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Management Practices, Competition, Innovation and the Performance of Enterprises in Canada

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Management Practices, Competition, Innovation and the Performance of Enterprises in Canada

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Abstract

Using data from the Survey of Innovation and Business Strategy 2009, a management practices index (MP^{index}) à la Bloom and Van Reenen (2007) is built to analyze the relationships between management practices, competition, innovation and firm performance in Canada. The results show that the distribution of MP^{index} varies among industries and that large firms tend to have more structured management practices. A positive correlation between (MP^{index}) and the intensity of sales and profits is found for manufacturing firms. There is also a positive correlation between (MP^{index}) and business innovation, a result that holds for enterprises in all sectors. Finally, the importance of competition depends on how it is measured: the number of competitors in the enterprise's main market is associated with a higher intensity of sales and profits, while it is the entry of new competitors in the main market that matters for innovation.

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* Now with the Bank of Canada

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1. Introduction

A number of recent reports by industry observers highlight that Canada's lagging performance in terms of productivity growth is associated with the low levels of business innovation (Competition Policy Review Panel, 2008; Expert Panel on Business Innovation, 2009; Drummond and Bentley, 2010; Expert Review Panel on Research and Development, 2012). Several possible causes have been put forward such as industry structure, subpar investments in tangible capital, small market size, "business complacency" and the low importance attributed to education by Canadian managers. The last two factors are of particular interest as they are intangible in nature. Also falling in this intangible assets category, are management practices (MP).

The role of MP in the success of enterprises has long been recognized in economics and other social sciences (see for example Huselid, 1995). And put by Alchian and Demsetz (1972), "efficient production… is a result not of having better resources but in knowing more accurately the relative productive performances of those resources."

The recent empirical work by Bloom and Van Reenen (2007) defines a tractable framework for measuring MP and assessing their relationship with firm performance. MP, and more generally intangible assets, may be an important factor explaining the persistent productivity differentials observed across countries, but also within a country in narrowly defined industries (Bartelsman and Doms, 2000; Syverson, 2004a,b, 2011). If firms in a same industry are observed to use the same inputs and technologies and face the same level of competition, then there must be something else affecting their productivity. Supporting the view that MP matter for productivity, Bloom et al. (2012b) estimated that better MP of US firms accounts on average for 30 percent of the total factor productivity differential between the US and other countries such as France, the UK, Sweden and Germany.

Manufacturing enterprises in Canada fare well compared to their counterparts located in other countries. Only US enterprises have better MP compared to those in Canada (Institute for Competitiveness and Prosperity, 2009). Bloom and Van Reenen (2010) showed that the US has the lowest proportion of badly managed enterprises compared to any other countries, including Canada. Moreover, there is no statistical difference between average MP in Canada, Germany, Sweden and Japan, while Canada is outperforming the UK and France, among others. From a broad perspective, Bloom (2010) mentioned that the marketplace framework in Canada is favourable to the implementation of good MP due to, for example, the high levels of competition and low market regulation. Firms in Canada, however, should make better use of skilled workers.

The objective of this paper is to determine the relationships between MP, firm performance and innovation using a framework similar to the one developed by Bloom and Van Reenen (2007). There are three main research questions: i) what are the firms' characteristics associated with better structured MP; ii) what is the relationship between MP and firm performance; and iii) what is the relationship between MP and innovation. Answering the last question is one of the main contributions of the paper as very little evidence exists on the link between MP and innovation. In addition to MP, the role of competition in firm performance and innovation is also considered. This analysis is based on the data from the Survey of Innovation and Business Strategy 2009 (SIBS) and other administrative sources (Statistics Canada).

The main results can be summarized as follows: i) the distribution of the management practices index $\left(MP^{index}\right)$ differs by sector; ii) the variables positively correlated with MP^{index} include firm size, percentage of workers with a university degree, the presence of a multinational in the enterprise's main market and whether the head office is located in the United States; iii) MP^{index} is positively correlated with sale and profit intensity for manufacturing enterprises only; iv) MP^{index} is positively correlated with innovation—no matter how innovation is defined—for enterprises in all industries; and v) the links between competition, performance and innovation depend on the nature of competition. More precisely, the number of competitors in the enterprise main market is positively correlated with higher performance but it is the entry of new enterprises that matter for innovation.

The rest of the paper is organized as follows. The analytical framework is presented in the second section while the data discussion is in the third one. Section 4 shows the results and Section 5 concludes.

2. Analytical Framework

2.1 Construction of the Management Practices Index

The MP^{index} used in this paper is based on the framework introduced by Bloom and Van Reenen (2006, 2007) (BVR). SIBS provided an opportunity to collect additional MP data for Canada and linked them to economic indicators such as sales, profits and innovation. Most SIBS questions on MP were derived from the BVR survey on MP. This allowed to build a similar but not identical MP^{index}.

The main contribution of BVR was to develop a comprehensive and tractable framework to analyze MP. The BVR index is based on four types of indicators referring to a specific aspect of MP: operational practices, monitoring of performance, target setting and incentives. See the Appendix in Bloom and Van Reenen (2007) for more details.

The BVR work can be linked to several strains of the economic literature: management style (Bertrand and Schoar, 2003); innovative work practices (Ichniowski et al., 1997; Macduffie, 1995; Osterman, 1994); workers empowerment (Cappelli and Neumark, 1999); incentives pay (Lazear, 2000; Bandiera et al., 2007); hiring practices (Oyer and Schaefer, 2011; Autor and Scarborough, 2008); total quality management (Powell, 1995); and information and communication technologies use (Black and Lynch, 2001; Bresnahan, 1999; Bresnahan et al., 2002; Bloom et al., 2012a).

The SIBS MP index $\left(MP^{index}\right)$ is built for 2009 using 19 indicators. Each indicator has been normalized between zero and one, the latter denoting the best practices and zero the worst. A simple average is taken, as shown by Equation (1), so MP^{index} also ranges from zero to one. MP^{index} has at least one element in each type of indicator of the BVR index, but as shown in Section A.1 of Appendix A, the coverage is unequal.

All SIBS MP questions were used, except for the share of workers with a university degree (Q63) and the one about who set the pace of work to achieve production performance targets (Q57). Exclusion of these variables are based on the fact that it is unclear which response should be attributed a higher score. Q63 was nevertheless included as a separate variable in the regression analysis.

$$MP_i^{index} = \frac{\Sigma_{j=1}^{19} Indicators_{ij}}{19} \qquad (1)$$

The normalization process is specific to each indicator and is consistent with the spirit of the BVR framework. See Section A.2 for more details on the normalization rules used (Appendix A).

