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The role of innovation and management practices in determining firm productivity in developing economies

Wiebke Bartz, Pierre Mohnen and Helena Schweiger

Abstract

In this paper we compare the effects of management practices and innovation on productivity, using data from a unique firm-level survey covering 30 mostly developing countries in eastern Europe and Central Asia in the period 2011-14. We adapt the well-established three-stage model by linking productivity to innovation activities and management practices. Results suggest that both returns to innovation and returns to management practices are important drivers of productivity in developing economies. However, productivity in lower-income economies is affected to a larger extent by management practices than by innovation while the opposite holds in higher-income economies. These results imply that firms operating in less favourable business environments can reap large productivity gains by improving the quality of management practices, before engaging in innovation by imitating and adapting foreign technologies.

Keywords: innovation, management practices, productivity, developing countries

JEL Classification Number: O3, M2, P21

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The working paper series has been produced to stimulate debate on economic transition and development. Views presented are those of the authors and not necessarily of the EBRD.

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1. Introduction

There are many ways in which firms can increase their productivity and thereby contribute to the improvement of aggregate productivity (see Syverson, 2011, for a review). However, the most common and most important driver of change within firms, particularly in advanced industrialised countries, is the introduction of new products, new processes or new ways of conducting business – in other words, innovation (see, for example, Geroski, 1989; Geroski et al., 2009).

The link between innovation and productivity is empirically generally positive and significant (see, for example, Mohnen and Hall, 2013, for an overview; recent studies by Hall and Sena, 2014, for the United Kingdom; Raymond et al., 2015, for Dutch and French manufacturing firms; Crespi and Zuniga, 2012, for six Latin American countries; Masso and Vather, 2008, for Estonian firms). Governments and policy-makers, regardless of the country's level of development, are keen to foster innovation (see, for example, European Commission, 2016), typically of the high-tech variety (EBRD, 2014).

While the concept of innovation as a driver of productivity is widely assessed in the literature, the role of the manager in determining firm performance has remained unexplored for a long time (Bertrand and Schoar, 2003). Existing empirical studies show that individual managers matter in determining firm performance. For example, evidence from the United States shows that managers have a significant impact on profitability (Mackey, 2008), investment and financing decisions (Bertrand and Schoar, 2003) as well as innovation (Galasso and Simcoe, 2011). In addition, there is evidence in FYR Macedonia that improving managers' business skills via technical assistance is associated with higher employment growth rates (Bah et al., 2011). Improvements in management practices also influence firm-level productivity in developed (Bloom and Van Reenen, 2007, 2010; Bloom et al., 2013b) and developing countries (Bloom and Van Reenen, 2010; Bloom et al., 2013a). Furthermore, studies reveal that a lack of managerial skills explains the low productivity of state-owned and formerly state-owned firms (see, for example, Brown et al., 2006; Steffen and Stephan, 2008; Estrin et al., 2009). An analysis of firm-level productivity should thus take the quality of management into account.

This paper combines both strands of research by assessing the impact of innovation as well as management practices on firm productivity. More specifically, we answer the question of whether both channels affect firm productivity significantly, with management practices having a direct impact on innovation and productivity, as well as an indirect impact on productivity via innovation. Moreover, we explore whether the importance of innovation and management practices varies according to the status of economic development. The catch-up growth literature suggests that firms in developing countries can imitate or adapt technologies introduced elsewhere in order to catch up with firms in advanced countries, while the latter need to innovate at the frontier to progress further (Acemoğlu et al., 2006; Aghion, 2016). However, there might be an even easier strategy for firms in the least developed countries: before they start imitating foreign production processes they can reap large productivity gains by improving their management practices. Furthermore, we ask whether the role of innovation and management in affecting firms' labour productivity varies across sectors with regard to the level of technical intensity. Again, productivity increases in the higher-tech sectors may be more likely to be driven by innovations, while management practices may be of higher importance in lower-tech sectors like food or textile producers, where the occurrence of innovative activities is by definition less frequent (Hall et al., 2009; EBRD, 2014).

We contribute to the literature in three important dimensions. First, our paper is the first to include both innovation and the quality of management practices in the model, rather than just one of them. In this paper we use a variation of the three-stage model devised by Crépon, Duguet and Mairesse (1998, known as the "CDM model"). In addition to research and development (R&D) we focus on management quality since in developing countries technological change is more likely to be driven by imitation and assimilation without formal R&D, whereas management practices are adopted everywhere.

Second, we use data from a unique firm-level survey, the fifth round of the European Bank for Reconstruction and Development (EBRD) – World Bank (WB) Business Environment and Enterprise Performance Survey (BEEPS V). For the first time, BEEPS V included an Innovation Module, with the aim of obtaining a better understanding of innovation in its various forms (that is, product, process, organisational and marketing), R&D and management practices. Our sample covers 30 countries in eastern Europe and Central Asia[1] in the period 2011-14, with a wide variety in terms of economic and institutional development. Within each of these countries, the sample of firms is representative, with a large variation in productivity levels. Due to data availability we focus on manufacturing enterprises with at least 20 employees.

Large differences in productivity across both firms and countries continue to exist (see, for example, Griffith et al., 2006; Arnold et al., 2008, for OECD countries; and Hsieh and Klenow, 2009, for China and India), and can be found even in industries producing very homogenous goods (Foster et al., 2008). In that respect, the countries in our sample are no exception: there are highly productive firms in lower-income economies and poorly performing firms in higher-income economies (Chart 1). Moreover, Akcigit et al. (2016) show that managerial delegation is important for firm selection: in developing countries, where managerial human capital is scarce and managerial delegation less efficient, firms with growth potential are not expanding enough to replace firms with little growth potential. Having such a diverse sample allows us to assess under which conditions firm productivity is boosted the most – through innovation or the quality of management.

Third, we improve the measures of product and process innovation typically available in surveys by analysing the verbatim descriptions of the firms' new products and processes and comparing them with the definitions in the Oslo Manual (Eurostat and OECD, 2005), which contains the guidelines for the collection and use of data on innovation activities. To our knowledge, this is the first paper to do so for a large number of countries.[2]

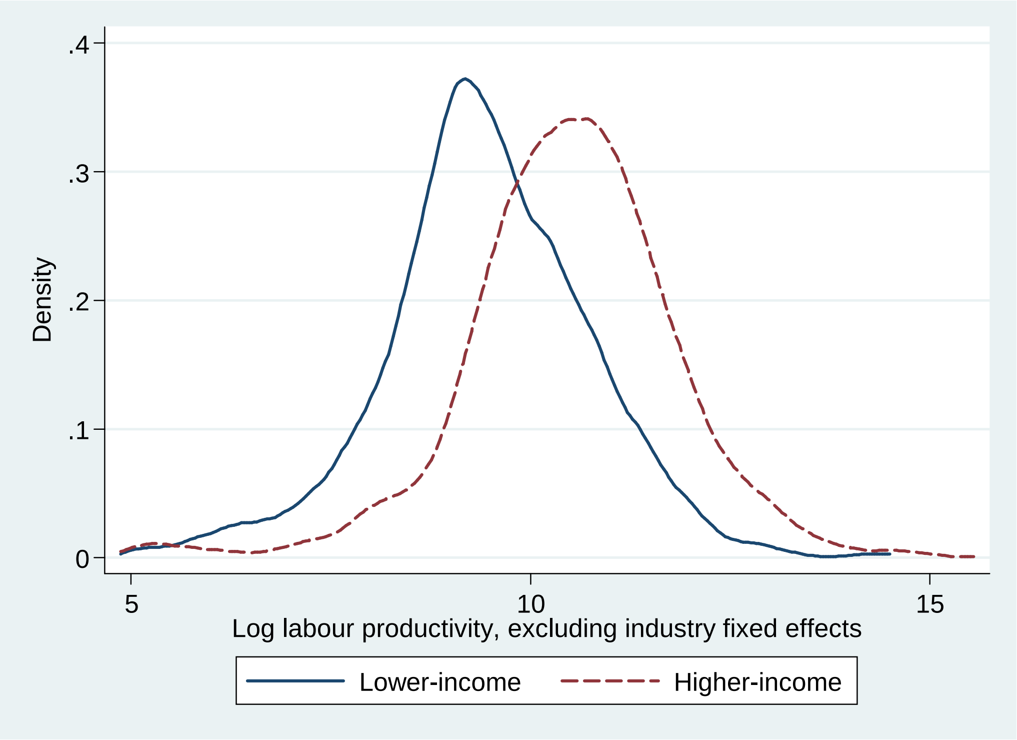
We find that both management practices and innovation (regardless of the type) are positively and significantly associated with labour productivity. However, the importance of each varies with the level of development. In lower-income economies, the economic impact of high quality management practices is stronger than the effect of introducing product and process innovation whereas the opposite holds for higher-income economies. We interpret these findings as evidence that economic progress can be achieved by improving management practices despite an unfavourable environment for innovative activities. Likewise, we find evidence that high quality management practices have a stronger impact on labour productivity than innovation in lower-technology intensity sectors, but not in higher-technology intensity sectors. Again, this implies that firms operating in an environment where

[1] Unless stated otherwise, the analysis includes the following countries: Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, FYR Macedonia, Georgia, Hungary, Kazakhstan, Kosovo, Kyrgyz Republic, Latvia, Lithuania, Moldova, Mongolia, Montenegro, Poland, Romania, Russia, Serbia, Slovak Republic, Slovenia, Tajikistan, Turkey, Ukraine and Uzbekistan.
[2] Arundel et al. (2013) do a similar exercise for Australia only.

innovations are scarce can improve their performance by improving the quality of their management practices.

The remainder of the paper is organised as follows. Section 2 describes the data. Section 3 presents the underlying model, while Section 4 contains the estimates and Section 5 a number of robustness checks. Section 6 concludes.

Chart 1: Distribution of firm level log labour productivity in manufacturing



Source: BEEPS V and authors' calculations.

Note: Firm-level labour productivity is measured in logs and defined as sales per employee. Cross-country differences in sectoral composition are controlled for. Sales in local currency are converted to US dollars using the average official exchange rate.[3] The World Bank income classification is based on GNI per capita in 2007 (see Table 1). Lower-income countries include low- and lower-middle income countries, while higher-income countries include upper-middle- and high-income countries.

[3] The results do not change significantly if purchasing power parities are used instead.

2. Data and descriptive statistics

Our main data source is BEEPS, a firm-level survey conducted by the EBRD and World Bank. BEEPS is based on face-to-face interviews with managers of registered firms with at least five employees to examine the quality of the business environment. It covers topics such as infrastructure, competition, sales and supplies, labour, innovation, land and permits, crime, finance, employment and business-government relations. Stratified random sampling is used to select eligible firms to participate in the survey. Strata are defined by sector (typically manufacturing, retail and other services), size (5-19, 20-99 and 100+ employees) and regions within a country. The recent fifth round of the survey (BEEPS V) was completed in 2012 in Russia and 2014 in all other countries. In addition to the topics mentioned above, BEEPS V included an innovation module with a section on management practices.[4]

In this paper we focus on manufacturing firms with at least 20 employees (50 in Russia[5]), for which both measures of innovation and management practices are available. Table 1 provides an overview of our sample including the geographical region and income level of the countries that firms belong to as well as a few descriptive statistics.[6] The number of observations per country ranges from 16 in Montenegro to 380 in Ukraine, 479 in Russia and 693 in Turkey.[7] In the same vein, the occurrence of innovation varies by country. While in the Czech Republic 54 per cent of firms brought a technological innovation onto the market, only one per cent of firms engaged in technological innovation activities in Azerbaijan. Likewise, the share of firms that report management practices of higher quality than the median of all firms in the sample varies from 8 per cent in Georgia to 87 per cent in the Slovak Republic.

2.1 Measuring innovation

The innovation module of BEEPS V builds on the established guidelines published in the third edition of the Oslo Manual (Eurostat and OECD, 2005), covering product and process innovation, organisational and marketing innovation, R&D spending and the protection of innovation.

Survey respondents were asked whether their firm had introduced any new or significantly improved product, process, organisational or marketing method in the last three years. The first two types of innovation are referred to as technological innovations, the latter two as non-technological innovations. Examples for each type of innovation were given to generate a common understanding of the definition of innovation. While non-innovators did not receive additional questions on innovations, innovating firms were asked to provide more information, including a detailed description of their main product or process innovation (in terms of impact on sales or costs respectively).

[4] See http://ebrd-beeps.com for further details.
[5] Russia was the first country in which BEEPS V was implemented. The number of firms with at least 50 employees was not as high as expected, so the threshold was lowered to 20 employees in subsequent countries.
[6] Data availability varies. For example, information on capital per employee is available only for about a third of the sample. Our findings are robust to its inclusion in the estimation (see section 5.2). Information on sales per employee is not available for almost one-fifth of the sample; there are some differences between firms that have such information available and those that do not, but there is not much we can do about them.
[7] As shown in section 5.3, our results are robust to excluding one country at a time.

