of my *Reward Structure* and *Empowerment* measure (Table A 9; Table A 10). I pair the HRM practices according to their survey source (ES or IFS) for two main reasons. First, this allows for comparability with results obtained in the individual estimations. Second, analysing the joint determination of all practices would leave me with a sample size that is too small to make any confident inferences.

Table A 9 shows that when conditioning on *Corporate Culture* and *Termination*, the suggested relationships identified above prevail in sign and statistical significance. In fact, the magnitude of the relationship for *Corporate Culture* increases with respect to process innovation ($Chi^2 = 18.1; p = 0.00$). Further, the suggested adverse effect of *Termination* on product innovation also increases in magnitude compared to my baseline estimates ($Chi^2 = 3.46; p = 0.063$). The findings here are not very surprising given the small, negative correlation between the two HRM measures (Table A 3).

Estimation results for *Reward Structure* and *Empowerment* draw a similar picture. The suggested relationships from my baseline estimations are identified in sign and with similar confidence levels. Additionally, I cannot reject the Hypothesis that the magnitude of the suggested effect is the same for any of the two HRM practices and across both innovation measures.

Summarizing my key estimation results, I want to emphasise four main findings. First, a *Corporate Culture* that fosters exploration is associated with a substantially higher innovation output propensity. The suggested effect is particularly large for my process innovation measure. Second, my *RLTS* measure positively relates to product innovation, while a negative association with process innovation is identified. Third, excessive *Termination* is inversely related to product innovation while no relationship with process innovation is identified. Finally, employee *Empowerment* is positively related to product innovation and no relationship is identified for process innovation.

With view to my theoretical prediction, the findings for product innovation perfectly resemble the narrative of my model section. Findings for process innovation reflect theoretical predictions for *Corporate Culture* only. The relationships identified for the remaining HRM practices do not mirror propositions derived from my theoretical model.

6.3 Auxiliary Control Variables

In the following subsequent paragraph, I will take a closer look at estimation results for my auxiliary control variables. While the overall tendency is consistent for all variables, magnitude or statistical confidence in an identified relationship may differ depending on which regression specification is considered. This is no reason for concern, but simply mirrors the fact that my estimates are based on different subsamples with additionally different minimum firm-sizes, depending on the particular HRM practice of interest. In the following I examine estimation results for *Corporate Culture* and innovation (Table A 4) simply for the fact that with about 21,000 observations, this specification uses almost my entire sample of firms which allows for the most adequate inferences about the underlying population.

Starting with firm-level characteristics, as stated before R&D propensity positively relates to both innovation measures. The suggested effect amounts to about 19.6 percentage points for product and 16.0 percentage points for process innovation. This finding of course reflects theoretical predictions in sign and significance, yet rather falls short on the magnitude identified by similar empirical investigations (cf. Roper, Du and Love 2008; Bourke and Cowley 2015). Second, the multi-plant variable shows a moderate but significant negative relationship with my process innovation measure while not being associated with product innovation. Estimation results suggest that single-plant firms have a higher likelihood of generating process innovation, adding on a body of literature that can be considered rather inconclusive in this respect (cf. Jensen 2004). Third, partial state-ownership is associated with a significantly higher product innovation propensity of about 6.27 percentage points. This finding has to be treated with care because it is only established for my *Corporate Culture* specification. Nevertheless, it does lend some support to a growing body in academic literature suggesting that governments' involvement in private businesses does not necessarily have to come at the expense of innovation activities, as has long been suspected (cf. Jefferson et al. 2003; Xu and Zhang 2008; Li and Xia 2008, Belloc 2014; Choi and Williams 2011). I want to emphasize that fully state-owned establishments are excluded from my sample, restricting the scope of interpretation in this respect. Fourth, larger firms are associated with a higher likelihood of generating product as well as process innovation. Findings here support what is known as the "Schumpeterian Hypothesis" and have been established repeatedly by empirical literature (cf. Adams and Dirlan 1966; Acs and Audretsch 1987). Finally, my estimation results suggest that younger firms are significantly more likely to engage in process innovation, while no relationship with my product innovation measure is identified.

Estimation outcomes support theoretical and empirical evidence, suggesting that firms are more innovative closer to their market entry date (cf. Audretsch 1995; Huergo and Jaumandreu 2004). Yet, the correlational effect amounts to about -0.035 percentage points per year from market entry, implying that the identified relationship is economically close to neglectable.

Moving on to my local business environment vector, I find that being located in a country's main business city is associated with a higher innovation output measure by about 4 – 5 percentage points for both measures. Further, relative to being located in a metropolitan city (population > 1 million) an establishments' location in a small city (population < 50,000) is inversely related to product innovation generation. Hence, I find some support for local labour market spill-over effects on innovation output (cf. Audretsch and Feldmann 1996; McCann and Simonen 2005).

7. ROBUSTNESS

In this section, I show that my estimation results are robust to modifications in my key regression specification. First, I present findings for all my HRM practices from an empirical investigation with a conditional logit specification. Second, I introduce estimation results for *Corporate Culture* and *RLTS*, restricting my samples to firms with 20+ employees. Third, I investigate the relationship between *Termination* and innovation for different thresholds determining excessive *Termination.* I a final step, I follow suggestions from academic literature and include a measure for the degree of product market competition in my estimation framework.

7.1 Conditional Logit

In my main specification, I deliberately decide against the use of a conditional logit model. The main reason is the intuitiveness and interpretability of LPM estimates compared to the strong assumptions necessary when interpreting marginal effects in a conditional logit model (Hellevik 2007). It is two concerns that are at the heart of the critique of using LPM models when estimating specifications with dichotomous outcomes: First, LPMs run danger of identifying "impossible results" (i.e. cumulative probabilities above 1 or below 0) due to the unboundedness of its specification. While I follow recommendations by Hellvik (2007) and use mostly binary independent variable for my identification strategy, for some variables the issue of unboundedness remains. Second and more important for the interpretation of my main results,

linear probability tests when dealing with dichotomous dependent variables are likely to deliver misleading significance levels. The main concern here is the LPM's homoscedasticity assumption, which is usually not satisfied for binary outcome variables. I use heteroscedasticity robust standard errors to counteract this issue, yet inconsistencies in the presented significance levels may remain.

Table A 11 shows estimation results for my conditional logit model specification. I find that for all HRM practices of interest, the conditional logit estimates replicate the estimates of my LPM in sign and significance. In fact, if anything conditional logic estimation results suggest that the level of confidence in my baseline estimates identified before is stated rather conservatively.