Apart from the contents, the other main difference between the BVR survey and the SIBS is the way data were collected. BVR used face-to-face interviews to collect in-depth information on the firm MP. In contrast, paper/electronic questionnaires were used for the SIBS. Because of their collection method, BVR can argue that their index is effectively a proxy for the quality of a firm's MP, but this is less clear for the SIBS. Therefore, the results are going to be interpreted as "more structured MP" rather than as "better MP." This interpretation is borrowed from Bloom et al. (2013), who also used MP data from a paper/electronic MP survey in the US.

The differences listed in this section raises the question of comparability between the BVR and the SIBS MP index. Comparison of the non-parametric distributions from Figure 2 in Bloom (2010) and Figure 2 shows that, overall, both indices yield similar distributions for manufacturing enterprises. The only noticeable difference is the seemingly fatter tails in Figure 2.

2.2 Determinants of MP

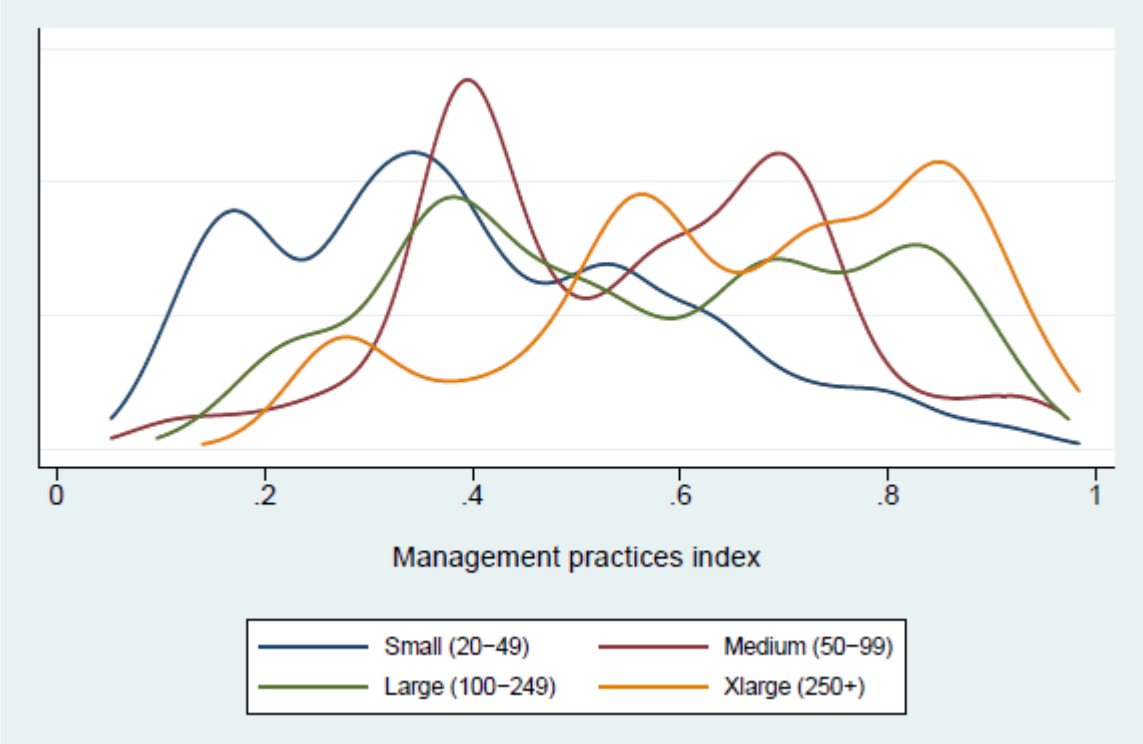
The first part of the regression analysis examines the relationship, at the firm level, between MP^{index} and a number of characteristics such as firm size and the degree of competition the firm faces. The relationship takes the following linear form (for 2009):

$$MP_i = \alpha_0 X_i + \alpha_1 COMP_i + \alpha_2 LERNER_i + \in_i \qquad (2)$$

Firms are denoted by i and $\in$ the usual error term. X is a vector of firm characteristics that includes workers education and binary variables for firm size, firm structure, industry and province. See Appendix B for a detailed description of all variables used in this analysis. The inclusion of most of these variables is justified given results from the BVR literature. Bloom (2010) and Institute for Competitiveness and Prosperity (2009) are especially relevant because of their focus on Canada.

Bloom (2010) found that large firms in Canada have the best MP, a evidence supported by SIBS data as shown in Figure 1. There is a clear pattern suggesting that the larger the enterprise, the more structured their MP. MP^{index} average is 0.40 for small enterprises and 0.66 for the x-large, while the average for medium and large ones are around 0.55. It is however unclear which factor is the cause. Large enterprises may need to implement good MP to conduct efficiently their operations, but it may be that good MP are required for growth. As for the other variables, the results must be interpreted as correlations, not causal effects. This applies to all relationships estimated in this paper and to other works in the BVR literature apart from Bloom et al. (2011).

Figure 1: Distributions for MP^{index} by firm size
– Weighted densities, total sample N = 4,227 –



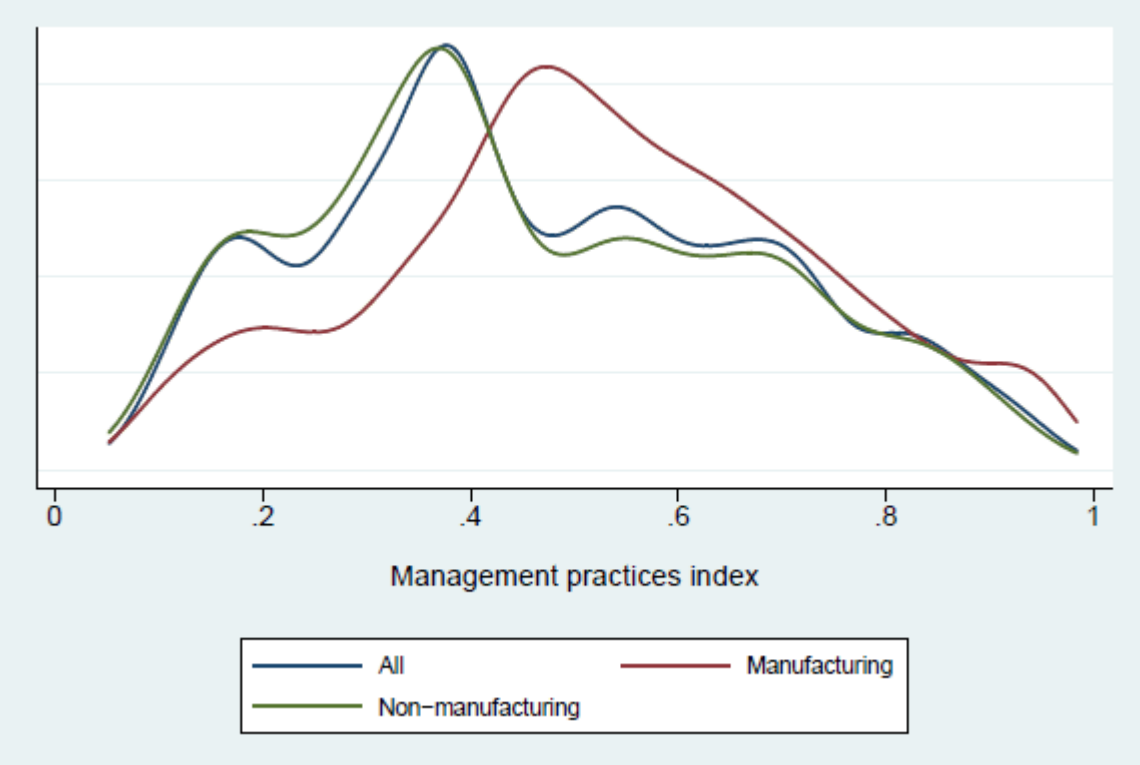
Source: Survey of Innovation and Business Strategy 2009
Note: Firm sizes are based on individual labour units.