Table 1: Sample breakdown

Country	Number of observations: All	With sales per employee	With sales and capital per employee	Proportion of firms with technological innovation (cleaned)	Proportion of firms with non-technological innovation (self-reported)	Proportion of firms with above median quality of management	Geographical region	WB income classification
Albania	52	46	8	0.111	0.067	0.556	SEE	Lower-middle-income
Armenia	67	46	19	0.169	0.185	0.369	EEC	Lower-middle-income
Azerbaijan	72	55	7	0.014	0.058	0.870	EEC	Lower-middle-income
Belarus	74	66	32	0.521	0.595	0.635	EEC	Upper-middle-income
Bosnia and Herzegovina	59	53	37	0.411	0.379	0.552	SEE	Upper-middle-income
Bulgaria	58	57	37	0.260	0.460	0.460	SEE	Upper-middle-income
Croatia	57	53	40	0.353	0.481	0.759	CEB	High-income
Czech Republic	66	61	28	0.543	0.327	0.673	CEB	High-income
Estonia	40	37	26	0.407	0.286	0.571	CEB	High-income
FYR Macedonia	56	54	40	0.367	0.588	0.373	SEE	Lower-middle-income
Georgia	54	50	21	0.208	0.208	0.083	EEC	Lower-middle-income
Hungary	47	30	16	0.235	0.205	0.359	CEB	High-income
Kazakhstan	121	100	22	0.289	0.316	0.479	Central Asia	Upper-middle-income
Kosovo	39	34	20	0.400	0.649	0.432	SEE	Lower-middle-income
Kyrgyz Republic	63	54	19	0.339	0.444	0.492	Central Asia	Low-income
Latvia	52	47	12	0.229	0.313	0.563	CEB	Upper-middle-income
Lithuania	56	50	25	0.425	0.439	0.585	CEB	Upper-middle-income
Moldova	53	47	13	0.489	0.563	0.500	EEC	Lower-middle-income
Mongolia	60	58	15	0.333	0.544	0.491	Central Asia	Lower-middle-income
Montenegro	16	10	5	0.357	0.357	0.357	SEE	Upper-middle-income
Poland	109	79	18	0.277	0.353	0.318	CEB	Upper-middle-income
Romania	101	95	72	0.521	0.600	0.620	SEE	Upper-middle-income
Russia	479	407	150	0.522	0.507	0.688	Russia	Upper-middle-income
Serbia	50	47	28	0.333	0.400	0.533	SEE	Upper-middle-income
Slovak Republic	57	42	16	0.174	0.255	0.863	CEB	High-income
Slovenia	37	36	26	0.541	0.405	0.595	CEB	High-income
Tajikistan	57	38	14	0.311	0.404	0.327	Central Asia	Low-income
Turkey	693	459	196	0.123	0.223	0.405	Turkey	Upper-middle-income
Ukraine	380	282	71	0.235	0.222	0.415	EEC	Lower-middle-income
Uzbekistan	94	87	66	0.144	0.077	0.253	Central Asia	Low-income
Total	3,219	2,580	1,099					

Source: BEEPS V.

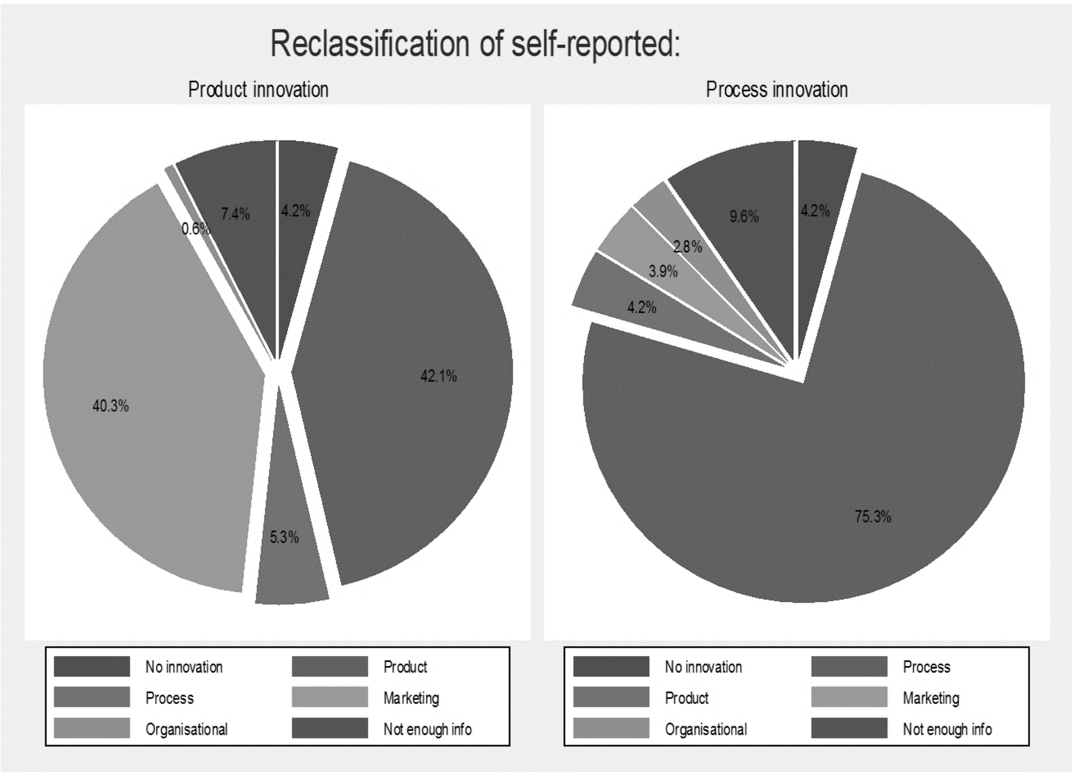
Note: WB income classification is based on GNI per capita in 2007. Low-income economies are those with a GNI per capita of US$ 935 or less in 2007. Middle-income economies are those with a GNI per capita of more than US$ 935 but less than US$ 11,456. Lower middle-income and upper middle-income economies are separated at a GNI per capita of US$3,705. High-income economies are those with a GNI per capita of US$11,456 or more. CEB = central eastern Europe and the Baltic states. SEE = south-eastern Europe. EEC = eastern Europe and the Caucasus. The median quality of management is 0.074.

This information was used to analyse whether the respective innovation complies with the formal definitions of product and process innovation, thereby taking into account the firm's main business. Based on this assessment, innovators may be reclassified as non-innovators, or moved to another category of innovation than the one self-reported. As a result, about two-thirds of the self-reported innovations were reclassified, whereby 24 per cent were no longer classified as an innovating firm, while the remaining innovations were reclassified according to their type. Such data "cleaning" can only be done for product or process, that is, technological innovations, as no additional questions were asked for non-technological innovations.

Chart 2 shows the percentage of self-reported product and process innovations that were reclassified as part of that cleaning process. Two types of misunderstanding were particularly common (EBRD, 2014):

- product customisation was considered to be a product innovation, for example, changing clothing lines seasonally is not a product innovation
- marketing innovations were considered as product innovations, whereas in fact changes in design are marketing innovations, as long as the characteristics of the product remain unmodified. For example, producing a waterproof outdoor jacket is a product innovation. By contrast, a change in the shape or colour of the outdoor jacket is a marketing innovation.

Chart 2: Reclassification of self-reported product and process innovation



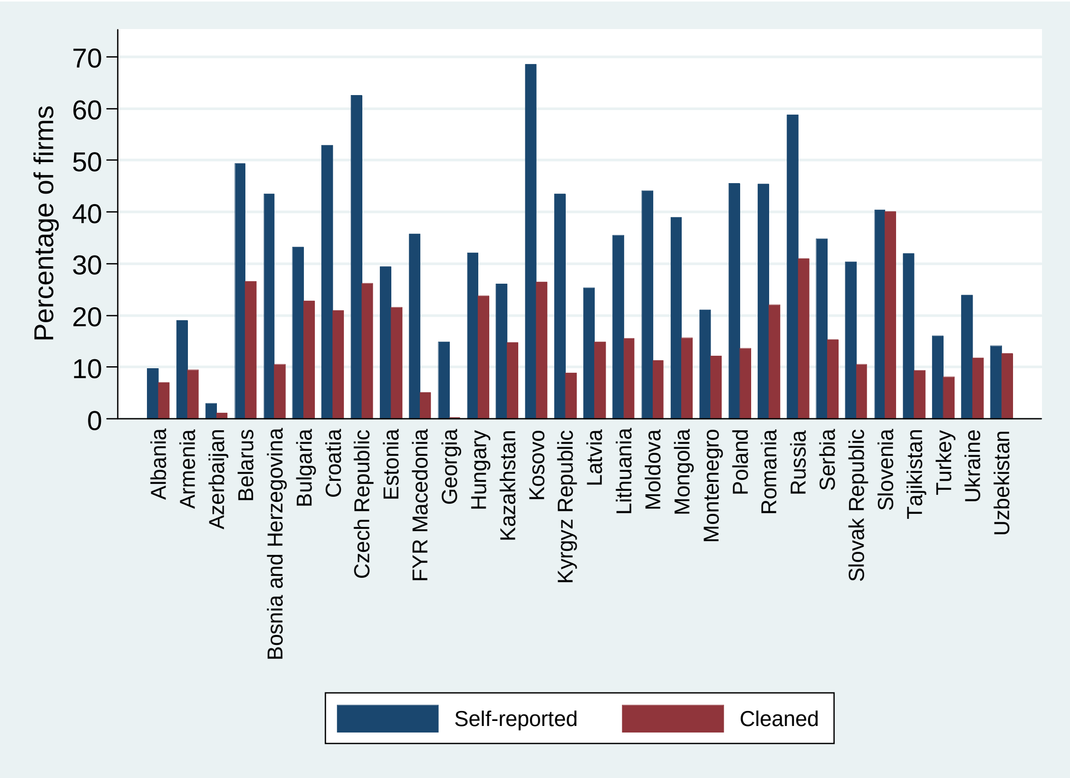
Source: BEEPS V and authors' calculations.

All in all, the BEEPS V methodology and the efforts made to cross-check and reinterpret individual responses go a long way towards achieving comparability of results across countries and firms. Still, they cannot ensure a common understanding of innovation across all survey respondents.

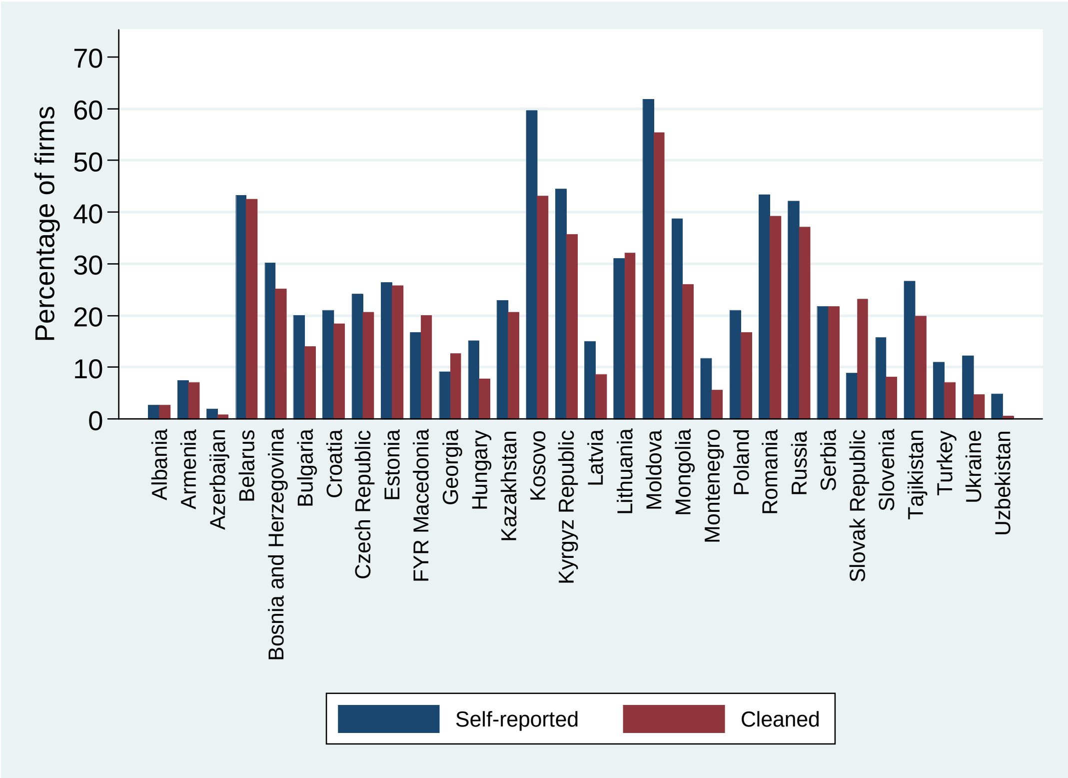
Chart 3 illustrates the innovation activity of the firms in our sample. In Slovenia, almost half of all the firms introduced new products, compared with less than 2 per cent in Georgia (panel (a)). More than 40 per cent of firms in Belarus and Moldova introduced new processes, while only 4.4 per cent did so in Hungary (which, however, is closer to the technological frontier) (panel (b)). Almost a third of all firms in our sample introduced new organisational or marketing methods, ranging from 5.6 per cent in Azerbaijan to 66.7 per cent in Kosovo (panel (c)).