7.2 Minimum Firm-Size

As pointed out in the methodology section, the minimum firm size differs for my HRM survey responses, depending on whether my measure is sourced from ES (including small and micro enterprises) or IFS (only medium and large enterprises). Not restricting the minimum firm-size allows me to consider the maximum possible variation in the data. However, this approach comes with obvious shortcomings when trying to compare estimated relationships between HRM practices sourced from different surveys. A large body in academic business literature suggests that the effectiveness of HRM practices and their interplay is determined by "contextual features" (Bowen and Ostroff 2004) such as firm size or industry (MacDuffie 1995; Yound et al. 1996; Bowen and Ostroff 2004). For instance, it is possible that a *Corporate Culture* fostering exploration yields greater innovation success in smaller firms, because the monitoring situation in smaller firms is substantially different compared to larger firms. Considering the predominant representation of small firms (≥ 5 and≤ 20 employees) in my total sample (Figure A 1), it is possible that the relationship identified for *Corporate Culture* (and *Termination*) differs fundamentally when increasing the minimum firm size to 20+ employees.

Table 4. Estimation Results – Medium and Large Firms

	(1)	(2)	(3)	(4)
VARIABLES	Product Innovation (ES)	Process Innovation (ES)	Product Innovation (ES)	Process Innovation (ES)
Corporate Culture	0.217***	0.341***		
	(0.0137)	(0.0136)		
Termination			-0.0433*	0.0689***
			(0.0225)	(0.0198)
Constant	0.417***	0.379***	-0.0533	0.342***
	(0.0939)	(0.0878)	(0.0726)	(0.0723)
Observations	11,244	10,928	4,771	4,767
R-squared	0.212	0.304	0.220	0.266
Distress	No	No	Yes	Yes
Hierarchy	No	No	No	No
Aux. Controls (incl. R&D)	Yes	Yes	Yes	Yes
Country Year Industry FE	Yes	Yes	Yes	Yes

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 Linear probability estimation results. Standard errors clustered at industry level. Data: World Bank Enterprise Survey (ES); World Bank Enterprise Survey – Innovation Follow Up Survey (IFS). Estimation Results for firms of all sizes (Corporate Culture, Termination).

Estimation results for *Corporate Culture* and *Termination* in Table 4 suggest that restricting my firm sample to medium sized and large firms does not alter the relationship of *Corporate Culture* and my two innovation measures. Further, the associated effect of *Termination* on product innovation remains effectively unchanged. Interestingly, I now identify positive relationship between excessive *Termination* and process innovation. The suggested effect amounts to 6.89 percentage points and is significant at the 1 per cent level. As pointed out in the Model and Results section, this should not come as a surprise but rather confirms earlier presumptions that when dealing with process innovation, *Termination* may come in handy for the firms by providing additional incentives that keep workers from shirking and encourage exploration instead. A new insight added by Table 4 is that this relationship seems to only come into effect for certain larger firm sizes. I abstain from hypotheses about underlying mechanisms, because such would be purely speculative at this point.

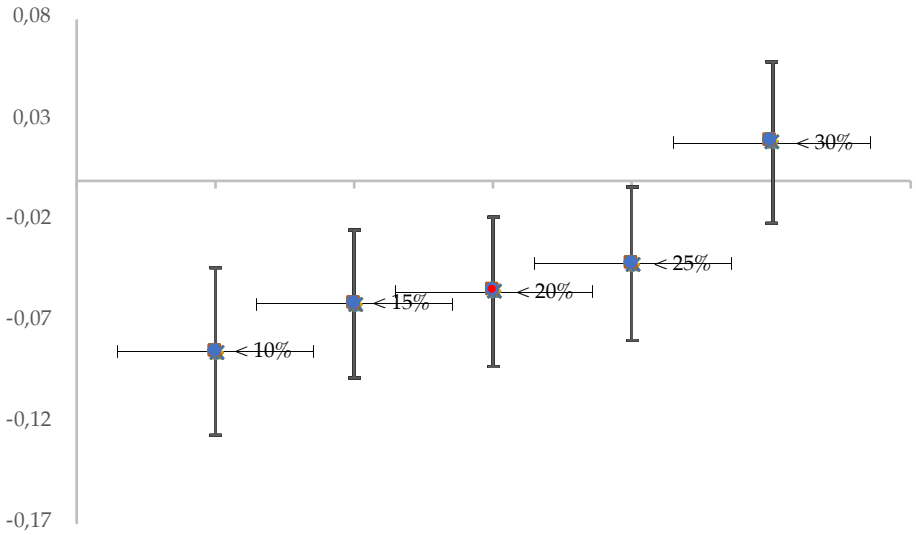
7.3 Excessive Termination Thresholds

In my key specification I set the threshold for "excessive *Termination*" at the first quintile of the permanent to total employee ratio distribution (determining "excessive *Termination"* in combination with firms' ability to "fire redundant employees"). This threshold was set deliberately for the ease of interpretation of my *Termination* measure, yet of course restricts the explanatory power of my variable. From theory, I would expect that a narrower definition (lower

permanent to total employee ratios) of excessive *Termination* should increase the magnitude of the relationship identified in my key estimation framework.

Figure 1 displays LPM point estimates (and the 95 per cent confidence interval) for different thresholds for firms' maximum permanent employees to still fall under my definition of "excessive *Termination"*. The point estimate from my key specification (< 20%) is marked red. Only the relationship with product innovation (which has been identified as statistically significant and economically substantial in my basic framework) is examined.

Figure 1. Point Estimates for Different Termination Thresholds



Note: **Y–Axis**: LPM Point Estimates. **X–Axis**: Minimum threshold for excessive Termination (percentiles for permanent to total employees ratio). Error Bars denoting the 95 per cent Confidence Interval. Data: World Bank Enterprise Survey (ES); World Bank Enterprise Survey – Innovation Follow Up Survey (IFS).

Figure 1 nicely resembles theoretical predictions, lending additional validation to estimation outcomes in my basic specification. I find that loosening my definition of the minimum "excessive *Termination*" threshold through increasing the permanent employee ratio consistently mitigates the magnitude of the identified relationships. Setting the minimum threshold at the first 10 per cent (< 10%) percentile delivers an adverse correlational effect of about 8.45 percentage points. A threshold at the first quartile (< 25) halves the point estimate to about 4.14 percentage points. The relationship identified becomes insignificant at the 30 per cent percentile.

7.4 Competition

Product market competition is generally seen as an important determinant of innovation output, yet not controlled for in my basic specification. However, theoretical literature and empirical evidence have long delivered contradictory findings with respect to the direction of the effect. Most theoretical models suggest that greater product market competition discourages innovation by reducing post-entry rents (cf. Salop 1977, Dixit and Stieglitz 1977). In contrast, most empirical evidence points towards a positive relationship between competition and innovation (cf. Geroski 1995; Blundell, Griffith and Van Reenen 1999). In a widely recognised theoretical and empirical analysis, Aghion et al. (2005) at least partly manage to explain inconsistencies by identifying an inverted U-shaped relationship.