Structure and ownership of the enterprise also matters for MP. Multinational enterprises (MNE) were found by Bloom and Van Reenen (2010) to have better MP compared to other enterprises. In this paper, a set of binary variables for the location of the headquarters (HQ) outside Canada is used as a proxy for MNE status. A country of control variable was also available, but it was so closely correlated with HQ variables that it could not be included. Note that the drawback of using the HQ variables is their inability to distinguish between a MNE and a non-MNE that both have their HQ in Canada. Another binary variable indicating the multi-establishment status of the enterprise was included as Bloom et al. (2013) reported that multiple establishment enterprises tend to have better MP. Finally, family-owned and managed enterprises are the worst managed compared to dispersed shareholders and private equity ownership (Van Reenen, 2011; Bloom and Sadun, 2009). Unfortunately, ownership information was not available in the SIBS.

Education is summarized by the percentage of workers with a university degree $(\%UNIV)$. Unfortunately, the SIBS did not collect data on managers' education. Bloom et al. (2013) showed that the magnitude of the correlation between MP and the workers' education is similar to the one between MP and managers' education. This means that the estimated coefficient of $\%UNIV$ may be overestimated.

The original BVR framework focussed on manufacturing enterprises, but a project was developped in collaboration with the Institute for Competitiveness and Prosperity to extend their framework to the retail sector. They found that in Canada, the US and the UK, manufacturing enterprises are better managed compared to retail sector enterprises (Institute for Competitiveness and Prosperity, 2010). SIBS data are again consistent with this evidence as shown in Figure 2. It is shown that the left tail of the distribution for non-manufacturing enterprises is much fatter compared to one for manufacturing enterprises. Given the difference between sectors, all descriptive statistics and regression analyses are going to be presented for manufacturing and non-manufacturing sector separately.

Figure 2: Distributions of MP^{index} by sector
– Weighted densities, total sample N = 4,227 –



Source: Survey of Innovation and Business Strategy 2009

Caution must, however, be exercised with non-manufacturing data because the SIBS coverage for this sector is not as comprehensive as for the manufacturing sector. For example, out of a population of 13,280 enterprises in the retail trade sector, only 26 were sampled (for more details see Appendix A of Industry Canada, 2011). In contrast, a third of all manufacturing enterprises in the target population (4,394 out of 12,846) were included in the sample. This implies that some non-manufacturing enterprises have large sampling weights that should be kept in mind when analyzing the results.

Despite this potential issue with sampling weights, it is possible to further decompose the MP^{index} distribution by two-digit NAICS industry. Two conclusions can be drawn from Figures 5, 6, 7 and 8 in Appendix C. First, there is a lot of variation in MP^{index} within a sector, no matter which sector is considered. Second, there is much more variation among the distributions of non-manufacturing sectors compared to two-digit manufacturing sectors. As mentioned in the previous paragraph, part of these results are due to small sample sizes and high sampling weights for non-manufacturing industries.

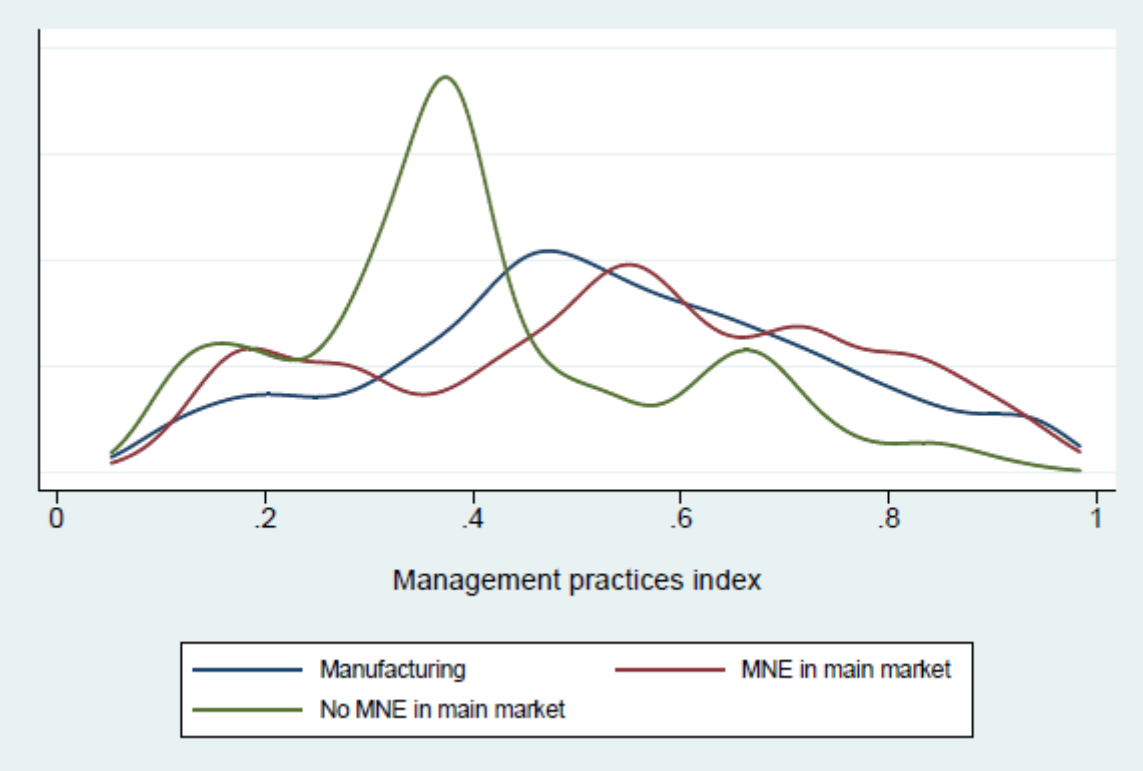
The ICAP report on retail also reported that the relationships between MP and size, MNE status, education and ownership have the same sign as in the manufacturing sector. In addition, the authors found that US-owned retail enterprises in Canada are better managed compared to Canadian-owned. Other non-manufacturing sectors studied by BVR, in separate initiatives, are health care services and school (Bloom et al., 2010).