Chart 3: Percentage of firms that engaged in product, process and organisational or marketing innovation

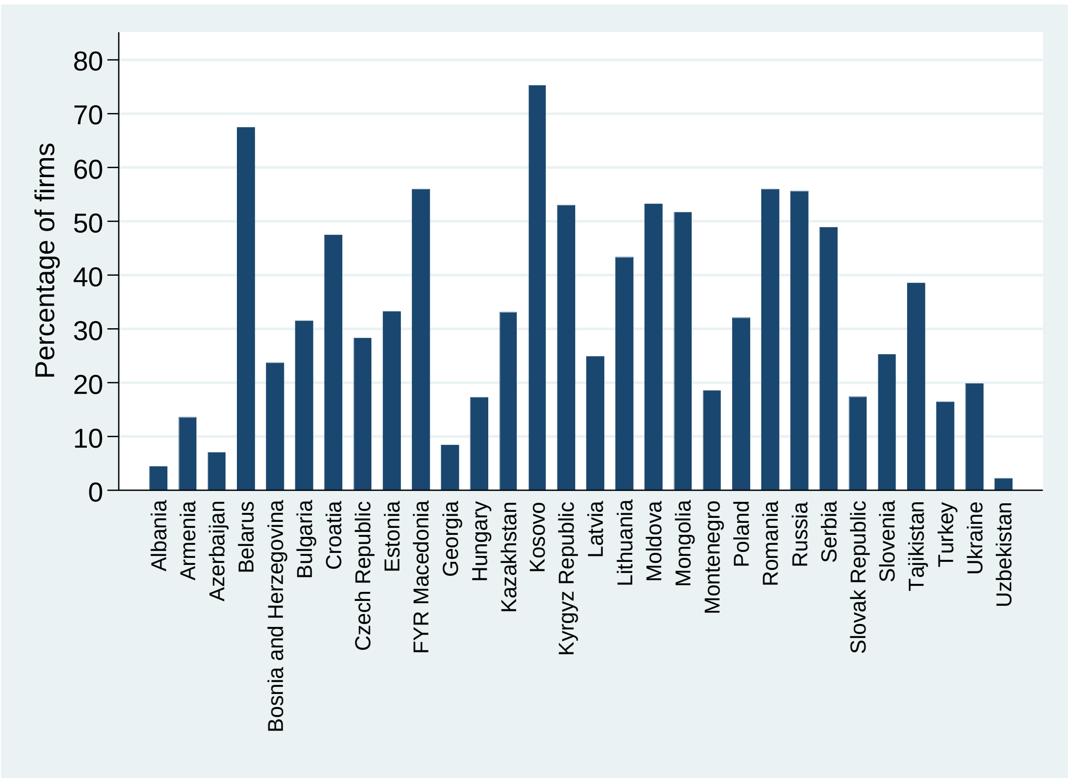
a) Product innovation (self-reported and cleaned)



b) Process innovation (self-reported and cleaned)



c) Organisational or marketing innovation (self-reported)



Source: BEEPS V and authors' calculations.

2.2 Management practices

Besides innovation, this paper highlights the role of management practices in determining productivity at the firm level. In order to examine their impact, we use survey responses to measure management practices. This survey section includes a selection of questions from the U.S. Census Bureau's Management and Organisational Practices Survey (MOPS) (Bloom et al., 2013b). The questions concerned four aspects of management – operations, monitoring, targets and incentives – and requested unordered categorical responses. The section on operations focused on how the firm handled a process-related problem, such as a machinery breakdown, while the question on monitoring covered the collection of information on production indicators. The timescale for production targets, as well as their difficulty and the awareness of them, are part of the section on targets. Lastly, the questions on incentives covered criteria governing promotion, practices for addressing poor performance by employees and the basis on which the achievement of production targets was rewarded. These questions were directed to all manufacturing firms with at least 20 employees (50 in the case of Russia). The median number of completed interviews with sufficiently high response rates to the management practices section was just below 55 per country, with totals ranging from 15 in Montenegro to 626 in Turkey.[8] On the basis of firms' answers, the quality of their management practices can be assessed and assigned a rating, which can then be used to explain productivity levels.[9]

As the scaling varies across management practices, we first standardise the scores of each management practice (that is, each question) to having a mean of zero and a standard deviation of one (as in EBRD, 2009; Bloom et al., 2012; EBRD, 2014):

$$(1)\quad z_{m_{ji}} = \frac{m_{ji} - \overline{m_j}}{\sigma_{m_j}}$$

where $z_{m_{ji}}$ is the standardised score (or z-score) of management practice m_j in firm i, $\overline{m_j}$ is the unweighted average of management practice m_j across all observations in all countries and σ_{m_j} is the standard deviation of management practice m_j across all firms in all countries. We then use the z-scores to calculate unweighted averages making use of the z-scores for each individual section of the respective management practice, in order to prevent accentuating the target or incentive section, which include multiple questions:

$$(2)\quad \overline{m}_{i,A} = \frac{1}{n_{m_{ji,A}}} \sum_{m_j \in A} z_{m_{ji}} \,,$$

$\overline{m}_{i,A}$ is the z-score of management practice for firm i, in a particular area of management A (operations, monitoring, targets or incentives), and $n_{m_{ji,A}}$ denotes the number of observations for which the measures are available. Lastly, we compute an unweighted average across the scores for the four management areas, and standardise once more this unweighted average:[10]

$$(3)\quad \tilde{M}_i = \frac{1}{4}\left(\overline{m}_{i,\text{operations}} + \overline{m}_{i,\text{monitoring}} + \overline{m}_{i,\text{targets}} + \overline{m}_{i,\text{incentives}}\right)$$

[8] The questions on management practices came at the end of a long face-to-face interview. This resulted in an unusually large number of people responding "don't know" or refusing to answer. Observations with a response rate excluding don't know or refusal below 62.5 per cent prior to recoding described in the Online appendix were excluded.

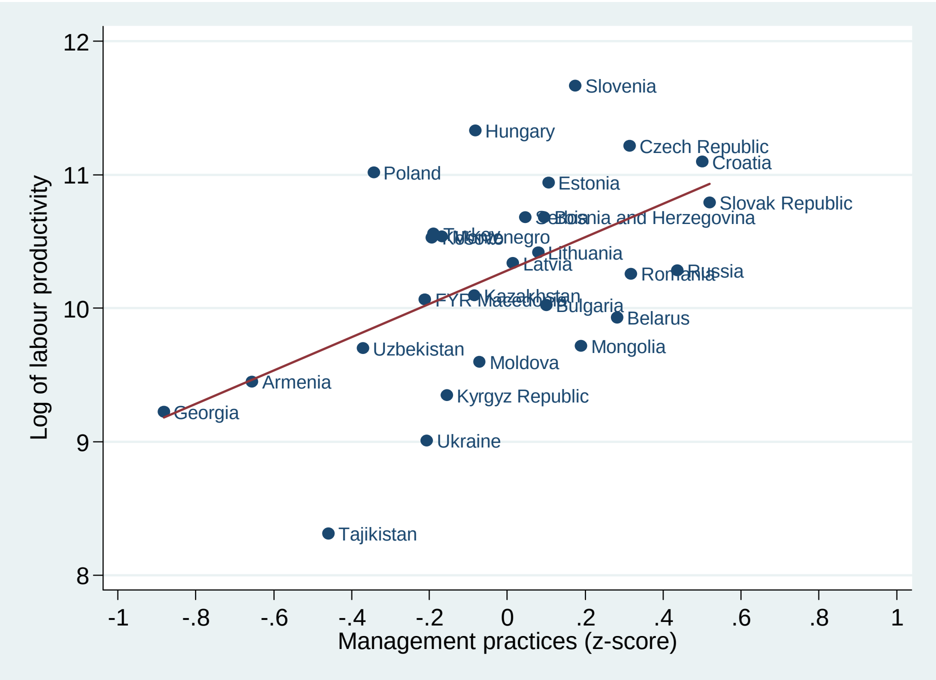
[9] Online appendix A1 provides more details on the questions and the ratings.

[10] We follow an established way of calculating index numbers – see Bresnahan et al. (2002).

$$(4)\quad z_{\tilde{M}_i} = \frac{\tilde{M}_i - \overline{\tilde{M}}}{\sigma_{\tilde{M}}} \quad .$$

That is, the average management score across all firms for which the underlying variables are available for all countries is equal to zero. Management practices of individual firms in turn deviate either left or right from zero. While the former indicates below average management practices, obtaining a positive overall z-score refers to a higher quality of management practices. As Bloom et al. (2012) put it, “indicators of management practices can be thought of as indicators for the quality of management (a latent variable, which cannot be observed directly)” (p. 601). Univariate statistics indeed emphasise the positive link between management practices and productivity that was established by, for example, Bloom et al. (2012). We find a significant positive correlation between average labour productivity and the average quality of management practices (Chart 4). Countries where the average quality of management is lower have a smaller percentage of firms with good management practices than countries where the quality of management practices tends to be higher. Lastly, we dichotomise the management quality variable by defining a variable Md_i that takes value 1 when $z_{\tilde{M}_i}$ is greater or equal to the median value for all firms in the sample and 0 otherwise.[11] Measuring the quality of management practices as an indicator variable instead of a continuous variable allows us to compare more easily the coefficients on innovation and management practices.

Chart 4: The average quality of management practices and average labour productivity



Source: BEEPS V and authors’ calculations.

[11] We preferred defining the dichotomous variable with respect to the median instead of the mean to diminish the influence of outliers. The median of (4) was 0.075, hence not very different from the mean (0).

2.3 Differences between management practices and innovation

There is potentially some overlap between management practices and organisational innovation, which deals primarily with people and the organisation of work. For example, the first introduction of quality management systems or lean production is an organisational innovation in business practices as well as an improvement in management practices. However, not every improvement in management practices is an organisational innovation; once a firm has introduced a quality management system, its further improvements are not organisational innovations anymore.

Furthermore, the survey measures the quality of management practices over the last complete fiscal year and *not improvements* in management practices. This is further reflected in the fact that the correlation coefficient between the quality of management practices and organisational innovation is only 0.1981 (even if it is statistically significant at p=0.000). Correlation coefficients with other measures of innovation (product, process and marketing) are even lower.[12] Hence, we are confident that our results on the impact of management practices on productivity are not confounded with innovation activities.

[12] The correlation coefficient of the quality of management practices and cleaned product innovation is 0.164 (self-reported 0.175), with cleaned process innovation it is 0.161 (self-reported 0.167) and with marketing innovation it is 0.149 in the full sample, all statistically significant at p=0.000.

3. Estimation model

In this paper we extend the original CDM model by adding the quality of management practices as an explanatory variable in innovation and productivity. The quality of management practices and R&D influence innovation, and labour productivity is related to firm innovation activities.[13] That is, we explain (i) the quality of management practices, (ii) the occurrence of R&D, (iii) the decision to innovate and (iv) the firm's labour productivity.