Additionally, academic literature finds various potential impact channels of product market competition on HRM practices applied at a firm level. Most principal agent models suggest that more product market competition leads to a greater goal alignment within organisation, calling for different HRM practices in optimum (cf. Hermalin 1992; Patel and Cardon 2010).

As a consequence, with my key estimation specification I run danger to identify a relationship between my HRM measures and innovation which is in fact driven by differences in product market competition. While the ES provides me with a question asking respondents about "the number of competitors in their main market", I chose not to include this variable in my key specification for two reasons. First, not even half of the firms in my sample were asked/responded to the question which would drastically compromise my sample sizes for each specification. Second, one possible answer to the question concerning the number of competitors is "too many to count". This answer was chosen by half of the respondents, severely complicating the creation of a variable with meaningful interpretation.

However, to rule out remaining concerns I create a dummy variable denoting low ($\leq$ 5 competitors), medium ($\leq$ 10 competitors), high ($\leq$ 20 competitors), very high ($\leq$ 50 competitors) and maximum ($>$ 50 competitors or answer: "too many to count") product market competition.

Table 5. Estimation Result – Corporate Culture, Competition and Innovation

VARIABLES	(1) Product Innovation (ES)	(2) Process Innovation (ES)
Corporate Culture	0.235***	0.347***
	(0.0139)	(0.0129)
R&D	0.207***	0.149***
	(0.0183)	(0.0137)
Competition Medium	-0.0456***	-0.0153
	(0.0172)	(0.0169)
Competition High	-0.0554***	-0.0291
	(0.0201)	(0.0221)
Competition Very High	-0.0522*	0.0135
	(0.0282)	(0.0267)
Competition Max	-0.0363***	-0.0265*
	(0.0113)	(0.0142)
Constant	0.264**	0.501***
	(0.110)	(0.0956)
Observations	11,742	11,533
R-squared	0.230	0.294
Distress	No	No
Aux. Controls	Yes	Yes
Country Year Industry FE	Yes	Yes

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 Linear probability estimation results. Standard errors clustered at industry level. Data: World Bank Enterprise Survey (ES); World Bank Enterprise Survey – Innovation Follow Up Survey (IFS). Estimation Results for firms of all sizes (Corporate Culture, Termination). Baseline Competition: ≤ 5 competitors in main product market.

Table 5 presents estimation results for *Corporate Culture* and my two innovation measures when conditioning on product market competition.[18] I do not find evidence that the inclusion of my competition dummies alters the relationships identified in my basic specification in any way. In essence, I obtain the same results for *RLTS, Termination* and *Empowerment*. Only the positive (inverse) relationship between *RLTS* and product innovation (process innovation) appears to lose its significance when conditioning on competition. However, taking a closer look I find that with p – values of 10.7 and 10.1, both coefficients just jump conventional significance thresholds and hence in fact do not lose substantial explanatory power.

Because of the aforementioned measurement error and the resulting, quite arbitrary construction of my variables, I do not want to go into too much detail interpreting my competition dummies. If anything, estimation results suggest that facing more than 5 competitors in the main product market adversely affects innovation output.

[18] $Corr.(Corporate\ Culture, Competition) \approx -0.0213$; $Corr.(R\&D\ (ES), Competition) \approx -0.0170$. With "Competition" denoting my continuous indicator of number of competitors in the main product market. Answer "too many to count" is replaced by 50 competitors.

Estimation results from a sample split into firms facing a high (≥ 20 competitors) or low (< 20 competitors) competition environment support the findings in Table 5. Overall, I do not find that for any of my HRM practices the relationship with innovation identified in my baseline estimation is significantly altered for either of my subsamples. Only my estimates for *RLTS* and *Empowerment* for firms with less than 20 competitors lose their significance. This however could also be a consequence of the critically reduced sample size when focusing on firms facing low competition.

8. DISCUSSION

This final section features a discussion on my key findings and is separated in two parts. First, I re-evaluate the validity of my findings by presenting some central limitations of this work and derive alternative interpretations. Second, I discuss my findings in the context of developing countries.

8.1 Limitations

Direction of Correlational Effect

To begin with, I am unable to make a definite statement about the direction of the correlational effects identified. My empirical investigation assumes that firms apply different HRM practices for reasons that are at least to some degree independent from their propensity to innovate, which then in turn results in different innovation efforts. In another interpretation it is also possible that firms, for some exogenous reasons face different innovation opportunities leading to differences in their propensity to innovate. Firms with a greater propensity to innovate then use HRM practices in a way as suggested by my analysis to generate innovation. The latter interpretation of course implies that firms are perfectly aware of the underlying theory about which HRM practices to apply for generating innovation output.

I want to emphasise that at no point I claim to be able to disentangle the two effects mentioned above. However, the following analysis constitutes a very rudimentary approximation to the issue. First, from IFS responses I generate a measure for firm's "desire to innovate", which I call innovation ambition index (IAI). The IAI considers answers to the following three questions: Did this establishment attempt to generate a new or significantly improved product/service, but this attempt was abandoned before completion/is still ongoing? Did this establishment provide

training for employees specifically to generate a new or significantly improved product/service? Did establishment buy new equipment/software specifically to generate innovative product/service? I denote $IAI = \{0, 1, 2, 3\}$ depending on the number of an establishment's positive responses.

Table 6. Innovation Ambition and HRM

VARIABLES	(1) Corporate Culture	(2) RLTS	(3) Termination	(4) Empowerment
IAI	0.110***	-0.0344***	0.0298***	0.0832***
	(0.00506)	(0.00706)	(0.00634)	(0.0114)
Constant	0.551***	0.376***	0.0988***	2.222***
	(0.0695)	(0.0593)	(0.0162)	(0.0871)
Observations	10,619	4,649	3,373	5,153
R-squared	0.139	0.092	0.103	0.256
Country Year Industry FE	Yes	Yes	Yes	Yes

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 Ordinary Least Squares estimation results. Standard errors clustered at industry level. Data: World Bank Enterprise Survey (ES); World Bank Enterprise Survey – Innovation Follow Up Survey (IFS). Estimation Results for firms of all sizes (Corporate Culture, Termination) and firms with 20+ employees (RLTS, Empowerment).

Table 6 suggests that the IAI is positively related to *Corporate Culture* and *Empowerment*, implying that firms that want to innovate indeed choose the "right" HRM practices in this respect. However, it is also revealed that the IAI relates positively to *Termination* and inversely to my *RLTS* dummy. Here if anything, firms that according to the IAI want to innovate tend to rather choose the "wrong" HRM practices to do so. I conclude that empirical evidence points towards a situation where firms are not completely strategic in their choice of HRM practices lending some support to the direction of the correlational effect as assumed throughout my analysis.