Competition was found to be an important determinant of MP by BVR. Bloom et al. (2012b) mentioned that competition may affect MP through at least two mechanisms. First, this can happen through reallocation of

resources toward better managed enterprises. In other words, competition drives badly managed enterprises out of business. Second, competition may reveal information about competitors' MP. This causes managers to revise their "over-optimistic" perceptions of their own performance and to increase managerial efforts. Overall, BVR found that more competition is associated with better MP.

Competition in the BVR literature is measured by the number of competitors, the penetration rate of imports and the Lerner index. In this study, the vector $COMP$ includes four indicators of competition related to the enterprise's main market: the number of goods that compete against the enterprise's highest selling product; the presence of a MNE; the number of competitors; and the entry of new competitors. The main market of an enterprise is defined as the geographic area from which the highest share of revenue from its highest selling product is derived.[1] Figure 3 shows that enterprises facing a MNE in their main market tend to have more structured MP. This is, again, consistent with the BVR results mentioned previously. In addition to $COMP$, a Lerner index is also included in Equation (2) as done in Bloom and Van Reenen (2006). A sensitivity analysis was also conducted for the Lerner index and it was bounded to a -10 to 1 interval.

Figure 3: Distributions of MP^{index} by presence of MNE
– Weighted densities, total sample N = 4,227 –



Source: Survey of Innovation and Business Strategy 2009

2.3 MP and Labour Productivity

This part aims to estimate the relationship between MP and performance of enterprises operating in Canada, controlling for environmental factors and firm characteristics. The relationship estimated is given by:

$$Perf_i = \gamma_0 MP_I^{index} + \gamma_1 X_i + \gamma_2 COMP_i + \upsilon_i \qquad (3)$$

$Perf$ denotes the performance of the enterprise in 2008, either measured by sales over employment (sales) or profits over employment (profits). The estimated parameter MP^{index} , is expected to be positive as in the BVR literature (see for example Bloom and Van Reenen, 2010). Note that while SIBS data are only available for 2009, sales and profits for 2009 were not timely available. It is thus assumed that MP were consistent between the two years. In addition to the variable in X, the ratio of capital over employment (cap) is also included. It is as the sum of tangible and intangible assets over employment.

There is some evidence in the empirical literature that competition increases productivity. For example, Nickell (1996) reported that the increase in the number of competitors is associated with significantly higher total factor productivity growth. Aghion et al. (2009) suggested that entry of new firms may increase productivity growth, but only in industries that are close to the technology frontier. Griffith et al. (2010) also show that the increased competition in the European Union, measured by the level of profitability, had a positive impact on productivity growth. However, Blanchflower and Machin (1995) did not find much evidence to support a positive relationship between competition and productivity growth. This suggests that different measures of competition matter for firm performance, which justify the inclusion of the $COMP$ variables in Equation (3).

Equation (3) is estimated using the ROBUSTREG SAS procedure which uses residuals from an initial linear regression to identify the outliers and leverage points. Based on these residuals, a set of weights is produced and applied to the data and the model is estimated using an iterative algorithm.[2] Consequently, each outlier and bad leverage point receives a lower weight, which can be set to zero in extreme cases. Finally, observations for which the sales to employment ratio was equal to zero were removed, but negative profits were allowed.

2.4 MP and Innovation

There is some evidence in the non-BVR literature that other intangibles, such as human capital and organizational changes, are positively related to innovation (Becheikh et al., 2006). Using the Workplace and Employee Survey from 1999–2006, Dostie and Paré (2013) showed that both firm-sponsored classroom and on-the-job training lead to more innovation in Canada. Arvanitis et al. (2013) found similar results for Switzerland for human capital and organizational changes. There are no results on the relationship between innovation output and MP in the BVR literature, but Bloom et al. (2013) reported a positive correlation between R&D (innovation input) and MP for US establishments.

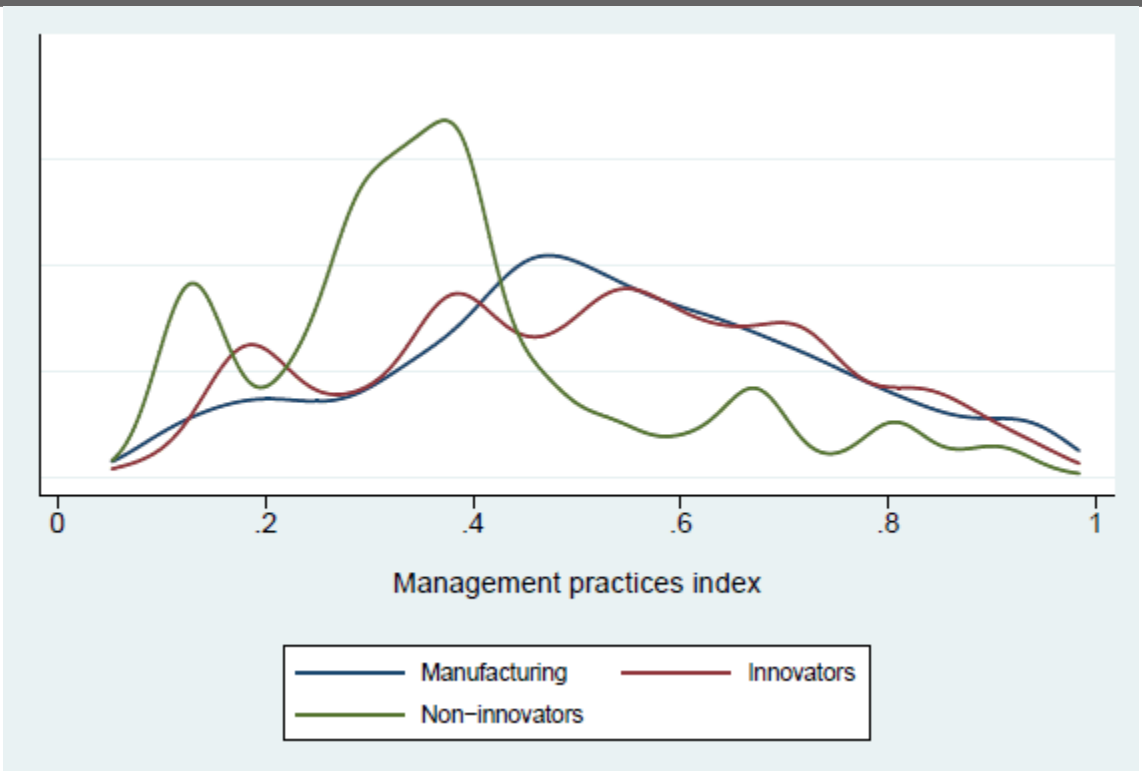
SIBS data suggest that innovation and MP are indeed positively associated. Figure 4 clearly shows that enterprises that have introduced innovation tend to have more structured MP compared to non-innovators. To further investigate this relationship, the following empirical specifications were estimated:

$$I_i = \delta_0 MP_i + \delta_1 X_i + \delta_i COMP_i + \mu_i \quad (4)$$

$$I_i^k = \delta_0^k MP_i + \delta_i^k X_i + \delta_i^k COMP_i + \mu_i^k \quad (5)$$

In Equation (4), I is a binary variable capturing whether the enterprise innovated from 2007–09. An innovator is defined as an enterprise that introduced any of the usual four types of innovation: process (PRCS), organizational (ORGZ), product (PRDT) or marketing (MRKT). The vector X contains the same variables as for Equation (2) plus R&D expenditures in 2004—results are robust to other definitions of R&D, 2004–06 average for instance—and the number of advanced technologies used by the enterprises in 2009. As μi is assumed to be normally distributed, so a simple Probit is used to estimate the relationship.

Figure 4: Distributions of MP^{index} by innovator status
– Weighted densities, total sample N = 4,227 –



Source: Survey of Innovation and Business Strategy 2009

For Equation (5), three additional definitions of innovation were used: i) technological (PRCS–PRDT) versus non-technological (ORGZ–MRKT); ii) PRCS–ORGZ versus PRDT–MRKT; iii) and PRCS, ORGZ, PRDT and MRKT. Innovation variables remained binary variables, but k sets of parameters were estimated. It was assumed that μ_k were normally distributed and correlated with each other, so multivariate Probits were used to estimate Equation (5). It was expected that some of δ will be positive, but it was unclear whether this relationship were to change depending on the type of innovation.

The impact of competition on innovation is not clear from the literature. Aghion et al. (2001) showed that an increase in product market competition has a positive impact on innovation. Similarly, Aghion et al. (2009) noted that entry of competitors spurs innovation in industries close to the technology frontier, a result that reflects their result for productivity. However, Boone (2000) reported that the effect of competition on innovation depends on the relative efficiency of the enterprise compared to its competitors. Therefore, in light of this brief overview of the literature, it is unclear what to expect about the relationship between MP^{index} and $COMP$.

1 Suppose that an enterprise's highest selling product revenue is distributed as follows: 45 percent comes from Canada, 25 percent from the US and 30 percent from the rest of the world. The main market for this enterprise is thus Canada.

2 These weights should not be confused with sampling weights. Both types of weights were used in this paper.

3. Data

Most variables were derived from the Survey of Innovation and Business Strategy 2009 (SIBS). The SIBS target population included all enterprises with at least 20 employees and $250,000 of revenue in NAICS 11 to 56, but manufacturing enterprises were oversampled. The statistics and results presented in this paper are weighted, so the results can be generalized to the target population. The SIBS final sample consists of 4,227 enterprises.

Data on MP, competition intensity (except the Lerner index), innovation and use of advanced technology were taken from the SIBS. In addition, some control variables such as location of head office and the share of workers with a university degree were also extracted from the SIBS. The other control variables were derived from the Business Register (province of location, industry and multi-establisment status).

SIBS data needed to be supplemented by information from other Statistics Canada administrative databases. Sales, profits, assets (tangible and intangible) and cost of goods sold variables were extracted from the General Index of Financial Information database. Dollars variables were expressed in $M and were deflated using the National Account Productivity price index (KLEMS) produced by Statistics Canada.

Employment was extracted from the Longitudinal Employment Analysis Program database. The individual labour unit (ILU) was used to construct all employment variables, including firm size. ILU is not a count of the number of employees, but a constructed variable reflecting the share of employment attributable to an enterprise. For example, if an employee works in two enterprises and derived half of his salary from each, ILU is equal to 0.5 for both enterprises for this employee.

The Research and Development in Canadian Industry database provides data on R&D expenditures. As a practical matter for the year 2004, this database was a census of all R&D performers in Canada, so any missing observation was considered to be a zero.

4. Results

4.1 Determinants of the MP^{index}

Table 1 summarizes the results from the regression of MP^{index} on firm characteristics and competition indicators. The full set of estimated parameters is presented in Table 4 of Appendix D. Overall, results are fairly robust across sectors and consistent with the BVR literature.

Firm size is one of the most important variables. Consistent with the evidence in Figure 1, there is a positive relationship between firm size and MP^{index} and the magnitude of the estimated parameters increases with size. These results hold for both sectors and estimated parameters for the non-manufacturing sector are larger. Enterprises with a higher percentage of workers with a university degree $(\%UNIV)$ tend to have more structured MP. The location of head office also matters, especially if it is located in the US. The multiple establishments variable is negatively correlated with MP^{index} for non-manufacturing enterprises only.

Table 1: Summary of Eq. (2): Determinants of MP^{index}

– Dep. var.: MP^{index}, weighted OLS regressions –

Variable	Manufacturing	Non-manufacturing
	– Characteristics –	
MEDIUM	**0.1025**	**0.1544**
LARGE	**0.1083**	**0.1827**
XLARGE	**0.1873**	**0.2378**
%LARGE	**0.0018**	**0.0026**
HQ_US	**0.0586**	**0.0943**
HQ_EU	**0.0668**	0.0543
HQ_ROW	0.0199	-0.0994
MULTI	0.0083	**-0.0211**
	– Competition variables –	
MNE	**0.0587**	**0.1022**
#COMP	**-0.0081**	-0.0006
ENTRY	0.0143	-0.0306
#GOODS	0.0006	0.0106
LERNER	-0.0063	**0.0998**

Estimated parameters significant at a 0.10 level or less are in bold.
Detailed results are presented in Table 4 of Appendix D.