More concretely, our model is composed of three sets of equations shown below and graphically represented in Chart 5:

(5) $Md_i = 1[M_i^* \geq 0]$, <u>and</u> $R_i = 1[R_i^* \geq 0]$ where

$$M_i^* = X_{i1}\beta_1 + X_{i2}\beta_2 + X_{i3}^1\beta_3 + \varepsilon_{i1}$$

$$R_i^* = X_{i1}\gamma_1 + X_{i2}\gamma_2 + X_{i3}^2\gamma_3 + \eta_{i1}$$

(6) $Innov_i = 1[Innov_i^* > 0]$, where

$$Innov_i^* = \delta_M M_i^* + \delta_R R_i^* + X_{i4}\delta_4 + X_{i2}\delta_2 + X_{i1}\delta_1 + \varepsilon_{i2}$$

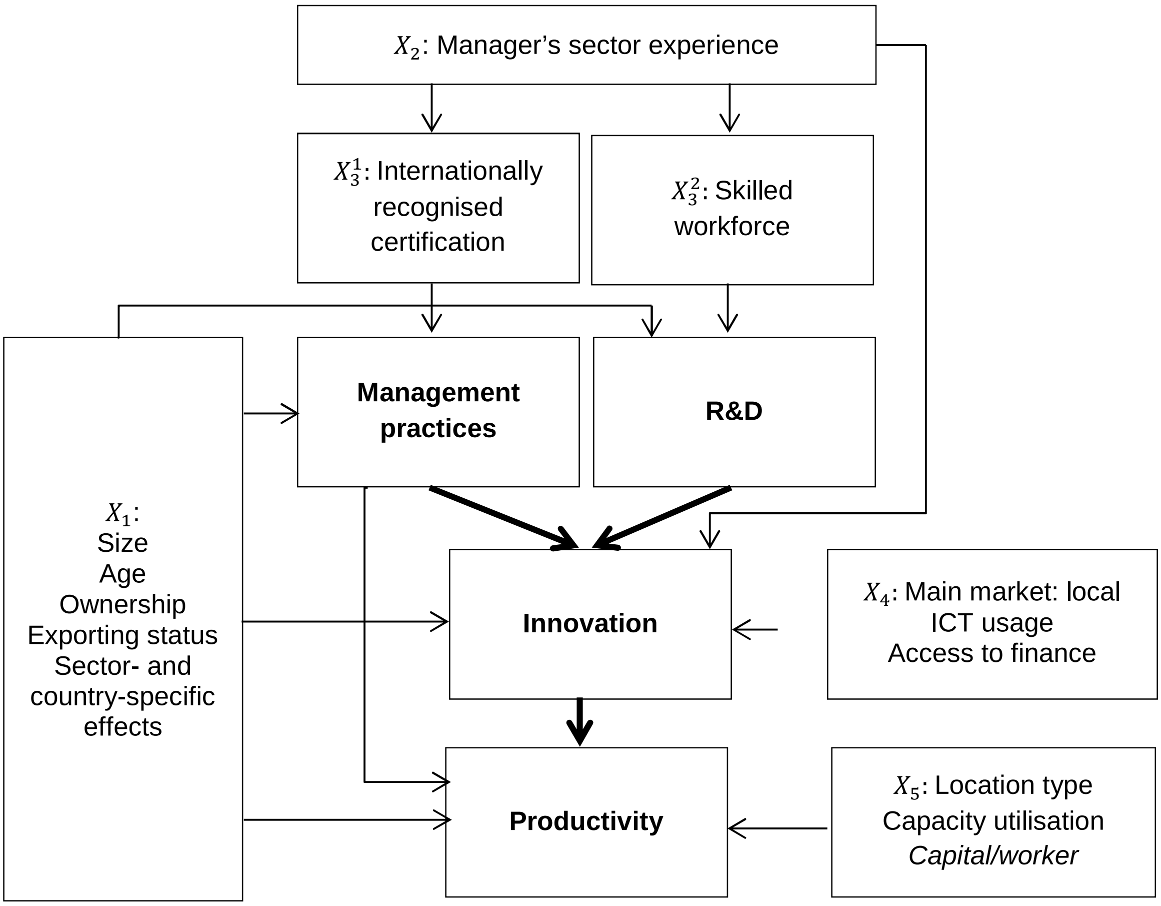
(7) $Prod_i = \theta_I Innov_i^* + \theta_M M_i^* + X_{i5}\theta_5 + X_{i1}\theta_1 + \varepsilon_{i3}$

The first set of equations, equation (5), is a bivariate probit model describing the binary variables of performing R&D and having management practices above the median of the overall distribution in the sample. ε_{i1} and η_{i1} follow a bivariate standard normal distribution. X_{i1} is a vector of control variables that occur in all the equations of the model; it includes the age of the firm, its size, ownership structure (whether a foreign company or the state have at least a blocking minority in the firm – a stake of 25 per cent or more), direct exporter status, and sector and country fixed effects, which account for differences in management practices, R&D, innovation, and productivity across sectors and countries. Start-ups or young firms are often assumed to be more innovative and/or productive, although survey evidence shows that this is not necessarily the case in the transition region, where large and old firms are more likely to engage in innovation activities (EBRD, 2014). Foreign owners may be an important source of information about new products, processes, organisational and marketing methods (EBRD, 2014). Foreign-owned firms may also have superior management practices and human capital (Girma and Görg, 2007; Kumar and Aggarwal, 2005). In contrast, managers of state-owned firms may have weaker incentives to achieve efficiency savings and improve productivity. Exporting firms may be more willing to use best practice management techniques so that they can compete on the international market, and they also learn about new products and processes through exporting.

X_{i2} comprises the variable that directly affects the quality of management practices, the likelihood of engaging in R&D activities, and the probability of innovating: the number of years of the manager's experience in the sector. Acemoğlu et al. (2015) suggest that openness to disruption, proxied by the manager's age, is associated with more creative innovations. Our dataset does not include the manager's age; instead, we control for the length of the manager's experience in the sector. Balsmeier and Czarnitzki (2014) show that managerial experience (the number of years the manager works in the same industry) increases innovativeness, especially in institutionally less developed economies.

[13] More concretely, the share of firms that engaged in R&D ranges from zero in Albania and Azerbaijan to more than 40 per cent in the Czech Republic.

Chart 5: Variation of the CDM model used in this paper



Source: Authors' representation of the model.

Note: Based on Crépon et al. (1998). X_{i2}, X_{i3}^1 and X_{i3}^2 also contain indicators for "don't know" values of the number of years of manager's sector experience, having an internationally recognised certification and percentage of employees with a completed university degree, respectively.

X_{i3}^1 contains the variable exclusive to management practices, namely an indicator taking the value of 1 if the firm has obtained an internationally recognised certification (such as HCPP, ISO or similar) and 0 otherwise. We expect that following international best practice standards improve management practices at the firm level (see, for example, Subba Rao et al., 1997). Likewise X_{i3}^2 is the variable exclusive to R&D, namely the percentage of employees with a completed university degree.[14]

The second equation of the model, equation (6), determines the probability of a firm implementing innovation, taking into account its management practices. The latent variables M_i^* and R_i^* derived from (5) are used to explain the effect that management practices and R&D exert on innovative activities. δ_M and δ_R denote the impact that the quality of management practices and R&D performance have on the probability to innovate. $Innov_i$ refers to the occurrence of one or a combination of the various types of innovation mentioned

[14] X_{i2}, X_{i3}^1 and X_{i3}^2 also contain indicators for "don't know" values of the number of years of a manager's sector experience, having an internationally recognised certification and percentage of employees with a completed university degree, respectively.

earlier. The probability of observing such an innovation is explained by the vectors X_{i1} and X_{i2} as before, as well as X_{i4}, which includes the set of variables that appear only in equation (6). These are whether a firm has a loan or a line of credit (a measure of access to finance), the firm's level of geographical expansion, that is whether the firm's main product is mostly sold in the local market, and the firm's level of ICT use (in other words, whether it uses email to communicate with its clients). While banks do not necessarily finance R&D or introduce new products, processes or other types of innovation directly – especially when innovation is of the more risky, frontier moving type – having access to a loan or a line of credit means that the firm can use its internal sources for financing R&D or innovation, rather than using them for working capital or fixed assets purchases (EBRD, 2014; Bircan and De Haas, 2015). Firms that sell their products mostly in the local (that is, municipal or regional) market are less likely to innovate, as their ability to spread the cost associated with innovation is low. Firms that use ICT have better access to information about innovations appearing elsewhere and the needs of their clients.[15]

The final equation of the model, equation (7), relates the firm's innovative activities – or more precisely, the latent variable that determines whether or not the firm innovates – to labour productivity (measured as sales per employee, converted into US dollars, in natural logarithmic terms).[16] θ_I captures the marginal effect of innovation occurrence and θ_M the direct marginal effect of management quality on labour productivity. In addition to the set of control variables in X_{i1} , the augmented production function includes variables contained in vector X_{i5}: information on whether the firm is located in the country's capital or main business centre and capacity utilisation. As a robustness check we also add the log of fixed assets per employee, the insertion of which, however, significantly reduces the sample size (Table 2).

We also explicitly control for the quality of management practices in the productivity equation, thus productivity is affected by management practices not only indirectly via innovation, but also directly by including the latent variable of management practices as an explanatory variable in the productivity equation. In this paper we are primarily interested in coefficient θ_I, which reflects the impact that innovation has on labour productivity, and the expression $\theta_M + \theta_I * \delta_M$, which reflects the accumulated direct and indirect impact that the quality of management practices has on labour productivity.

In summary, we propose a recursive system of simultaneous equations, where exclusion restrictions that are based on theoretical considerations or empirical evidence are used to identify the drivers of our endogenous variables. The selectivity of R&D, management practices and innovation is explicitly modelled and explains the complexity behind the observed correlations between these variables and productivity. For instance, the correlation observed between innovation and productivity may be weaker than the true underlying impact that innovation has on productivity. Indeed, if poorly performing firms find themselves under greater pressure to innovate, innovation may appear to be linked to poor short-term performance, although it improves firms' productivity in the longer run.

We estimate the model by asymptotic least squares, as was done in the original CDM paper (Crépon et al., 1998). That is, we first estimate the reduced form of the model by a bivariate probit for the management quality and R&D equations, a simple probit for the innovation equation, and an OLS for the productivity equation. In a second stage we minimise the

[15] We found none of the variables in X_{i4} to be statistically significant if also included in (5) or (7).
[16] Note that the way the questionnaire is set up, innovation occurs within the three-year period preceding the survey, while the productivity and management quality data refer to the last complete fiscal year, which is typically the last year of the three-year period that innovation variables refer to.

distance between the reduced form and the structural form parameters using the identification conditions. We winsorise labour productivity at 1 per cent to reduce the impact of outliers on the results and use cleaned measures of innovation, which are based on the actual descriptions of new products and processes introduced and comply with the definitions in the Oslo Manual.

Table 2 shows the number of observations, mean and standard deviation for the main variables in the various subsamples that correspond to our estimating equations. It also indicates the exclusion restrictions that underlie the identification of the structural parameters of the model. [17] The β and γ coefficients are identified; for the δ coefficients to be identifiable, we need and have two exclusion restrictions; for the θ coefficients to be identifiable we need two exclusion restrictions and we have six.

[17] The results are robust to using the same number of observations in all three stages. We have favoured using the maximum possible number of observations in each equation to increase the efficiency of the estimation.

Table 2: Descriptive statistics by subsample underlying each equation

	Management and R&D equations			Innovation equation			Productivity equation		
	N	Mean	Std. dev.	N	Mean	Std. dev.	N	Mean	Std. dev.
Control variables									
<5 years old	2,842	0.058	0.233	2,766	0.058	0.234	2,139	0.057	0.232
20-99 employees	2,842	0.620	0.485	2,766	0.621	0.485	2,139	0.627	0.484
25+% foreign ownership	2,842	0.118	0.323	2,766	0.117	0.321	2,139	0.121	0.326
25+% state ownership	2,842	0.027	0.163	2,766	0.027	0.161	2,139	0.028	0.164
Direct exporter	2,842	0.410	0.492	2,766	0.405	0.491	2,139	0.424	0.494
Manager's sector experience (number of years)	2,842	18.350	11.430	2,766	18.380	11.440			
Exclusion restrictions									
Internationally recognised certification	2,842	0.463	0.499						
% FTE with university degree (per cent)	2,842	20.85	21.66						
ICT usage				2,766	0.472	0.499			
Access to finance				2,766	0.316	0.465			
Main market: local				2,766	0.925	0.264			
Capacity utilisation							2,139	75.77	21.73
Capital or main business city							2,139	0.213	0.409
Capital per employee (logs)*							993	8.983	2.201
Outcome variables									
Above-median quality of management practices	2,842	0.501	0.500						
R&D (self-reported, observed)	2,842	0.191	0.393						
Product innovation (cleaned, observed)				2,766	0.168	0.374			
Process innovation (cleaned, observed)				2,747	0.195	0.396			
Technological innovation (cleaned, observed)				2,711	0.296	0.457			
Non-technological innovation (self-reported, observed)				2,817	0.339	0.474			
Log (labour productivity)							2,139	10.180	1.422

Source: BEEPS V and authors' calculations.

Note: All variables, unless otherwise indicated, are dummies. * Capital per employee is only used for robustness checks. FTE = full-time employees.

4. Estimation results

We now turn to the estimation results, more precisely the total marginal effects (direct and indirect) of all our control variables on the various endogenous variables of our model. We explore possible sources of heterogeneity depending on the country level of development or the sector level of technology intensity.