Spurious Relationships

A second limitation concerns my identification strategy and its susceptibility to identifying spurious relationships. There are two reasons why underlying confounding factors should be of particular concern for my analysis. First, I approximate my model parameters from survey responses. This means that the definitions I use do not necessarily exclusively describe the variable of interest but may as well be close approximations of other variables affecting innovation. Second, HRM practices are determined by choice and hence by definition never fully exogenous. The choice for or against any of my HRM practices is quite likely driven by some

common factors. Such common factors can then serve as common response variable confounding estimation result if neither identified as control variable nor captured by my fixed effects.

One very likely confounding factor can be found in the quality of employees. First, I expect "capable" managers to produce more innovation output. Yet, those managers are also the ones implementing HRM practices. Second, "capable" employees in general are more likely to succeed in their innovation efforts. At the same time, those employees are quite possibly the ones who can be "given time to try out new approaches", are "less frequently terminated" etc. A third way to think about employee quality as confounding factor driving my estimation results is directly connected to my *Termination* measure. One could think of a situation where excessive *Termination* leads to a lower quality of employees with respect to generating innovation, because people with knowledge relevant for innovation are fired.

In an attempt to approximate the impact of employee quality, I use ES responses indicating the degree to which "an inadequately educated workforce [is] an obstacle to the current operations of the establishment". The measure I construct ranges from 0 ("no obstacle") to 4 ("very severe obstacle"). Table A 12 presents estimation results for my HRM practices of interest when conditioning on my approximation for "employee quality". I do not find that sign, magnitude or statistical significance of any of the relationships identified before is substantially altered in my new specification. Empirical evidence here of course does not rule out that i.) "capable" managers drive my estimation results ii.) my approximation of employee quality is too imprecise and "capable" employees are responsible for my findings and iii.) any other spurious relationship explains my estimation outcomes. However, it does demonstrate a way to approach the issue and should certainly reduce concerns regarding employee quality as major confounding factor.

Subjective Survey Data

The final limitation I want to discuss relates to measurement errors in variables constructed from subjective survey data. Numerous influential studies have called for caution when subjective measures constructed from survey data are used for empirical investigations. Bertrand and Mullainathan (2001) state that cognitive issues arising from ordering and phrasing of questions quite possibly explain a large part of the variation in subjective survey data. Further, the context in which a survey is conducted is often shown to substantially affect subjective response data. For instance, Kaplan and Pathania (2010) find that reported perceptions about the quality of firms' business environment are highly correlated with an economy's business cycle. Finally, Johnson and van de Vijver (2003) suggest that social desirability plays an important role

determining subjective survey responses. Famous examples are the repeatedly identified underreporting of racial attitudes or the overreporting of election-participation by non-voters (Bertrand and Mullainathan 2001). Fagerberg, Shrolec and Verspagen (2010) specifically criticise the concept of innovation as defined by the 2005 OECD Oslo Manual and hence as used in this study as being "too subjective", causing potential measurement errors due to different interpretations of innovation by respondents.

For my empirical investigation the subjective character of survey responses comes with three issues affecting my estimation outcomes that deserve further attention:

First, I want to draw attention to possible measurement error in my process innovation measure. Even though survey questions in the ES and the IFS mirror the definition from the OECD Oslo Manual (2005), the concept itself is a lot more vague than the concept of product innovation. More precisely, what can and what cannot be considered a "new […] way of manufacturing products/offering services […] or distributing inputs" leaves more room for subjective interpretation than questions about "new […] products/services". The greater subjectivity then gives rise to the biases mentioned above. I do not expect the resulting measurement error to be systematically related to responses on HRM practices, which is why sign and magnitude of my estimates can still be trusted in this respect. However, random noise in my dependent variable leads to uncertainty in my estimates. This may explain some of the weak findings for process innovation.

Second, I expect random noise due to the subjective character of the questions asked to determine my HRM practices of interest to result in a regression delusion biasing my correlational estimates towards 0. This is not too much of a problem since I am not trying to identify a causal effect. However, it should be noted that key estimates may turn out rather conservative in magnitude statistical significance.

Finally, I want to call attention to a potential bias in my estimates due to the aforementioned issue of "social desirability" affecting subjective survey responses. Innovation is commonly associated with productivity, progress and growth. Based on the widespread positive connotation with those terms, it is fairly reasonable to assume that innovation is considered a "desirable outcome" by a large share of survey respondents. The resulting overreporting of innovation is not too much of an issue for my empirical analysis, as long as it is not systematically related to responses on HRM practices. Yet, there is good reason to believe that respondents who want to be perceived as progressive in the sense of innovation also want to be seen as progressive managers/employers. If by those individuals certain HRM practices used in my identification

strategy such as "giving employees freedom to try out new approaches [..]" or including employees in the decision-making progress are also perceived as more progressive and thus socially desirable, my estimation runs danger to identify relationships that are driven by measurement error.

8.2 Innovation in Developing Countries

I want to end my analysis by putting the key insights into the broader context of innovation in developing countries. First, I want to contrast the fundamentally different environment for innovation in developed vs. developing countries. Then I make inferences about the different types of innovation that thrive in those environments, to finally see how my study of HRM practices compares. I want to stress that I do not aim to present a comprehensive overview of different innovation models that have been developed in the past,[19] but rather try to outline the dissimilarities that matter for my reasoning.

Innovation models that have been established for developed countries can be summarized as i.) being focused on "radical" innovation which is "reshaping the marketplace" in a "discontinuous" way,[20] ii.) resulting from a close interconnectedness between public, private and research sector and iii.) being driven by mostly large enterprises in close cooperation with leading-edge experts (Fagerberg, Shrolec and Verspagen 2010; Hobday 2005). The principal catalyst is almost unanimously identified as large-scale R&D investments, undertaken by "technological leaders" (Hobday 2005).

So far, there has not been a single framework for firm-level innovation that was able to explain innovation in developed as well as developing countries, because the business environments for firms differ fundamentally. First, innovation networks fostering the cooperation between private, public and research sector often only exist in very rudimentary states in developing countries (Fagerberg, Shrolec and Verspagen 2010; Becheikh 2013). Second, juridical protection of intellectual property rights is widely non-existent or not enforced (Chen and Puttitanun 2005; Fagerberg, Shrolec and Verspagen 2010). Third, forward looking public financial institutions or private venture capital firms that facilitate the realisation of risky, "heavyweight" R&D projects are usually absent in developing countries. Finally, the demand for radically innovative products

[19] cf. Fagerberg, Shrolec and Verspagen (2010) and Hobday (2005)

[20] The notion of innovation as "discontinuous" and "revolutionary" dates back to Schumpeter's very understanding of the concept of innovation.

is often either uncertain due to a lack of market research or simply non-existent due to the tighter budget constraints of the potential indigenous customer base (Crane 1977; Becheikh 2013; Tiwari and Herstatt 2014).