In terms of competition, the presence of a MNE in the enterprise's main market for its highest selling product is positely correlated with MP^{index}. Few other competition variables are found to be significant. For the manufacturing sector, there is a negative relationship between the number of competitors in the main market $(\#COMP)$ and MP^{index} as in Bloom and Van Reenen (2007). For non-manufacturing enterprises, a positive link has been identified between the Lerner index and MP^{index}. Exclusion of the Lerner index does not have much impact as shown in Table 4.

4.2 Relationships between Sales, Profits and MP^{index}

Table 2 summarizes the results for sales and profits regressions. The full set of estimated parameters is presented in Table 5 of Appendix D. The main difference between sectors relates to MP^{index} as the estimated coefficient for this variable is positive and significant for manufacturing enterprises, but not for non-manufacturing enterprises.

One possible explanation for this result is the heterogeneity among enterprises outside the manufacturing sector. Complementary evidence on this heterogeneity is provided in Figures 6 to 8 in Appendix C. These figures show that, at least in terms of MP distributions, non-manufacturing industries are less similar among themselves compared to the three-digit manufacturing industries (Figure 5). The results may also be driven by some non-manufacturing enterprises with large sampling weights—the SIBS coverage being much less comprehensive outside the manufacturing sector.

Table 2: Summary of Eq. (3): Economic performance and MP^{index}
– Dep. var.: sales and profits (intensity), weighted robust regressions –

	Manufacturing		Non-manufacturing	
Variable	*Sales*	*Profits*	*Sales*	*Profits*
		– Characteristics –		
cap	+	+	+	+
MP^{index}	+	+		
MEDIUM	+	+		–
XLARGE	+	–		–
LARGE	+	–	–	–
%UNIV		+	+	+
HQUS	+	+	+	+
HQEU	+	+		
HQROW		–		
MULTI	+	+	+	+
		– Competition Variables –		
MNE	+	–		–
#COMP		+	+	+
ENTRY		–		–
#GOODS		–	–	–

+/−: significant at a 0.10 level or less.
Detailed results are presented in Table 5 of Appendix D.

To further investigate this issue, Equation (3) was estimated for two additional non-manufacturing sectors groupings: resources-based and best-managed. The first group includes NAICS 11 (agriculture), 21 (mining and oil and gas extraction), 22 (utilities) and 23 (construction). The second is a grouping of NAICS 52 (finance and insurance) and 54 (professional services), which are the two services sectors with the highest MP^{index} average (Figure 7). The estimated coefficient for MP^{index} (not shown here) is negative and significant in the sales regression for the best-managed group and in the profits regression for the resources-based group. While these results seems to confirm the importance of heterogeneity and the effect of the sampling strategy used, it is hard to explain why the sign for MP^{index} is negative.

A second explanation for the non-significance of MP^{index} in Table 2 is that the SIBS MP questions were less appropriate for non-manufacturing activities. Testing of the questionnaire revealed that respondents in non-manufacturing enterprises had more difficulty answering some of these questions. A different framework for the non-manufacturing sector would have been better, as in Institute for Competitiveness and Prosperity (2010) for the retail trade sector—but this was not possible to implement at the time SIBS was developed. In turn, this suggests that MP^{index} may not accurately measure the extent of MP in non-manufacturing industries.

Turning to the competition indicators, the results in Table 2 indicate that facing more competitors (*#COMP*) is associated with better performance while a higher number of goods competing with the enterprise's highest selling product (*#GOODS*) has the opposite effect. Presence of a MNE and entry of new competitors are also negatively correlated with profits in both sectors. Two conclusions can be drawn from the competition results. First, not all aspects of competition correlate in the same way with firm performance. Second, profits seem more sensitive to competition compared to sales.

Among the other variables, the estimated coefficient of asset-to-employment ratio cap has a positive sign in all specifications, which is also the case for *HQ_US* (head office located in the United States) and *MUTLI* (multi-establishments). The percentage of workers with a university degree is positively correlated with performance, except for the sales regression for manufacturing enterprises. Finally, performance increased with firm size only for manufacturing enterprises in the sales regression.

4.3 Relationships between Innovation and MP^{index}

Table 3 summarizes the results from the innovation regressions. Column (1) shows the results for the general indicator of innovation; Column (2) shows the ones for technological and non-technological innovations; Column (3) shows the results for the PRDT–MRKT and PRCS–ORGZ innovation groupings; and the last column shows them for the four types of innovation. All estimated parameters are presented in Tables (5) to (7) in Appendix D.

The most important result is the estimated positive correlation between MP^{index} and innovation. This holds for manufacturing enterprises no matter how innovation is measured and for most indicators for non-manufacturing enterprises. This is an important result because it shows how critical MP is for innovation even when accounting for other control variables such as innovation inputs, firm size, enterprise structure and competition indicators.

Table 3: Summary of Eq. (4) and (5): Innovation and MP^{index}
– Dep. var.: see table, weighted Probit –

Manufacturing									
Variable	(1)	(2)		(3)		(4)			
	INNO	TECH	NTECH	PD–MK	PC–OG	PRCS	ORGZ	PRDT	MRKT
				– Characteristics –					
MP^{index}	+	+	+	+	+	+	+	+	+
RD									
ADVTECH	+	+	+	+	+			–	
MEDIUM				–			–		
LARGE			–				–		–
XLARGE	–		–			+	+	+	+
%UNIV			+	+				+	+
HQ_US		–				–			
HQ_EU					+	–			
HQ_ROW		–	–			–	–	–	
MULTI	–								
				– Competition Variables –					
MNE	+			+				+	
#COMP	–	–						–	
ENTRY	+	+	+	+	+	+	+	+	+
#GOODS		+		+				+	+

Non-Manufacturing									
Variable	(1)	(2)		(3)		(4)			
	INNO	TECH	NTECH	PD–MK	PC–OG	PRCS	ORGZ	PRDT	MRKT
				– Characteristics –					
MP			+	+	+	+	+		+
RD		+							
ADVTECH	+	+			+	+	+	+	
MEDIUM								+	
LARGE	+		–	+			+		+
XLARGE	–			+			+	+	
%UNIV									
HQ_US		–			+		+		
HQ_EU									
HQ_ROW		–							
MULTI	–				–	–	–		
				– Competition variables –					
MNE	+	+			+	+		+	
#COMP			–			+	–	–	
ENTRY	+	+	+	+			+	+	+
#GOODS	–	–				–			

+/–: significant at a 0.10 level or less.
Detailed results are presented in Tables 5, 6 and 7 of Appendix D.