4.1 Baseline specification

Table 3[18] shows that the estimated marginal effects of the quality of management practices ($\theta_M + \theta_I \delta_M$) and innovation ($\theta_I$) on productivity are economically and statistically significant, while the marginal effect of R&D ($\theta_I \delta_R$) is not.[19] On average, a high quality of management practices is associated with higher labour productivity more than the occurrence of any type of innovation. It should be noted that, whenever management practices, R&D and innovationappear as explanatory variables in equations (4) and (5), their latent variables are used and not the observed binary variables. This has the advantage of providing a measure for these variables even when they are actually reported as being equal to zero. Indeed, small values for R&D and innovation may not be reported and therefore these variables may be mis-measured (Crépon et al., 1998; Raymond et al., 2015).

Another way to interpret these marginal effects is in terms of the differences in the means of latent variables of firms that engaged in R&D, innovation or had above-median quality of management practices and firms that did not engage in R&D, innovation or had below-median quality of management practices.

The estimated differences in the means of latent variables of these two groups of firms for the subsample of observations used to estimate the productivity equation (2,139 observations) are: 0.75 for R&D, 0.48 for management practices, 0.68 for product innovation, 0.59 for process innovation and 0.61 for technological innovation.[20]

Hence, switching from below-median to above-median quality of management practices is associated with a 45.3 per cent (($e^{0.786*0.475}$-1) x 100) higher labour productivity, whereas switching from not engaging in product innovation to introducing a new product is associated with a 27.5 per cent higher labour productivity (column 1). The association between labour productivity and process innovation is even stronger: engaging in process innovation is associated with a 55.1 per cent higher labour productivity (column 2).

In the absence of complementarity or substitutability and no differences in the sample size, the marginal effect of technological innovation should be a linear combination of the marginal effects of product and process innovation. It is somewhat lower than the other two but not significantly so. These effects are somewhat stronger than those found for developed economies, but they are comparable to those observed in developing economies.[21] Carrying out R&D does not have a significant effect on labour productivity. As we noticed, few firms

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[18] Tables 3 and 4 show that as we include more exogenous variables to identify the endogenous variables in our model, the sample size decreases slightly from 2,842 observations for the estimation of R&D and management practices to 2,139 observations for the estimation of the productivity equation. This is primarily due to the unavailability of data on sales and employment.

[19] Table A1 in the Appendix reports the coefficient estimates of the structural equations.

[20] See Table A2 in the Appendix.

[21] See Mohnen and Hall (2013) for an overview.

in these economies carry out R&D, and those that do are likely to also have a high quality of management. The latter seems to dominate between the two.[22]

Table 3: Average marginal effects on Ln(labour productivity) for four types of innovation, baseline model

Type of innovation	Product	Process	Technological
	(1)	(2)	(3)
Above-median quality of management practices	0.786***	0.788**	0.776***
	(0.241)	(0.352)	(0.292)
R&D	0.266	0.246	0.258
	(0.481)	(0.197)	(0.187)
Innovation	0.356***	0.644***	0.526***
	(0.086)	(0.153)	(0.113)
Internationally recognised certification	0.048	0.122**	0.097**
	(0.031)	(0.061)	(0.047)
% FTE with university degree	0.002	0.002	0.002
	(0.004)	(0.002)	(0.002)
Manager sector experience	0.004	0.002	0.004
	(0.008)	(0.004)	(0.003)
Main market: local	-0.035	-0.060	-0.062*
	(0.029)	(0.043)	(0.035)
ICT usage	0.173**	0.263**	0.263***
	(0.080)	(0.114)	(0.092)
Access to finance	0.096***	0.173***	0.169***
	(0.033)	(0.056)	(0.047)
Capacity utilisation	0.005***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)
Capital or main business city	0.177***	0.171**	0.170**
	(0.066)	(0.067)	(0.067)
<5 years old	-0.02	-0.085	-0.06
	(0.361)	(0.213)	(0.190)
20-99 employees	0.404	0.307	0.341**
	(0.278)	(0.188)	(0.164)
25+% foreign ownership	0.246	0.296*	0.283*
	(0.270)	(0.168)	(0.150)
25+% state ownership	0.208	0.212	0.211
	(0.526)	(0.309)	(0.278)
Direct exporter	0.176	0.246	0.221
	(0.272)	(0.170)	(0.150)
Observations	2,139	2,131	2,105

Source: BEEPS V and authors' calculations.

Note: Cleaned innovation variables (see section 2.1). Ln(labour productivity) winsorised at 1%. Standard errors in parentheses. * = significant at the 10% level, ** = significant at the 5% level, *** = significant at the 1% level. FTE= full-time employees. The results are obtained by estimating the model presented in Chart 5 and described in section 3 using asymptotic least squares.

[22] When estimating the innovation equations without including R&D, the total marginal effect of management practices was even higher than in Table 3. Part of the marginal effect of managerial practices is now carried by R&D but not sufficiently precise to be able to uncover a significant effect.

Labour productivity is also affected by some other factors. Estimates using technological innovation in column (3) suggest that firms located in the capital or the main business city seem to benefit from better infrastructure and other resources available there, and have on average almost a 19 per cent higher labour productivity than their counterparts outside of the capital or the main business city. A higher labour productivity is also associated with having access to external finance (18.4 per cent), ICT usage (more than 30 per cent), obtaining an internationally recognised certification (10.2 per cent), and a higher capacity utilisation (0.5 per cent).[23,24]

The exclusion restrictions – internationally recognised certification in the management quality equation, percentage of full-time permanent employees with a university degree in the R&D equation and ICT usage and access to finance in the innovation equation – are statistically significant, indicating that those are strong variables to instrument the endogenous variables. Following Duguet and Lelarge (2012), we have performed a test of over-identifying restrictions. As discussed, we have four over-identifying exclusion restrictions. The value of the χ_4^2 statistic is 11.67, which is below the critical value of 13.28 at a significance level of 1 per cent. This result shows that the over-identifying exclusion restrictions do not significantly increase the distance between the structural and the reduced form coefficients, in other words that the way we instrument the endogenous variables is valid.

Overall, the results suggest that labour productivity of firms operating in developing countries benefits from both a higher quality of management practices as well as the introduction of innovation. This finding holds regardless of the type of technological innovation. The magnitudes indicate that improving management practices seems to matter to a greater extent than being innovative in this set of countries. Additionally, the results point to the discrepancies in the availability of infrastructure, external funding and other resources available in the capital or main business city versus other locations in the country.

4.2 Heterogeneous effects

The role of economic development

Given the high heterogeneity of the countries in our sample in terms of income level, we run our model for subsamples by gross national income (GNI) per capita (calculated using the World Bank Atlas method) in 2007.[25] The results for the sample split into two groups according to GNI per capita, higher-income (high-income and upper-middle-income) economies and lower-income (lower-middle-income and low-income) economies in Table 4 reveal significant differences of how both channels work across these groups.[26]

[23] Since the dependent variable is the natural logarithm of labour productivity, the discrete impact of binary variables is computed as $e^{\text{marginal effect}} - 1$.
[24] It should be noted that this estimation does not correct for the endogeneity of capacity utilisation and capital intensity in labour productivity (see, for example, Olley and Pakes, 1996).
[25] Because there are only few high-(low-) income economies in our sample, we group them together with upper-(lower-) middle-income economies. We decided to use 2007 as a cut-off for two reasons: (i) innovation variables refer to the period of three years before the interview took place, which in the case of Russia means 2008-11, and (ii) existing evidence suggests that management practices evolve slowly over time due to informational barriers (see, for example, Bloom and Van Reenen, 2010; Bloom et al., 2013a; Acemoğlu et al., 2007), so the assumption that the management practices as reported at the time of the interview are similar to those the firms had in 2007 is acceptable (although not perfect). The results are broadly robust to using GNI per capita in more recent years instead.
[26] We refrain from reporting the control variables and focus on the marginal effects of interest, namely innovation, R&D and management practices. The complete results are available on request.

Table 4: Average marginal effects of R&D, innovation and management practices on Ln(labour productivity) for four types of innovation, by GNI per capita

Type of innovation	Product	Process	Technological
	(1)	(2)	(3)
Higher-income economies			
Above-median quality of management practices	0.490**	0.538	0.490*
	(0.238)	(0.364)	(0.273)
R&D	0.129	0.386**	0.288**
	(0.259)	(0.193)	(0.136)
Innovation	0.310**	0.716***	0.501***
	(0.121)	(0.167)	(0.121)
Observations	1,392	1,431	1,408
Lower-income economies			
Above-median quality of management practices	1.977*	2.194**	2.047*
	(1.104)	(0.954)	(1.242)
R&D	1.461	-1.432	-0.697
	(34.49)	(3.732)	(13.87)
Innovation	0.455**	0.502***	0.753***
	(0.196)	(0.134)	(0.221)
Observations	697	654	697

Source: BEEPS V and authors' calculations.

Note: Cleaned innovation variables (see section 2.1). Ln(labour productivity) winsorised at 1%. Standard errors in parentheses. * = significant at the 10% level, ** = significant at the 5% level, *** = significant at the 1% level. The results are obtained by estimating the model presented in Chart 5 and described in section 3 using asymptotic least squares. Only the marginal effects of management practices, R&D and innovation are reported. Lower-income economies include lower-middle-income and low-income economies, higher-income economies include high-income and upper-middle-income economies (refer to Table 1 for the list of countries in each category).

To begin with, the results confirm our baseline findings suggesting a significantly positive effect of innovation on labour productivity. This relationship in general also holds for management practices. It is only when we restrict ourselves to process innovations in the higher-income economies that we do not obtain a significant marginal effect for management quality.

Having said this, two major differences across the groups stand out. In the higher-income group the marginal effects of innovation are in general larger than those of management practices. Switching from not being a technological innovator to becoming one, for example, is associated with a 40.7 per cent $((e^{0.501*0.609}-1) \times 100)$ higher labour productivity, while improving the quality of management practices from below to above median quality is associated with a 26.2 per cent higher labour productivity (column 3). The exception is product innovation, suggesting that introducing new products may be more difficult than improving management practices in raising labour productivity even in higher-income economies. To a large extent, new products replace old products and this substitution dampens the effect on productivity. Moreover, R&D is also positively and significantly associated with labour productivity in combination with process and technological innovation (columns 2 and 3).

In the lower-income group, the marginal effects of innovation on labour productivity are still positive and statistically significant. However, the marginal effect of management quality on labour productivity is more than twice as high as the marginal effect of innovation. Moreover, the marginal effects of R&D are no longer statistically significant.

Overall, these results suggest that the analysis of the role of management practices and innovation in determining labour productivity needs to take the economic environment into account. While firms in higher-income economies benefit more from introducing process innovation, firms operating in lower-income economies can improve labour productivity to a greater extent by improving the quality of their management practices.

The role of technological intensity

Differences in the technological intensity of industries could also result in differences in the impact innovation and management practices have on labour productivity. Table 5 shows that this is indeed the case. We replicate our baseline results and find that the estimated marginal effects of innovation and management practices are positive and significant in the higher-tech (high- and medium-high-tech) and lower-tech (medium-low and low-tech) industries.

Table 5: Average marginal effects of R&D, innovation and management practices on Ln(labour productivity) for four types of innovation, by technological intensity

Type of innovation	Product	Process	Technological
	(1)	(2)	(3)
Higher-tech			
Above-median quality of management practices	0.706*	0.493	0.614*
	(0.366)	(0.399)	(0.372)
R&D	0.305	0.389	0.385
	(0.598)	(0.296)	(0.527)
Innovation	0.440**	0.608**	0.645***
	(0.171)	(0.241)	(0.224)
Observations	455	438	449
Lower-tech			
Above-median quality of management practices	0.812***	0.830**	0.826**
	(0.289)	(0.352)	(0.342)
R&D	0.294	0.114	0.198
	(2.089)	(0.547)	(0.434)
Innovation	0.358***	0.463***	0.475***
	(0.101)	(0.138)	(0.122)
Observations	1,600	1,637	1,608

Source: BEEPS V and authors' calculations.

Note: Cleaned innovation variables (see section 2.1). Ln(labour productivity) winsorised at 1%. Standard errors in parentheses. * = significant at the 10% level, ** = significant at the 5% level, *** = significant at the 1% level. The results are obtained by estimating the model presented in Chart 5 and described in section 3 using asymptotic least squares. Only the marginal effects of management practices, R&D and innovation are reported. Sectors are based on ISIC Rev. 3.1. Higher-tech manufacturing sectors include chemicals (24), machinery and equipment (29), electrical and optical equipment (30-33) and transport equipment (34-35, excluding 351). Lower-tech manufacturing sectors include food products, beverages and tobacco (15-16), textiles (17-18), leather (19), wood (20), paper, publishing and printing (21-22), coke, refined petroleum and nuclear fuel (23), rubber and plastics (25), other non-metallic mineral products (26), basic metals and fabricated metal products (27-28), building and repairing ships and boats (351) and other manufacturing (36-37).