Thus, the business environment in developing countries severely restricts the indigenous transformation of large-scale R&D projects into radical innovation output as being promoted by conventional innovation models for developed countries. Taking the business environment as given, this calls for a drastic rethinking on i.) what kind of innovation can be expected in developing countries and ii.) how it can be realised.

The first answer to those questions found in academic literature revolves around the concept of "innovation absorption" and is of minor importance for my reasoning. Essentially, it has long been suggested by a large body of literature that firms in developing countries should focus on "absorbing" foreign technology from abroad, as the indigenous generation of innovation is so severely restricted by the business environment (cf, Adler 1965; Eckhaus 1973; Crane 1977; Becheikh 2013).

A second, more recent approach based on cutting-edge business/innovation literature suggests that instead of rejecting the idea of indigenous innovation in developing countries entirely, one should rather adapt the conventional concept of innovation to the capabilities of such countries. Terms such as "Grassroot Innovation" (Guputa 2010), "Inclusive Innovation" (Sigh et. al 2010), "Innovation from the Base [of the Pyramid]" or "Frugal Innovation" (Tiwari and Herstatt 2014) in essence all capture the same phenomenon of a type of innovation that is particularity prevalent and fruitful in developing countries. This type of innovation has two main objectives: to deliver functional products and services that maintain a high quality level while at the same time providing a cost advantage for a very price-sensitive customer base. In contrast to the conventional, R&D centred concept of innovation, innovation in developing countries does not "stubbornly re-invent the wheel" (Tiwari and Herstatt 2014) but rather focuses on the novel combination of already existing elements to make production more efficient in the use of material and finances. As a consequence, indigenous innovation in developing countries has a rather "incremental" character comparted to the rather "radical" innovation in developed countries (Hobday 2005).

As apparent from the above, the concept of "innovation absorption" and "incremental innovation" deliver some answers to the question of – what – innovation can be expected in developing countries. With view to my innovation measure, I believe that my study indeed

captures a large share of indigenous, predominantly incremental innovation for two reasons: My innovation variables are defined as products/services or processes that are *new* or significantly improved. With *new* referring to new to the establishment and not necessarily to the market. The latter distinction is repeatedly emphasised by Hobday (2005) as crucial when trying to capture innovation in developing countries which is rather incremental. Second, Tiwari and Herstatt (2014) state that including "significantly improved" products/services is an essential precaution when trying to measure especially "frugal", "non-radical" innovation.

However, the answer to the question of – how – this kind of innovation can be generated remains largely open. This is exactly where my study of HRM practices and innovation reveals its strength. This paper delivers an alternative explanation on how innovation can be generated, apart from simply extending R&D activities. As pointed out in my reasoning so far, the latter practice on the one hand may not even be available to firms in developing countries and on the other hand not be as fruitful for generating innovation.[21] Therefore I infer that relatively speaking, the implementation of adept HRM practices is possibly even more important for generating innovation output in developing countries, than in developed countries. Of course, this statement is purely speculative at this point. A study that follows the definition of adept HRM practices in this paper and hence allows for a comparison with findings for developed countries remains to be done.

9. CONCLUSION

Development economics looks back at almost 50 years of continuous struggle to provide a comprehensive policy framework that effectively initiates the catching up process of less developed countries with their first world counterparts. As a consequence, the (re-) recognition of technological innovation as driver behind economic development has become a fashionable approach in this respect. The importance of adept Human Resource Management as catalyst behind innovation activities has long been neglected in economic literature. One particular obstacle seems to be that the link between different HRM practices and innovation generation

[21] I want to re-emphasise at this point that I find a relationship between R&D propensity and innovation that is substantially lower in magnitude than what has been found in comparable studies for more advanced economies (cf. Roper, Du and Love 2008; Bourke and Cowley 2015).

has either not yet been established by theoretical literature or not been supported by empirical evidence. This study seeks to shine some light on the issue.

From consistent theoretical reasoning, I expect a *Corporate Culture* that encourages exploration, *Rewarding Long-Term Success* and employee *Empowerment* to promote firm-level innovation generation while excessive *Termination* should have an adverse effect.

Empirical evidence for product innovations in my sample of more than 23,000 firms in 18 developing countries perfectly mirrors theoretical propositions. In fact, I identify a relationship between *Corporate Culture* and product innovation that even tumps the magnitude of the suggested effect for R&D propensity. Further, the positive relationships established for *Rewarding Long-Term Success* and *Empowerment* as well as the inverse relationship identified for excessive *Termination* are all statistically significant and economically substantial.

Findings for my process innovation measure are weaker and not as conclusive. Only the positive relationship established for *Corporate Culture* reflects theoretical predictions. The correlational effect even exceeds the estimate for product innovation by a large margin. This does indeed fit well with my theoretical reasoning since I expect *Corporate Culture* to be especially effective in incentivising lower-tier employees. *Rewarding Long-Term Success* shows and inverse relationship with product innovation. Commitment problems when rewarding process innovations are possibly at the heart of this result, yet empirical findings appear to be inconclusive in this respect. My *Termination* measure if anything shows a positive association with process innovation. A possible explanation may be different incentive constraints faced by lower-tier production workers. Finally, no relationship is identified for employee *Empowerment,* which is likely based on the idiosyncratic construction of my measure. All my results are remarkably robust to modifications in the principal estimator, the subsamples used for my estimation as well as to changes in the regression specification.

The need for future research is clearly demonstrated by the limitations of this study. First, investigating panel data will certainly help to tackle remaining unobserved heterogeneity leading to endogeneity issues confounding the findings of this study. In the best case such research could pave the way for more causal inferences. Yet, a thorough understanding about the underlying interconnectedness between different HRM practices has to be established first. While economic theorists start to succeed in linking individual HRM practices to innovation activities, the relationships within HRM systems remain widely neglected to this day. Third, I want to emphasise the importance of an in-depth analysis of firm-level process innovations and HRM. My findings suggest a situation that differs from product innovation in various ways, yet

my reasoning for this is very limited and often speculative. Finally, a study for developed countries that follows the methodology of this paper would deliver valuable insights about the idiosyncrasy of firm-level innovation in developing countries.

The motivation behind this study itself reveals the far-reaching implications from a policy perspective. I present a straightforward approach of how innovation and consequently economic development can be stimulated through simple adjustments in firm-level HRM. Insights from this study might be of particular value for policy makers in developing countries. In comparison to their more advanced counterparts, the rather incremental character of- and special requirements for indigenous innovation as well as the fundamentally different business environment in developing countries call for a rethinking of the classical ways of how innovation can be promoted. My study introduces adept HRM as promising tool in this respect.