Of the two inputs to innovation, R&D expenditures (*RD*) and the number of advanced technologies used (*ADVTECH*), only the latter is found to be positively correlated with innovation. For manufacturing enterprises, this relationship holds for all aggregated measures of innovation as shown by Columns (1), (2) and (3). In contrast, for non-manufacturing enterprises, the results suggest that *ADVTECH* is positively correlated with PRCS, ORGZ and PRDT innovations.

RD is significant only for technological innovation introduced by non-manufacturing enterprises (Column (2)). Although a similar result was found in Brouillette (2013), R&D is nevertheless still important for innovation in Canada. It is likely that R&D expenditures affect indirectly innovation, for example, through the use of advanced technology.

The influence of the competition indicators depend on how competition is measured. The most striking result is the entry of new competitors in the enterprise's main market for its highest selling product. The estimated parameters for *ENTRY* is systematically positive and significant for all types of innovation in the manufacturing sector regressions and for almost all cases in the nonmanufacturing sector regressions, a result consistent with Aghion et al. (2009). Another aspect of competition that is positively correlated with innovation is the presence of a MNE in the enterprise's main market although fewer significant relationships were found. Results are consistent for both manufacturing and non-manufacturing sectors. The link between the number of competitors (*#COMP*) in the main market is negative overall for both sectors. This contrasts with the results for the performance analysis where this variable was found to have a positive and significant sign.

The results also show that a small number of positive estimated correlations between innovation and *%UNIV* were found in the manufacturing sector, but no such association was found in the non-manufacturing sector. This is in contrast to the results of the performance analysis where *%UNIV* is more important for non-manufacturing enterprises.

The relationship between firm size and innovation is less clear. Compared to small ones, large and x-large non-manufacturing enterprises are more susceptible to innovate, but results depend on the innovation indicator used. Results are even more mixed for manufacturing enterprises. Finally, the links between innovation and the location of headquarters and multi-establishment status are mostly negative.

5. Conclusion

This analysis confirms the presence of a positive correlation between firms' financial performance and business innovation and well structured management practices (MP). This study also provides evidence on the role played by competition.

The results show large differences in MP distribution across industries. Firm size, presence of a multinational enterprise (MNE) in the enterprise’s main market, head office located in the United States and the percentage of workers with a university degree are the main determinants of MP. In terms of firm performance, MP are positively correlated with the intensity of sales and profits in the manufacturing sector, but not in the non-manufacturing sector. In contrast, MP are important for all industries when it comes to innovation. Finally, the role of competition depends on its nature and to a certain extent of the industry considered. The presence of a MNE and entry of new competitors are positively correlated with innovation, while it is the number of competitors that is important for firm performance.

From a policy perspective, this analysis highlights the importance of intangible capital for firm performance and business innovation. While this analysis focusses on MP, other intangibles such as managers’ education, investments in skills and intellectual property management are perhaps equally important for growth and innovation. More research at the enterprise-level on theses intangibles is needed to better understand their interactions with productivity growth. This would allow better support to enterprises so that they can achieve their full potential.

Two caveats should be mentioned. The first one relates to data limitation for performance indicators. As described in Section 3, the last year available for these data was 2008. Since most SIBS data cover 2009 only—this is the case for MP and competition indicators—the implicit assumption made is that these variables did not change between 2008 and 2009.

The second caveat is about the endogeneity of the MP index. Although this is acknowledged as a serious issue, it was not possible to address it in this paper for lack of instruments. This may change with the availability of the SIBS 2012 data in 2014. By combining the 2009 and 2012 waves, this will provide a measure of the change in management practices that could be compared to the change in firms' performance or innovation.

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Appendix A. The Management Practices Indices

A.1 Comparison of MP Indicators from the BVR Survey and the SIBS

Contents comparison between BVR and SIBS indices			
BVR index (Bloom and Van Reenen, 2007)	BVR types of indicators	SIBS index (MP^{index})	
1 Modern manufacturing, introduction	Operations		No equivalent
2 Modern manufacturing, rationale	Operations		No equivalent
3 Process documentation	Operations	Q52	The enterprise has a systematic process to resolve problems associated with production of goods or delivery of services
4 Performance tracking	Monitoring	Q53	Number of key production performance indicators (KPPI) monitored in the enterprise
5 Performance review	Monitoring	Q54	Frequency at which KPPI are shown to managers of operations
		Q55	Frequency at which KPPI are shown to workers
		Q56	Frequency of review of KPPI by top and middle managers
6 Performance dialogue	Monitoring	Q62	Employees' involvement in the decision-making process on task allocation
7 Consequence management	Monitoring		No equivalent
8 Target breadth	Targets		No equivalent
9 Target interconnection	Targets		No equivalent
10 Target time horizon	Targets	Q58	Time frame of the enterprise production performance targets for its highest product
11 Targets are stretching	Targets		No equivalent
12 Performance clarity	Monitoring	Q64d	Formal performance agreements based on objective, quantifiable results are prepared for managerial/supervisory /executive employees at least annually
		Q64e, Q64f	Formal appraisals are conducted for the majority of managerial and non-managerial staff at least annually
13 Managing human capital	Targets		No equivalent
14 Rewarding high-performance	Incentives	Q59	How does the enterprise reward production performance target achievement
15 Removing poor performers	Incentives	Q61	Enterprise's main policy to deal with employees not meeting expectations
16 Promoting high performers	Incentives	Q60	Enterprise's main way to promote employees
		Q64b	Formal training programs are available to employees to teach them the skills required to perform their job
		Q64c	Formal training programs are available to employees to increase their promotability
17 Attracting human capital	Incentives	Q64a	At least one of the following selection methods to select candidates is used: personality/attitude tests, intelligence or aptitude tests, work sample
18 Retaining human capital	Incentives	Q64g	Incentives programs such as employee stock ownership, profit-sharing, gain-sharing or merit bonus are available to non-managerial employees
		Q64h	Incentives programs are available to managerial, supervisory, or executive employees
		Q64i	Incentives programs are available to all employees

Appendix A (continued)