There is an important difference between the higher- and lower-tech groups, though. In lower-tech industries, the marginal effect of management practices is about twice that of innovation, suggesting that returns to improving the quality of management practices are more relevant in fostering labour productivity in lower-tech firms than innovation. Firms in higher-tech industries, on the other hand, would benefit more from introducing new processes or technological innovation than from improving their management practices (columns 2 and 3) again with the exception of product innovation.

To sum up, we find some evidence that having established above-median quality of management practices is associated with a higher labour productivity than introducing product, process or technological innovation in the sectors characterised by a lower degree of technological intensity. Lower-tech firms (such as food products or textiles), may be less well managed so that benefits of improving management practices to become part of the top-level group of firms are more pronounced. The quality of management practices in lower-tech sectors is indeed lower than the quality of management practices of higher-tech sectors in our sample.

This is generally not the case in the higher-tech sectors, where firms are more likely to introduce new products and processes and more likely to compete in national or international markets. As shown by Bloom et al. (2016), European firms respond to competition from China's imports by increasing their innovation efforts and by moving towards more high-tech sectors. Returns to improvements in management practices are of lower significance in the higher-tech sector, possibly because the level of management quality is already high so that marginal returns of any further improvement may be lower.

5. Sensitivity analysis

Our results could be affected in four additional ways. First, while we argue that cleaned measures of innovation are more reliable than self-reported measures, the former might be affected by the cleaning effort made. Second, the estimations have so far not taken into account capital intensity. This may undermine our results as for instance the effect of innovation in determining productivity improvements could be overstated if a firm increases its capital base at the same time.[27] However, we refrained from including the variable in the first place as the sample size reduces significantly to just over a third of the available sample (Table 1). Third, as shown in Table 1, our sample covers 30 mostly developing economies and the number of observations per country varies significantly, with Russia, Turkey and Ukraine making up almost half of the total sample. This runs the risk that results are affected by the inclusion of a specific country in the sample. Fourth, our estimates are based on the structural model and could thus be model-specific. We address these four issues in turn.

5.1 Self-reported innovation measures

To test for the robustness of results to using self-reported rather than cleaned measures of innovation, we re-estimate the baseline model (Table 3) using self-reported measures of innovation. This allows us to additionally check whether the impact is different for organisational or marketing innovation, that is, non-technological innovation.

The results in Table 6 show that the estimated marginal effects of management practices and innovation are positive and significant regardless of the measure of innovation used, and slightly higher in magnitude compared with the estimates in Table 3. For instance, engaging in technological innovation is now associated with a 38.9 per cent (($e^{0.569*0.577}$-1) x 100) higher labour productivity, compared with a 37.8 per cent (($e^{0.526*0.609}$-1) x 100) increase when using the cleaned measure of technological innovation. Introducing a non-technological innovation is associated with a 42.9 per cent (($e^{0.688*0.519}$-1) x 100) higher labour productivity (column 4). Similarly, management practices also affect productivity to a slightly larger extent in this specification. The marginal effect of R&D on labour productivity remains the same in magnitude as in the baseline model: engaging in R&D is associated with a 28.2 per cent (($e^{0.329*0.754}$-1) x 100) higher labour productivity for process innovators (column 2). Contrary to the baseline model the marginal effect of R&D is now statistically significant, at least for process and technological innovation. This could be because with the self-reported innovation measures the sample increases by about a quarter and because those responses were more correlated to the answers to the R&D question than the cleaned responses.

[27] We alternatively include labour productivity three fiscal years ago in order to correct the productivity figures from a firm specific time-invariant effect. The inclusion also results in a reduced sample size, which is still slightly bigger than when including capital per worker. However, the impact on the coefficients of interest is remarkable. Neither innovation nor management practices are significantly associated with labour productivity any longer. Lagged labour productivity is statistically and economically significant; a one per cent increase in lagged labour productivity is associated with a 0.7 per cent increase in labour productivity in the last fiscal year (persistence in productivity is a stylised fact as reported by Syverson, 2001). As reported earlier, management practices are rather stable over time, and if innovations are also persistent, management quality and innovation effects are captured by the lagged labour productivity.

Table 6: Average marginal effects of R&D, innovation and management practices on Ln(labour productivity) with self-reported innovation variables

Type of innovation	Product	Process	Technological	Non-technological
	(1)	(2)	(3)	(4)
Above median quality of management practices	0.832***	0.850**	0.857***	0.821**
	(0.291)	(0.379)	(0.296)	(0.347)
R&D	0.279	0.329***	0.266**	0.391
	(0.186)	(0.125)	(0.109)	(0.343)
Innovation	0.553***	0.640***	0.569***	0.688***
	(0.113)	(0.153)	(0.117)	(0.154)
Observations	2,817	2,817	2,817	2,816

Source: BEEPS V and authors' calculations.

Note: Ln(labour productivity) winsorised at 1%. Standard errors in parentheses. * = significant at the 10% level, ** = significant at the 5% level, *** = significant at the 1% level. The results are obtained by estimating the model presented in Chart 5 and described in section 3.1 using asymptotic least squares. Only the marginal effects of management practices, R&D and innovation are reported.

5.2 Total factor productivity

Our results are also broadly robust to the inclusion of capital per employee in the baseline model as an additional control variable in the labour productivity equation, despite the significant reduction in sample size (Table 7). Controlling for capital intensity is equivalent to analysing total factor productivity instead of just labour productivity. The marginal effects of management practices and innovation remain positive and statistically significant at least at the 10 per cent level of significance. To compare the results with and without correction for capital intensity we run the baseline regression only for the sample for which capital per employee is available (Table 7, columns 4-6). The results indicate that some of the decline in the marginal effects of innovation is a consequence of the reduction in sample size when capital per employee is included in the regression and some is due to controlling for capital intensity. In the version with capital intensity, management practices continue to have a higher marginal effect than innovation on total factor productivity and R&D remains insignificant.

Table 7: Average marginal effects of R&D, innovation and management practices on Ln(labour productivity), controlling for capital per worker

Type of innovation	Baseline with capital per employee			Baseline on sample for which capital per employee is available		
	Product	Process	Technological	Product	Process	Technological
	(1)	(2)	(3)	(4)	(5)	(6)
Above-median quality of	0.744**	0.723*	0.731*	0.835**	0.816*	0.821**
management practices	(0.348)	(0.413)	(0.379)	(0.361)	(0.445)	(0.400)
R&D	0.223	0.135	0.162	0.267	0.188	0.210
	(0.416)	(0.137)	(0.139)	(0.490)	(0.170)	(0.168)
Innovation	0.301**	0.393**	0.344**	0.357**	0.504**	0.429***
	(0.136)	(0.192)	(0.155)	(0.140)	(0.202)	(0.161)
Capital per	0.130***	0.129***	0.129***			
employee	(0.017)	(0.017)	(0.017)			
Observations	993	993	976	993	993	976

Source: BEEPS V and authors' calculations.

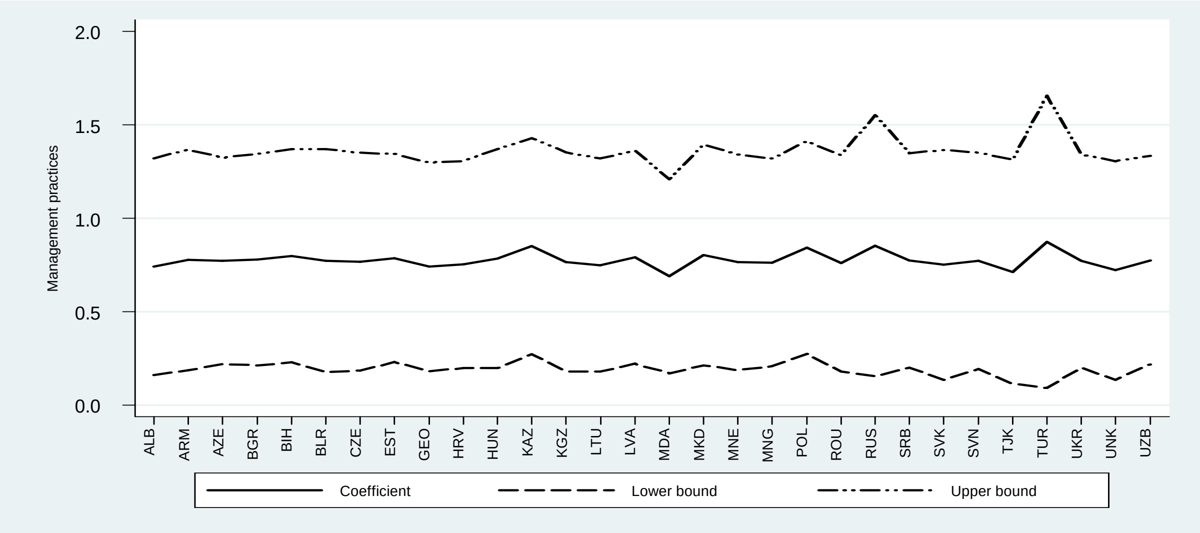
Note: Cleaned innovation variables (see section 2.1). Ln(labour productivity) winsorised at 1%. Standard errors in parentheses. * = significant at the 10% level, ** = significant at the 5% level, *** = significant at the 1% level. The results are obtained by estimating the model presented in Chart 5 and described in section 3.1 using asymptotic least squares. Columns 1-3 show the results when controlling for fixed assets per employee in the productivity equation, while columns 4-6 report those obtained when not controlling for fixed assets per employee, both on the same subsample for which the variable is available.

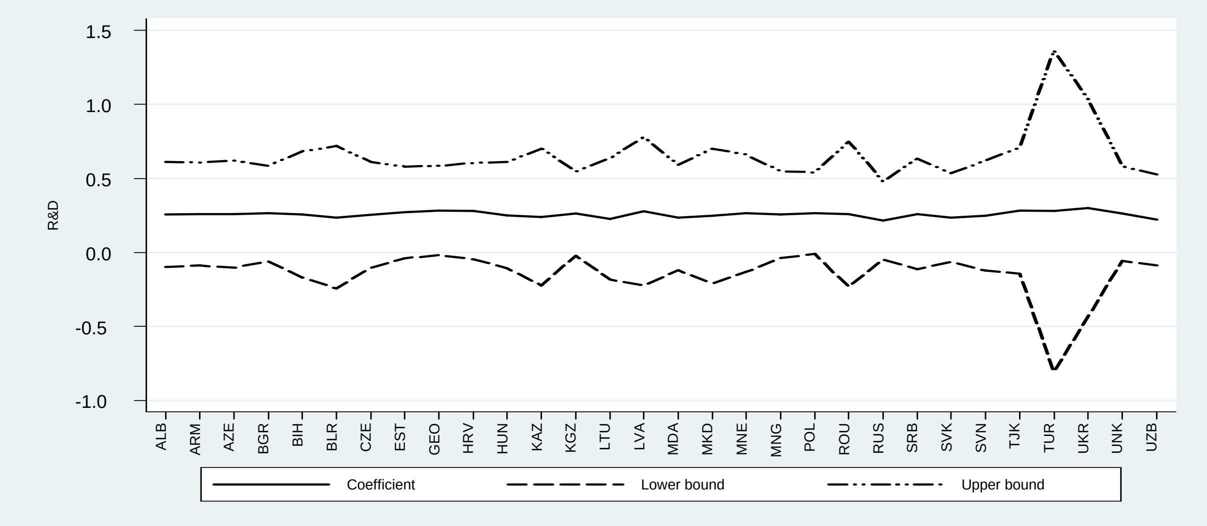
5.3 Changes in the sample

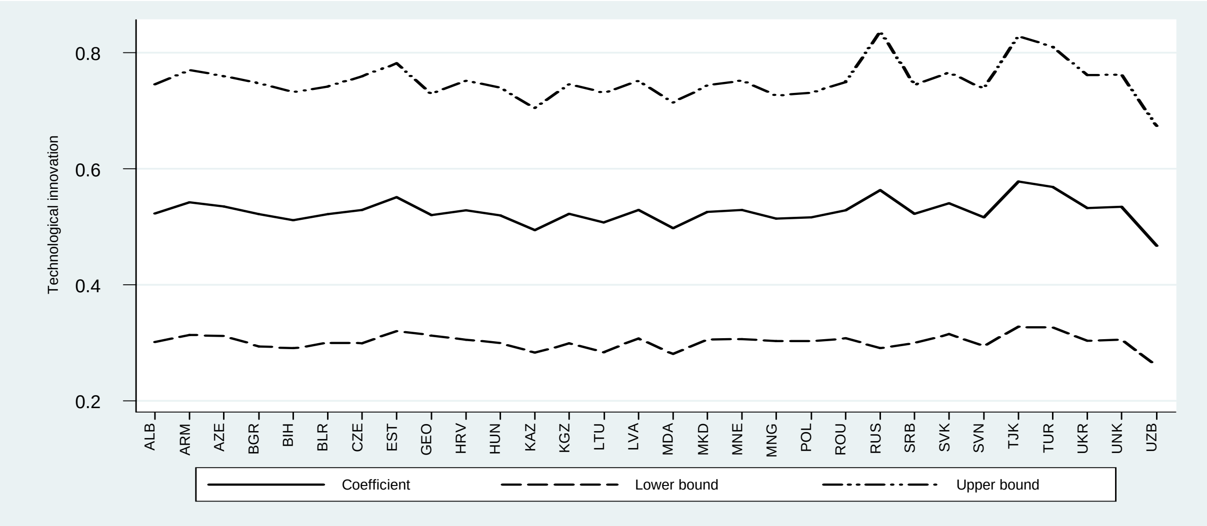
To test for the robustness of results to changes in the sample, we re-estimate our baseline specification (Table 3), removing one country at a time from the sample. The results in Chart 6 show a remarkable stability of the estimated marginal effects of the quality of management practices, R&D and technological innovation on productivity to the exclusion of one country at a time. The marginal effects of the quality of management practices and technological innovation are always positive and statistically significant. The marginal effects of R&D and management practices are somewhat sensitive to the exclusion of Turkey, but they keep their sign and significance. The results are also robust for product, process and non-technological innovation.[28] We thus conclude that our results are not driven by any country in particular.