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APPENDIX

Derivation 1

If exploitation constraints are binding, then solving:

$$\Delta\Big(W(\vec{w},\langle 2_0^2\rangle),\mathrm{C}(\langle 2_0^2\rangle)\Big) \geq \Delta\left(W\big(\vec{w},\langle i_k^j\rangle\big),\mathrm{C}\big(\langle i_k^j\rangle\big)\right)$$

For w_{SS}^t we obtain:

$$w_{SS}^t = \alpha^t + \frac{p_1 - p_0}{E[p_2]E[p_2|S,2] - p_0\, p_1} \cdot \frac{p_1(1+E[p_2])c_1}{E[p_2]E[p_2|S,2] - p_1^2} \cdot \left(\frac{c_2}{c_1} - \beta^t\right)$$

with:

$$\alpha^t = \frac{1 + E[p_2]c_2 - p_0 c_1}{E[p_2]E[p_2|S,2] - p_0 p_1]}$$

$$\beta^t = \frac{(E[p_2]E[p_2|S,2] - p_0 p_1) + E[p_2](p_1 E[p_2|S,2] - p_0 E[p_2|S,2])}{(p_1^2 - p_0) + E[p_2](p_1^2 - p_0)}$$

it follows that:

$$w_{SS}^t - w_{SS} = -\frac{(E[p_2] - p_0)p_0 c_1}{(E[p_2]E[p_2|S,2] - p_0 p_1)(p_1 - p_0)} + \frac{p_1 - p_0}{E[p_2]E[p_2|S,2] - p_0\, p_1} \cdot \frac{p_1(1+E[p_2])c_1}{E[p_2]E[p_2|S,2] - p_1^2} \cdot \left(\frac{c_2}{c_1} - (\beta^t - \beta)\right)$$

with:

$$\beta^t < \beta = \frac{(E[p_2]E[p_2|S,2] - p_0 p_1) + E[p_2](p_1 E[p_2|S,2] - p_0 p_1)}{(p_1^2 - p_0 p_1) + E[p_2](p_1^2 - p_0 p_1)}$$

such that:

$$\frac{p_1 - p_0}{E[p_2]E[p_2|S,2] - p_0\, p_1} \cdot \frac{p_1(1+E[p_2])c_1}{E[p_2]E[p_2|S,2] - p_1^2} \cdot \left(\frac{c_2}{c_1} - (\beta^t - \beta)\right) > \frac{(E[p_2] - p_0)p_0 c_1}{(E[p_2]E[p_2|S,2] - p_0 p_1)(p_1 - p_0)}$$

and hence $w_{SS}^t - w_{SS} > 0$

Derivation 2

If *shirking constraints are binding,* then:

$$w_{SS}^t - w_{SS} = -\frac{(E[p_2] - p_0)p_0 c_1}{(E[p_2]E[p_2|S,2] - p_0 p_1)(p_1 - p_0)} < 0$$

Figure A 1. Distribution – Firms According to Size

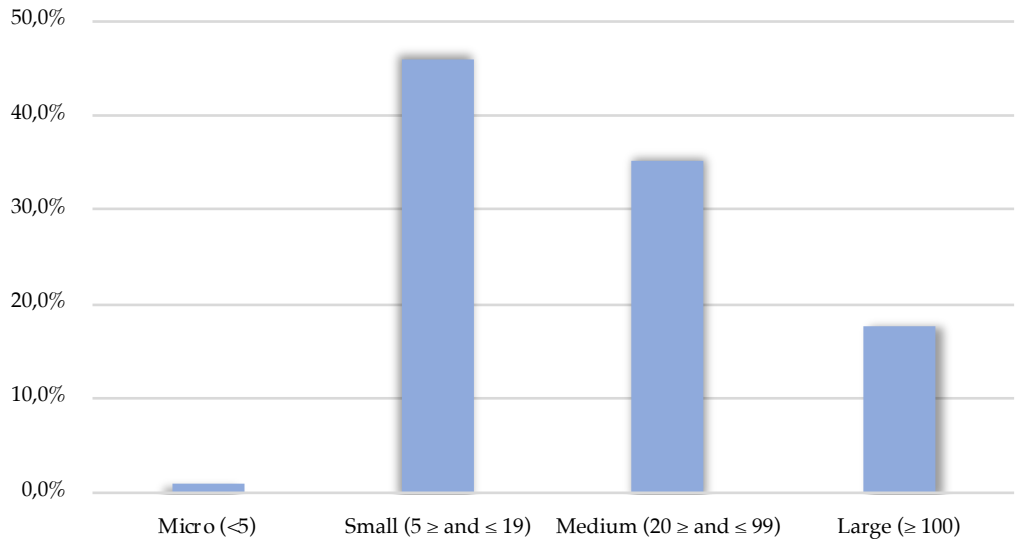

Table A 1. Summary Statistics – Auxiliary Control Variables

VARIABLES	N	Mean	SD	Min	Max
R&D (ES)	23,178	0.275	0.446	0	1
R&D (IFS)	10,887	0.297	0.457	0	1
Employees	22,101	3.425	1.296	0	9.616
Age	22,745	18.03	14.25	0	168
State-owed	22,928	0.0200	0.140	0	1
Multi-plant	23,429	1.801	0.399	1	2
City Small	23,429	0.0286	0.167	0	1
City Medium	23,429	0.149	0.356	0	1
City Large	23,429	0.320	0.467	0	1
City Metropolitan	23,429	0.500	0.500	0	1
Capital	23,429	0.278	0.448	0	1
Business	23,429	0.678	0.467	0	1

Table A 2. Correlation Matrix: Innovation Measures

VARIABLES	Product Innovation (ES)	Product Innovation (IFS)	Process Innovation (ES)	Process Innovation (IFS)
Product Innovation (ES)	1.0000			
Product Innovation (IFS)	0.3765	1.0000		
Process Innovation (ES)	0.4374	0.1832	1.0000	
Process Innovation (IFS)	0.1133	0.2401	0.3495	1.0000

Table A 3. Correlation Matrix: HRM Measures

VARIABLES	Corporate Culture	RLTS	Termination	Empowerment
Corporate Culture	1.0000			
RLTS	-0.0027	1.0000		
Termination	-0.0300	0.0032	1.0000	
Empowerment	0.1566	0.0298	0.0495	1.0000