[28] The results are available on request.

Chart 6: Estimated marginal effects on the quality of management practices, R&D and technological innovation and 95 per cent confidence intervals, excluding one country at a time







Source: BEEPS V and authors' calculations.

Note: ISO 3166-1 alpha-3 country codes. The estimated model corresponds to column (3) from Table 3.

5.4 OLS results

In order to test whether our findings are an outcome of our model setup, we run a simple OLS regression with labour productivity as the dependent variable. The results in Table 8 are now to be interpreted as discrete shifts of innovation, R&D or management practice from 0 to 1 and no longer as continuous variations. They show that both the quality of management practices and innovation are positively and significantly associated with labour productivity. Introducing a technological innovation, for example, is associated with an almost 23 per cent higher labour productivity than not being a technological innovator, while having a high quality of management practices is associated with about 14 per cent higher labour productivity than having a low quality of management practices (column 3). Performing R&D is also associated with an approximately 20 per cent higher labour productivity. Overall, the OLS results confirm the importance of all three variables without favouring one over the others.

When interpreting these findings, it is important to remember that the OLS estimates are likely to be biased because they do not take into account the endogeneity of management practices and innovation activities. Unobservable factors such as the manager’s competence or dynamism may affect productivity, the adoption of management practices, and innovation activities at the same time. Nevertheless, the OLS results do not contradict those derived from our structural equations.

Table 8: Average marginal effects of R&D, innovation and management practices on Ln(labour productivity), ordinary least squares

Type of innovation	Product (1)	Process (2)	Technological (3)
Above-median quality of management practices	0.136**	0.126**	0.131**
	(0.057)	(0.057)	(0.057)
R&D	0.199***	0.223***	0.183**
	(0.072)	(0.072)	(0.075)
Innovation	0.187**	0.181***	0.206***
	(0.075)	(0.070)	(0.064)
Capacity utilisation	0.005***	0.006***	0.006***
	(0.001)	(0.001)	(0.001)
Capital or main business city	0.220***	0.201***	0.213***
	(0.071)	(0.071)	(0.071)
<5 years old	-0.256**	-0.259**	-0.255**
	(0.115)	(0.114)	(0.114)
20-99 employees	0.171***	0.196***	0.181***
	(0.059)	(0.059)	(0.059)
25+% foreign ownership	0.331***	0.350***	0.331***
	(0.085)	(0.085)	(0.085)
25+% state ownership	0.175	0.260	0.239
	(0.169)	(0.171)	(0.171)
Direct exporter	0.366***	0.359***	0.362***
	(0.063)	(0.063)	(0.063)
Observations	2,151	2,141	2,115

Source: BEEPS V and authors’ calculations.

Note: Cleaned innovation variables (see section 2.1). Ln(labour productivity) winsorised at 1%. Standard errors in parentheses. * = significant at the 10% level, ** = significant at the 5% level, *** = significant at the 1% level. The results are obtained by estimating the third stage (equation (7)) of the model presented in Chart 5 and described in section 3 using a simple OLS regression.

6. Conclusion

As the contribution of firm productivity to economic growth is widely acknowledged, both researchers and policy-makers are interested in the drivers of productivity. In particular, innovativeness is found to be crucial in determining firm performance (see, for example, Rosenbusch et al., 2011). Because of institutional obstacles (access to credit, corruption, poor intellectual property rights) and because of their distance to the technological frontier, firms in developing countries have less of an incentive to invest in R&D and innovation. Improving management practices requires less of an investment and may be more rewarding in the short term. Moreover, as Bloom et al. (2013a) have shown, there is a causal relationship between management quality and firm performance.

In this paper we explore the relationship between innovative activities and management practices in determining firm level productivity. Moreover, we analyse this relationship in different economic environments to investigate if potential effects are dependent on the respective environment. In the same vein, we examine differences with regard to the technological intensity. We use data from a unique firm-level survey on innovation and management practices to estimate, for the first time in the same model, the impacts of the quality of management practices and innovation on manufacturing firm productivity in mostly developing countries in eastern Europe and Central Asia, while controlling for capacity utilisation and other firm characteristics. These countries range from low-income economies such as Tajikistan to high-income economies such as Slovenia.

We find that management practices and any type of innovation are significant drivers of firm productivity. Moreover, these two factors work differently within higher- and lower-income countries. More specifically, above-median-quality management practices of firms operating in lower-income economies are associated with a stronger positive impact on labour productivity than the introduction of product, process or technological innovation. In other words, firms can achieve higher returns to labour productivity by improving their management practices than by introducing new products and processes. By contrast, in higher-income countries, firm-level management practices play a somewhat less important role in boosting firms' labour productivity; in line with catch-up growth literature, firms need to engage in innovation instead. These findings suggest that firms operating in less favourable environments are able to over-compensate non-existent innovation activities by improving the quality of their management practices, thereby overcoming potential institutional barriers and contributing to aggregate productivity.

In the same vein, we find indications that management quality is also of higher relevance than innovation activities in lower-tech sector firms, while this is not the case in the higher-tech sector. Again, the results suggest that when innovation is missing or harder to achieve as in lower-tech sectors, firms can improve their productivity significantly by improving the quality of management practices.

Our findings raise the question of why firms in low-income economies and low-tech sectors do not adopt better management practices. The recent management field experiment looking at large Indian textile firms suggests that this may be due to information barriers. Firms might not have heard of some management practices, or they may be sceptical regarding their impact (Bloom et al., 2013a). Improvements to certain management practices – particularly those relating to underperforming employees, pay or promotions – may also be hampered by regulations or a lack of competition (since competition could force badly managed firms to exit the market).

Training programmes covering basic operations (such as inventory management and quality control) could be helpful, but suitable consultancy or training services offering such products may not exist in a given market or may be geared towards large firms, making them too expensive for SMEs.[29]

Policy-makers in less developed countries should focus their attention on providing more basic business education and improving the quality of education in general, as well as improving the general business environment, rather than aspiring to create new Silicon Valleys.

[29] See McKenzie and Woodruff (2014) for a review of evaluations of business training programmes in developing countries.

Appendix A

Table A1: Coefficient estimates of the structural equations underlying the computation of the marginal effects in Table 4 – Asymptotic least squares

Equations	Management practices	R&D	Innovation				Labour productivity			
			Product	Process	Techno-logical	Non-technological	Product	Process	Techno-logical	Non-technological
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Management practices (latent)			0.572 (0.307)	0.793** (0.294)	0.778** (0.275)	0.891*** (0.227)	0.583** (0.209)	0.277 (0.271)	0.367 (0.238)	0.209 (0.278)
R&D (latent)			0.748 (1.341)	0.382 (0.291)	0.490 (0.339)	0.569 (0.482)				
Innovation (latent)							0.356*** (0.085)	0.644*** (0.153)	0.526*** (0.113)	0.688*** (0.154)
Internationally recognised certification	0.238*** (0.057)									
% FTE with university degree		0.008*** (0.002)								
Manager sector experience	-0.000 (0.002)	0.005 (0.003)	0.008 (0.021)	0.002 (0.005)	0.005 (0.005)	-0.000 (0.007)				
Main market: local			-0.100 (0.078)	-0.093 (0.063)	-0.117 (0.062)	-0.027 (0.053)				
ICT usage			0.486* (0.194)	0.409** (0.148)	0.499*** (0.139)	0.335** (0.105)				
Access to finance			0.269*** (0.066)	0.268*** (0.059)	0.322*** (0.056)	0.265*** (0.050)				
Capacity utilisation							0.005*** (0.001)	0.004*** (0.001)	0.005*** (0.001)	0.005*** (0.001)
Capital or main business city							0.177** (0.066)	0.171* (0.067)	0.170* (0.066)	0.166* (0.067)
<5 years old	-0.157 (0.114)	-0.030 (0.135)	0.096 (0.960)	0.083 (0.234)	0.051 (0.258)	0.100 (0.351)	-0.014 (0.106)	-0.051 (0.131)	-0.015 (0.117)	-0.064 (0.134)
20-99 employees	-0.355*** (0.056)	-0.290*** (0.063)	0.417 (0.608)	0.267 (0.177)	0.327 (0.187)	0.273 (0.233)	0.405*** (0.097)	0.388*** (0.115)	0.389*** (0.105)	0.421*** (0.115)
25+% foreign ownership	0.177* (0.083)	0.142 (0.091)	-0.150 (0.683)	-0.112 (0.174)	-0.083 (0.189)	-0.050 (0.252)	0.226* (0.089)	0.243* (0.107)	0.218* (0.097)	0.177 (0.108)
25+% state ownership	-0.040 (0.162)	0.027 (0.197)	0.102 (1.391)	0.0975 (0.334)	0.065 (0.368)	0.226 (0.508)	0.173 (0.168)	0.163 (0.200)	0.186 (0.182)	0.066 (0.207)
Direct exporter	0.266*** (0.06)	0.268*** (0.068)	-0.302 (0.622)	-0.196 (0.168)	-0.234 (0.181)	-0.271 (0.233)	0.158 (0.086)	0.170 (0.102)	0.166 (0.093)	0.187 (0.104)

Source: BEEPS V and authors' calculations.

Note: Cleaned innovation variables, with exception of non-technological innovation (see section 2.1). Ln(labour productivity) winsorised at 1%. Standard errors in parentheses. * = significant at the 10% level, ** = significant at the 5% level, *** = significant at the 1% level. FTE= full-time employees. The model is presented in section 3.1. Industry and country dummies are also controlled for.

Table A2: Descriptive statistics on the latent variables

Latent variable	Observed variable status	Observations	Mean	Standard deviation	Minimum	1st quartile	Median	3rd quartile	Maximum
R&D	All	2,842	-1.206	1.280	-7.439	-1.396	-0.975	-0.619	1.039
	Yes	542	-0.596	0.494	-2.441	-0.898	-0.606	-0.246	1.039
	No	2,300	-1.35	1.363	-7.439	-1.488	-1.072	-0.719	0.664
Management practices	All	2,842	0.002	0.589	-2.227	-0.393	-0.012	0.399	1.840
	Yes	1,424	0.239	0.532	-1.684	-0.145	0.239	0.563	1.840
	No	1,418	-0.236	0.546	-2.227	-0.582	-0.245	0.123	1.547
Product innovation (cleaned)	All	2,766	-1.157	0.678	-3.417	-1.607	-1.176	-0.713	0.939
	Yes	466	-0.590	0.596	-2.323	-1.036	-0.576	-0.149	0.939
	No	2,300	-1.272	0.634	-3.417	-1.673	-1.274	-0.850	0.793
Process innovation (cleaned)	All	2,747	-1.037	0.675	-3.945	-1.455	-1.029	-0.521	0.688
	Yes	535	-0.562	0.499	-2.190	-0.890	-0.484	-0.198	0.688
	No	2,212	-1.152	0.661	-3.945	-1.546	-1.164	-0.646	0.513
Technological innovation (cleaned)	All	2,711	-0.659	0.689	-3.323	-1.102	-0.641	-0.162	1.095
	Yes	802	-0.23	0.541	-1.903	-0.615	-0.193	0.177	1.095
	No	1,909	-0.839	0.665	-3.323	-1.236	-0.839	-0.357	0.824
Non-technological innovation (self-reported)	All	2,817	-0.492	0.616	-2.684	-0.901	-0.493	-0.044	1.094
	Yes	956	-0.149	0.522	-2.051	-0.495	-0.139	0.237	1.094
	No	1,861	-0.668	0.585	-2.684	-1.023	-0.675	-0.279	1.069
Product innovation (self-reported)	All	2,817	-0.516	0.643	-2.86	-0.96	-0.465	-0.03	1.03
	Yes	946	-0.154	0.499	-1.879	-0.478	-0.107	0.226	1.03
	No	1,871	-0.699	0.630	-2.86	-1.133	-0.685	-0.231	0.853
Process innovation (self-reported)	All	2,817	-0.862	0.630	-3.179	-1.283	-0.859	-0.374	0.934
	Yes	660	-0.438	0.505	-2.077	-0.795	-0.36	-0.079	0.934
	No	2,157	-0.991	0.607	-3.179	-1.377	-0.997	-0.564	0.656
Technological innovation (self-reported)	All	2,817	-0.313	0.661	-2.527	-0.778	-0.269	0.191	1.321
	Yes	1,131	0.032	0.523	-1.682	-0.302	0.084	0.425	1.321
	No	1,686	-0.545	0.643	-2.527	-0.978	-0.536	-0.07	1.041

Source: BEEPS V and authors' calculations.