Table A 4. Estimation Results – Corporate Culture and Innovation

VARIABLES	(1) Product Innovation (ES)	(2) Process Innovation (ES)
Corporate Culture	0.231***	0.342***
	(0.00842)	(0.0103)
R&D	0.196***	0.160***
	(0.0120)	(0.00968)
Multi-plant	-0.00180	-0.0352***
	(0.0105)	(0.00889)
State-owned	0.0627**	0.0290
	(0.0249)	(0.0259)
Employees	0.0258***	0.0348***
	(0.00455)	(0.00311)
Age	3.61e-05	-0.000353***
	(0.000216)	(0.000132)
Small City	-0.0673***	0.0440
	(0.0232)	(0.0284)
Medium City	0.00971	0.0208*
	(0.0131)	(0.0110)
Large City	0.0413***	0.0507***
	(0.00980)	(0.00934)
Capital	0.0122	-0.0288**
	(0.0103)	(0.0118)
Business	0.0395***	0.0464***
	(0.00989)	(0.00944)
Constant	0.271***	0.456***
	(0.0680)	(0.0696)
Observations	20,985	20,339
R-squared	0.198	0.287
Hierarchy	No	No
Distress	No	No
Country, Year, Industry FE	Yes	Yes

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 Linear probability estimation results. Standard errors clustered at industry level. Data: World Bank Enterprise Survey (ES); World Bank Enterprise Survey – Innovation Follow Up Survey (IFS). Estimation Results for firms of all sizes. Baseline city: Metropolitan (pop. > 1 million).

Table A 5. Estimation Results – RLTS and Innovation

VARIABLES	(1) Product Innovation (IFS)	(2) Process Innovation (IFS)	(3) Product Innovation (IFS)	(4) Process Innovation (IFS)
RLTS	0.0298*	-0.0321**	0.0420**	-0.0353**
	(0.0153)	(0.0131)	(0.0184)	(0.0152)
RLTS x Bonus			-0.0478	0.00484
			(0.0362)	(0.0320)
Bonus			-0.0107	
			(0.0222)	
R&D	0.188***	0.141***	0.182***	0.131***
	(0.0167)	(0.0182)	(0.0176)	(0.0180)
Multi-plant	0.00124	-0.0446***	0.00616	-0.0460***
	(0.0182)	(0.0154)	(0.0188)	(0.0167)
State-owned	0.0904	0.0245	0.0378	0.0410
	(0.0845)	(0.0841)	(0.0990)	(0.0963)
Employees	0.0106	0.0112	0.0151*	0.0110
	(0.00767)	(0.00748)	(0.00821)	(0.00778)
Age	-0.000394	-0.000192	-0.000155	-0.000134
	(0.000534)	(0.000509)	(0.000544)	(0.000539)
Small City	0.0284	0.179***	0.0565	0.192***
	(0.0570)	(0.0433)	(0.0541)	(0.0440)
Medium City	0.0644**	0.0964***	0.0746***	0.111***
	(0.0271)	(0.0279)	(0.0271)	(0.0287)
Large City	0.0563**	0.0104	0.0727***	0.0144
	(0.0228)	(0.0200)	(0.0234)	(0.0205)
Capital	-0.0234	-0.0246	-0.0378	-0.0348
	(0.0268)	(0.0271)	(0.0287)	(0.0338)
Business	0.0582**	0.0264	0.0758***	0.0359
	(0.0232)	(0.0224)	(0.0246)	(0.0257)
Constant	0.416***	0.585***	0.369***	0.582***
	(0.0557)	(0.0528)	(0.0569)	(0.0579)
Observations	4,378	4,375	4,005	4,003
R-squared	0.199	0.222	0.210	0.228
Hierarchy	No	No	No	No
Distress	No	No	No	No
Country, Year, Industry FE	Yes	Yes	Yes	Yes

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 Linear probability estimation results. Standard errors clustered at industry level. Data: World Bank Enterprise Survey (ES); World Bank Enterprise Survey – Innovation Follow Up Survey (IFS). Estimation Results for firms with 20+ employees. RLTS = Reward for Long-Term Success. Bonus = Performance bonus based on production targets. Baseline city: Metropolitan (pop. > 1 million).

Table A 6. Estimation Results – Reward Structure and Process Innovation

VARIABLES	Process Innovation (IFS)
Short-term production targets	0.0213
	(0.0167)
Combinational production targets	0.0392**
	(0.0151)
Constant	0.753***
	(0.0871)
Observations	4,375
R-squared	0.222
Aux. Controls	Yes
Hierarchy	No
Distress	No
Country, Year, Industry FE	Yes

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 Linear probability estimation results. Standard errors clustered at industry level. Data: World Bank Enterprise Survey (ES); World Bank Enterprise Survey – Innovation Follow Up Survey (IFS). Estimation Results for firms with 20+ employees.

Table A 7. Estimation Results – Termination and Innovation

VARIABLES	(1) Product Innovation (ES)	(2) Process Innovation (ES)
Termination	-0.0552***	0.0226
	(0.0186)	(0.0304)
R&D	0.333***	0.382***
	(0.0216)	(0.0179)
Multi-plant	-0.0101	-0.0786***
	(0.0175)	(0.0156)
State-owned	0.126	0.0635
	(0.0768)	(0.0722)
Employees	0.0273***	0.0332***
	(0.00658)	(0.00691)
Age	0.000900*	0.000515
	(0.000465)	(0.000418)
Small City	0.0366	0.199***
	(0.0256)	(0.0475)
Medium City	0.101***	0.116***
	(0.0164)	(0.0163)
Large City	0.145***	0.168***
	(0.0149)	(0.0170)
Capital	0.0675**	-0.0796***
	(0.0287)	(0.0280)
Business	0.0886***	0.0882***
	(0.0177)	(0.0148)
Distress	0.00187***	-0.00101*
	(0.000550)	(0.000522)
Constant	-0.0401	0.356***
	(0.0592)	(0.0582)
Observations	6,942	6,937
R-squared	0.218	0.245
Hierarchy	No	No
Year, Industry FE	Yes	Yes

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 Linear probability estimation results. Standard errors clustered at industry level. Data: World Bank Enterprise Survey (ES); World Bank Enterprise Survey – Innovation Follow Up Survey (IFS). Estimation Results for firms of all sizes. Baseline city: Metropolitan (pop. > 1 million).