Appendix B

Construction of the management practice variable

We distinguish four management areas:

1. Operations

Practice 1 (question R.1): Over the last complete fiscal year, what best describes what happened at this establishment when a problem in the production process arose?

Answers (score in parentheses): “No action was taken” or “Don’t know” (1), “We fixed it but did not take further action” (2), “We fixed it and took action to make sure it did not happen again” (3), “We fixed it and took action to make sure that it did not happen again, and had a continuous improvement process to anticipate problems like these in advance” or “Does not apply” (4).

2. Monitoring

Practice 2 (question R.2): Over the last complete fiscal year, how many production performance indicators were monitored at this establishment?

Answers (score in parentheses): “No production performance indicators” or “Don’t know” (1), “1-2 production performance indicators” (2), “3-9 production performance indicators” (3), “10 or more production performance indicators” (4).

3. Targets

Practice 3 (question R.6): Over the last complete fiscal year, what best describes the time frame of production targets at this establishment? Examples of production targets are: production, quality, efficiency, waste, on-time delivery.

Answers (score in parentheses): “No production targets” or “Don’t know” (1), “Main focus was on short-term (less than one year) production targets“ (2), “Combination of short-term and long-term production targets” (3), and “Main focus was on long-term (more than one year) production targets” (4).

Practice 4 (question R.7): Over the last complete fiscal year, how easy or difficult was it for this establishment to achieve its production targets?

Answers (score in parentheses): “Possible to achieve without much effort” or “Only possible to achieve with extraordinary effort“ or “Don’t know” or “Does not apply” (1), “Possible to achieve with some effort” (2), “Possible to achieve with normal amount of effort” (3), “Possible to achieve with more than normal effort“ (4).

Practice 5 (question R.8): Over the last complete fiscal year, who was aware of the production targets at this establishment?

Answers (score in parentheses): “Only senior managers” or “Don’t know” or “Does not apply” (1), “Most managers and some production workers” (2), “Most managers and most production workers” (3), “All managers and most production workers” (4).

4. Incentives

Practice 6 (question R.11): Over the last complete fiscal year, what were managers' performance bonuses usually based on?

Answers (score in parentheses): "No performance bonuses" or "Don't know" (1), "Their company's performance as measured by production targets" (2), "Their establishment's performance as measured by production targets" (3), "Their team or shift performance as measured by production targets" (4), "Their own performance as measured by production targets" (5).

Practice 7 (question R.13): Over the last complete fiscal year, what was the primary way non-managers were promoted at this establishment?

Answers (score in parentheses): "Non-managers are normally not promoted" or "Don't know" or "Does not apply" (1), "Promotions were based mainly on factors other than performance and ability (for example, tenure or family connections)" (2), "Promotions were based partly on performance and ability, and partly on other factors (for example, tenure or family connections)" (3), "Promotions were based solely on performance and ability" (4).

Practice 8 (question R.15): Over the last complete fiscal year, when was an under-performing non-manager reassigned or dismissed?

Answers (score in parentheses): "Rarely or never" or "Don't know" or "Does not apply" (1), "After 6 months of identifying non-manager under-performance" (2), "Within 6 months of identifying non-manager under-performance" (3).

References

D. Acemoğlu, P. Aghion and F. Zilibotti (2006), "Distance to frontier, selection, and economic growth", *Journal of European Economic Association* 4, no. 1: 37-74.

D. Acemoğlu, P. Aghion, C. Lelarge, J. Van Reenen and F. Zilibotti (2007), "Technology, information, and the decentralization of the firm", *Quarterly Journal of Economics* 122, no. 4: 1759-1799.

D. Acemoğlu, U. Akcigit and M. Alp Celik (2015), "Young, restless and creative: Openness to disruption and creative innovations", mimeo, July 30. Available at http://economics.mit.edu/files/10656. Last accessed on 31 May 2016.

P. Aghion (2016), "Competitiveness and growth policy design", in Christian Keuschnigg (editor), *Moving to the Innovation Frontier*, CEPR Press eBook, pp. 5-30. Available at http://www.voxeu.org/sites/default/files/Innovation%20Frontier.pdf. Last accessed on 31 May 2016.

U. Akcigit, H. Alp and M. Peters (2016), "Lack of selection and limits to delegation: Firm dynamics in developing countries", NBER Working Paper No. 21905. Available at http://www.nber.org/papers/w21905.pdf. Last accessed on 30 March 2016.

J. Arnold, G. Nicoletti and S. Scarpetta (2008), "Regulation, allocative efficiency and productivity in OECD countries: Industry and firm-level evidence", OECD Economics Department Working Paper No. 616.

A. Arundel, K. O'Brien and N. (A.) Torugsa (2013), "How firm managers understand innovation: Implications for the design of innovation survey", in Gault, Fred (editor), *Handbook of Innovation Indicators and Measurement*, Edward Elgar Publishing, Cheltenham, United Kingdom, pp. 88-108.

E. Bah, J. C. Brada and T. Yigit (2011), "With a little help from our friends: The effect of USAID assistance on SME growth in a transition country", *Journal of Comparative Economics* 39, no. 2: 205-220.

B. Balsmeier and D. Czarnitzki (2014), "How important is industry-specific managerial experience for innovative firm performance?" ZEW Discussion Paper No. 14-011.

M. Bertrand and A. Schoar (2003), "Managing with style: The effect of managers on firm policies", *Quarterly Journal of Economics* 118, no. 4: 1169-1208.

Ç. Bircan and R. De Haas (2015), "The limits of lending: Banks and technology adoption across Russia", EBRD Working Paper No. 178.

N. Bloom and J. Van Reenen (2007), "Measuring and explaining management practices across firms and countries", *Quarterly Journal of Economics* 122, no. 4: 1351-1408.

N. Bloom and J. Van Reenen (2010), "Why do management practices differ across firms and countries?" *Journal of Economic Perspectives* 24, no. 1: 203-224.

N. Bloom, H. Schweiger and J. Van Reenen (2012), "The land that lean manufacturing forgot? Management practices in transition countries", *Economics of Transition* 20, no. 4: 593-635.

N. Bloom, B. Eifert, A. Mahajan, D. McKenzie and J. Roberts (2013a), "Does management matter? Evidence from India", *Quarterly Journal of Economics* 128, no. 1: 1–51.

N. Bloom, E. Brynjolfsson, L. Foster, R. Jarmin, I. Saporta-Eksten and J. Van Reenen (2013b), "Management in America", US Census Bureau Center for Economic Studies Paper No. CES-WP-13-01.

N. Bloom, M. Draca and J. Van Reenen (2016), "Trade induced technical change? The impact of Chinese imports on innovation, IT and productivity", *Review of Economic Studies* 83, no. 2: 87-117.

T. F. Bresnahan, E. Brynjolfsson and L. M. Hitt (2002), "Information technology, workplace organisation, and the demand for skilled labour: Firm-level evidence", *Quarterly Journal of Economics* 117, no. 1: 339-376.

J. D. Brown, J. S. Earle and Á. Telegdy (2006), "The productivity effects of privatization: Longitudinal estimates from Hungary, Romania, Russia, and Ukraine", *Journal of Political Economy* 114, no. 1: 61-99.

B. Crépon, E. Duguet and J. Mairesse (1998), "Research, innovation and productivity: An econometric analysis at the firm level", *Economics of Innovation and New Technology* 7, no. 2: 115-158.

G. Crespi and P. Zuniga (2011), "Innovation and productivity: Evidence from six Latin American countries", *World Development* 40, no. 2: 273-290.

E. Duguet and C. Lelarge (2012), "Does patenting increase the private incentives to innovate? A microeconometric analysis", *Annals of Economics and Statistics* No. 107-108: 201-238.

EBRD (2009), *Transition Report 2009: Transition in crisis?* Chapter 5, London.

EBRD (2014), *Transition Report 2014: Innovation in transition*, London.

S. Estrin, J. Hanousek, E. Kočenda and J. Svejnar (2009), "The effects of privatization and ownership in transition economies", *Journal of Economic Literature* 47, no. 3: 699-728.

European Commission (2016), Innovation. See http://ec.europa.eu/growth/industry/innovation/ (last accessed on 7 June 2016).

Eurostat and OECD (2005), *Oslo Manual: Guidelines for collecting and interpreting innovation data*, third edition.

L. Foster, J. C. Haltiwanger and C. Syverson (2008), "Reallocation, firm turnover and efficiency: Selection on productivity or profitability?" *American Economic Review* 98, no. 1: 394-425.

A. Galasso and T. S. Simcoe (2011), "CEO overconfidence and innovation", *Management Science* 57, no. 8: 1469-1484.

P. Geroski (1989), "Entry, innovation and productivity growth", *Review of Economics and Statistics* 71, no. 4: 572-578.

P. Geroski, T. Kretschmer and C. Walters (2009), "Corporate productivity growth: Champions, leaders and laggards", *Economic Inquiry* 47, no. 1: 1-17.

S. Girma and H. Görg (2007), “Multinationals’ productivity advantage: Scale or technology?” *Economic Inquiry* 45, no. 2: 350-362.

R. Griffith, E. Huergo, J. Mairesse, and B. Peters (2006), “Innovation and productivity across four European countries”, *Oxford Review of Economic Policy* 22, no. 4: 483-498.

B. H. Hall, F. Lotti and J. Mairesse (2009), “Innovation and productivity in SMEs: Empirical evidence for Italy”, *Small Business Economics* 33, no. 1: 13-33.

B. H. Hall and V. Sena (2014), “Appropriability mechanisms, innovation and productivity: Evidence from UK”, NBER Working Paper No. 20514.

C.-T. Hsieh and P. J. Klenow (2009), “Misallocation and manufacturing TFP in China and India”, *Quarterly Journal of Economics* 124, no. 4: 1403-1448.

N. Kumar and A. Aggarwal (2005), “Liberalization, outward orientation and in-house R&D activity of multinational and local firms: A quantitative exploration for Indian manufacturing”, *Research Policy* 34, no. 4: 441-460.

A. Mackey (2008), “The effect of CEOs on firm performance”, *Strategic Management Journal* 29, no. 12: 1357-1367.

J. Masso and P. Vahter (2008), “Technological innovation and productivity in late-transition Estonia: Econometric evidence from innovation surveys”, *European Journal of Development Research* 20, no. 2: 240-261.

D. McKenzie and C. Woodruff (2014), “What are we learning from business training and entrepreneurship evaluations around the developing world?” *World Bank Research Observer* 29, no. 1:48-82.

P. Mohnen and B. H. Hall (2013), “Innovation and productivity: An update”, *Eurasian Business Review* 3, no. 1: 47-65.

G. S. Olley and A. Pakes (1996), “The dynamics of productivity in the telecommunications equipment industry”, *Econometrica* 64, no. 6: 1263-1297.

W. Raymond, J. Mairesse, P. Mohnen and F. Palm (2015), “Dynamic models of R&D, innovation and productivity: Panel data evidence for Dutch and French manufacturing”, *European Economic Review* 78: 285-306.

N. Rosenbusch, J. Brinckmann and A. Bausch (2011), “Is innovation always beneficial? A meta-analysis of the relationship between innovation and performance in SMEs”, *Journal of Business Venturing* 26, no. 4: 441-457.

W. Steffen and J. Stephan (2008), “The role of human capital and managerial skills in explaining productivity gaps between East and West”, *Eastern European Economics* 46, no. 6: 5-24.

S. Subba Rao, T.S. Ragu-Nathan, and L. S. Solis (1997), “Does ISO 9000 have an effect on quality management practices? An international empirical study”, *Total Quality Management* 8, no. 6:335-346.

C. Syverson (2011), “What determines productivity?” *Journal of Economic Literature* 49, no. 2: 326–365.