Table A 8. Estimation Results – Empowerment and Innovation

VARIABLES	(1) Product Innovation (IFS)	(2) Process Innovation (IFS)
Empowerment	0.0385***	0.0127
	(0.0129)	(0.0101)
Hierarchy	-0.0134	0.0204
	(0.0160)	(0.0158)
R&D	0.176***	0.132***
	(0.0165)	(0.0156)
Multi-plant	-0.00615	-0.0397**
	(0.0182)	(0.0165)
State-owned	0.0360	-0.0123
	(0.0857)	(0.0842)
Employees	0.00269	0.00998
	(0.00737)	(0.00829)
Age	-5.24e-05	-1.14e-05
	(0.000527)	(0.000481)
Small City	-0.0187	0.154***
	(0.0513)	(0.0420)
Medium City	0.0415	0.0821***
	(0.0251)	(0.0252)
Large City	0.0414**	0.00289
	(0.0199)	(0.0177)
Capital	-0.0155	-0.0185
	(0.0277)	(0.0263)
Business	0.0528**	0.0186
	(0.0233)	(0.0217)
Constant	0.435***	0.539***
	(0.0577)	(0.0604)
Observations	4,742	4,739
R-squared	0.196	0.207
Distress	No	No
Country, Year, Industry FE	Yes	Yes

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 Linear probability estimation results. Standard errors clustered at industry level. Data: World Bank Enterprise Survey (ES); World Bank Enterprise Survey – Innovation Follow Up Survey (IFS). Estimation Results for firms with 20+ employees. Baseline city: Metropolitan (pop. > 1 million).

Table A 9. Estimation Results – Corporate Culture, Termination and Innovation

VARIABLES	(1) Product Innovation (ES)	(2) Process Innovation (ES)
Corporate Culture	0.225***	0.394***
	(0.0202)	(0.0198)
Termination	-0.0613***	0.0114
	(0.0188)	(0.0244)
Constant	-0.121*	0.211***
	(0.0617)	(0.0535)
Observations	6,917	6,912
R-squared	0.247	0.334
Hierarchy	No	No
Distress	Yes	Yes
Aux. Controls (incl. R&D)	Yes	Yes
Country, Year, Industry FE	Yes	Yes

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 Linear probability estimation results. Standard errors clustered at industry level. Data: World Bank Enterprise Survey (ES); World Bank Enterprise Survey – Innovation Follow Up Survey (IFS). Estimation Results for firms of all sizes.

Table A 10. Estimation Results – RLTS, Empowerment and Innovation

VARIABLES	(1) Product Innovation (IFS)	(2) Process Innovation (IFS)
RLTS	0.0270*	-0.0338**
	(0.0152)	(0.0138)
Empowerment	0.0421***	0.0150
	(0.0144)	(0.0111)
Constant	0.385***	0.551***
	(0.0607)	(0.0593)
Observations	4,181	4,178
R-squared	0.197	0.210
Hierarchy	Yes	Yes
Distress	No	No
Aux. Controls (incl. R&D)	Yes	Yes
Country, Year, Industry FE	Yes	Yes

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 Linear probability estimation results. Standard errors clustered at industry level. Data: World Bank Enterprise Survey (ES); World Bank Enterprise Survey – Innovation Follow Up Survey (IFS). Estimation Results for firms with 20+ employees RLTS = Reward for Long-Term Success.

Table A 11. Conditional Logit Estimation Results – HRM and Innovation

	(1)	(2)	(3)	(4)
VARIABLES	Product Innovation (ES)	Product Innovation (IFS)	Product Innovation (ES)	Product Innovation (IFS)
Corporate Culture	1.029***			
	(0.0356)			
RLTS		0.154*		
		(0.0798)		
Termination			-0.289***	
			(0.0835)	
Empowerment				0.188***
				(0.0512)
Hierarchy				-0.0660
				(0.0725)
R&D	0.915***	0.894***	1.482***	0.838***
	(0.0412)	(0.0755)	(0.0609)	(0.0728)
Observations	20,946	4,295	6,925	4,672
Distress	No	No	Yes	No
Aux. Controls	Yes	Yes	Yes	Yes
Country, Year, Industry, FE	Yes	Yes	Yes	Yes

	(5)	(6)	(7)	(8)
VARIABLES	Process Innovation (ES)	Process Innovation (IFS)	Process Innovation (ES)	Process Innovation (IFS)
Culture	1.011***			
	(0.0364)			
RLTS		-0.166**		
		(0.0809)		
Termination			0.122	
			(0.0842)	
Empowerment				0.0693
				(0.0522)
Hierarchy				0.108
				(0.0768)
R&D	0.522***	0.701***	1.967***	0.651***
	(0.0428)	(0.0776)	(0.0714)	(0.0744)
Observations	20,299	4,332	6,926	4,711
Distress	No	No	Yes	No
Aux. Controls	Yes	Yes	Yes	Yes
Country, Year, Industry FE	Yes	Yes	Yes	Yes

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 Conditional Logit estimation results. Data: World Bank Enterprise Survey (ES); World Bank Enterprise Survey – Innovation Follow Up Survey (IFS). Estimation Results for firms of all sizes (Corporate Culture, Termination) and 20+ (RLTS, Empowerment) employees. RLTS = Reward for Long-Term Success.

Table A 12. Estimation Results – Conditioning on Employee Quality

VARIABLES	(1) Product Innovation (ES)	(2) Product Innovation (IFS)	(3) Product Innovation (ES)	(4) Product Innovation (IFS)
Culture	0.228***			
	(0.00832)			
RLTS		0.0307**		
		(0.0155)		
Termination			-0.0582***	
			(0.0187)	
Empowerment				0.0408***
				(0.0130)
Employee Quality	0.00418	-0.00676	-0.000584	-0.00678
	(0.00362)	(0.00673)	(0.00666)	(0.00627)
Constant	0.268***	0.493***	-0.0454	0.458***
	(0.0690)	(0.0849)	(0.0590)	(0.0842)
Observations	20,780	4,334	6,896	4,696
R-squared	0.198	0.197	0.216	0.195
Distress	No	No	Yes	No
Aux. Controls	Yes	Yes	Yes	Yes
Country, Year, Industry FE	Yes	Yes	Yes	Yes

VARIABLES	(5) Process Innovation (ES)	(6) Process Innovation (IFS)	(7) Process Innovation (ES)	(8) Process Innovation (IFS)
Culture	0.339***			
	(0.0105)			
RLTS		-0.0314**		
		(0.0134)		
Termination			0.0218	
			(0.0305)	
Empowerment				0.0119
				(0.0101)
Employee Quality	0.0129***	0.0147**	0.0288***	0.0140**
	(0.00353)	(0.00630)	(0.00729)	(0.00675)
Constant	0.451***	0.781***	0.312***	0.648***
	(0.0691)	(0.0862)	(0.0605)	(0.0856)
Observations	20,138	4,331	6,891	4,693
R-squared	0.288	0.221	0.248	0.207
Distress	No	No	Yes	No
Aux. Controls	Yes	Yes	Yes	Yes
Country, Year, Industry FE	Yes	Yes	Yes	Yes

Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 Linear probability estimation results. Standard errors clustered at industry level. Data: World Bank Enterprise Survey (ES); World Bank Enterprise Survey – Innovation Follow Up Survey (IFS). Estimation Results for all firm sizes (Culture, Termination) and firms with 20+ employees (RLTS, Empowerment). RLTS = Reward for Long-Term Success.