A.2 Details on MP^{index}

Indicators and score of MP^{index}					
QUESTION	SCORE		QUESTION	SCORE	
Q52 Systematic process	No	0	Q64a Use selection	No	0
to solve problems	Yes	1	methods for candidates	Yes	1
Q53 #KPPI	None	0	Q64b Training	No	0
	At least one	1	for skills	Yes	1
Q54 Frequency KPPI	Never/don't know	0	Q64c Training for	No	0
shown to managers	Any frequency	1	promotion	Yes	1
Q55 Frequency KPPI	Never/don't know	0	Q64d Performance	No	0
shown to workers	Any frequency	1	agreements	Yes	1
Q56 Frequency KPPI	Don't know	0	Q64e Appraisal	No	0
shown to executives	Rarely	$1/3$	for workers	Yes	1
	Periodically	$2/3$			
	Continually	1			
Q58 Time frame	No targets	0	Q64f Appraisal	No	0
for performance	Short-term	$1/3$	for managers	Yes	1
targets	Long-term	$2/3$			
	Both	1			
Q59 Rewards	None	0	Q64g Incentives	No	0
	Managers only	½	for workers	Yes	1
	All staff	1			
Q60 Promotion	Tenure	0	Q64h Incentives	No	0
based on …	Effort and tenure	½	for managers and	Yes	1
	Effort	1	executives		
Q61 If employees	Never moved	0	Q64i Incentives	No	0
don't meet	Warned	$1/3$	for all	Yes	1
expectations	Warned, re-trained	$2/3$			
	Removed	1			
Q62 Employees	No	0			
make decisions	yes	1			

The SIBS questionnaire is constructed in such a way that Q54 to Q59 have to be answered only if the number of key production performance indicators monitored (Q53) is greater than zero. This means that for all enterprises not monitoring any, the maximum score is 14, not 19. A score of 0 was nevertheless assigned to Q54–Q59 for these enterprises so that an enterprise with fewer MP obtains a lower value of MP^{index} compared to one with more practices. Without this assumption, Enterprise A with MP^{index} = 13/14 (0.93) would rank higher than Enterprise B with MP^{index} = 17/19 (0.89). Enterprise B should, however, rank higher compared to Enterprise A because it has a broader set of MP and its performance for indicators other than those of Q54–Q59 is as good as for Enterprise A.

Appendix B. Variables Definition

Dependent variables		
NAME	DESCRIPTION	SOURCE
MP	Management practice index (2009)	SIBS
sales	Sales over employment ratio in $M (2008)	GIFI, LEAP
profits	Profits over employment ratio in $M (2008)	GIFI, LEAP
INNO	= 1 if enterprise has innovated (2007–09)	SIBS
I^{PRCS}	= 1 if PRCS innovation has been introduced (2007–09)	SIBS
I^{ORGZ}	= 1 if ORGZ innovation has been introduced (2007–09)	SIBS
I^{PRDT}	= 1 if PRDT innovation has been introduced (2007–09)	SIBS
I^{MRKT}	= 1 if MRKT innovation has been introduced (2007–09)	SIBS
I^{TECH}	= 1 if PRCS or PRDT have been introduced (2007–09)	SIBS
$I^{NON-TECH}$	= 1 if ORGZ or MRKT have been introduced (2007–09)	SIBS
I^{PD-MK}	= 1 if PRDT or MRKT have been introduced (2007–09)	SIBS
I^{PC-OG}	= 1 if PRCS or ORGZ have been introduced (2007–09)	SIBS

Competition variables		
NAME	DESCRIPTION	SOURCE
MNE	= 1 if a MNE is present in the main market (2009)	SIBS
#COMP	Number of competitors in the main market (2009) Categories: 1 = 1 comp.; 2 = 2 comp.; 3 = 3 comp.; 4 = 4–5 comp.; 5 = 6–10 comp.; 6 = 11–20 comp.; 7 = 20+ comp.	SIBS
ENTRY	= 1 if a new competitor entered main market (2009)	SIBS
#GOODS	Number of competing products in main market (2009) Categories: 1 = 1–2 prod.; 2 = 2–4 prod.; 3 = 5–7 prod.; 4 = 8–9 prod.; 5 = 10–19 prod.; 6 = 20–49 prod.; 7 = 50–100 prod.; 8 = 100+ prod.	SIBS
SALES	Sales in $M (2008)	GIFI
COGS	Cost of goods sold in $M (2008)	GIFI
LERNER	Lerner index (2008): $^{(SALES-COGS)}/_{SALES}$	GIFI

Appendix B (continued)

Control variables		
NAME	DESCRIPTION	SOURCE
SIZE	Binary variables for firm size (ILU) (2009) SMALL: [20-50[ILU; MEDIUM: [50-100[ILU; LARGE: [100-250[ILU; XLARGE: 250+ ILU. SMALL size is the reference.	LEAP
PROV	Binary variables for the location of the enterprise (2009) QC: Québec; ON: Ontario; AB: Alberta; BC: British Columbia; ROC: Rest of Canada. ON is the reference.	BR
NAICS	Binary variables for industries (2009) MANU 1: NAICS 31; MANU 2: NAICS 32; MANU 3: NAICS 33; RES: NAICS 11, 21, 22 and 2 SERV : NAICS 41, 44–45, 48–49, 51, 52, 53, 54, 55 and 56. MANU 1 is the reference for manufacturing and RES is the reference for non-manufacturing.	BR
HQ	Binary variables for location of head office (2009) HQ CA: Canada; HQ US: United States; HQ EU: Europe; HQ ROW: All other countries. HQ CA is the reference.	SIBS
%UNIV	Percentage of workers with university degree (1009)	SIBS
MULTI	= 1 if the enterprise has multiple establishments	BR
CAP	Sum of tangible and intangible assets in $M (2008)	GIFI
cap	CAP over employment ratio in $M (2008)	GIFI
RD	R&D expenditures in $M (2004)	RDCI
ADVTECH	Number of advanced technologies used (2009)	SIBS

Appendix C. Descriptive Statistics (weighted)

Statistics by sector					
		– *Manufacturing N = 2,890* –			
MP	0.54 [0.4]	*#COMP* (%)		*SIZE* (%)	
sales * ($M)	0.16 [0.2]	1	3.9 [0.4]	*SMALL*	54.3
profits ** ($M)	0.04 [0.1]	2	4.9 [0.5]	*MEDIUM*	24.3
INNO (%)	81.2 [0.9]	3	9.0 [0.6]	*LARGE*	13.8
I^{PRCS}	58.1 [1.2]	4–5	24.4 [1.0]	*XLARGE*	7.2
I^{ORGZ}	53.9 [1.2]	6–10	23.2 [1.0]	*PROV* (%)	
I^{PRDT}	48.6 [1.1]	11–20	9.8 [0.7]	*ON*	41.9
I^{MRKT}	40.0 [1.1]	20+	24.8 [1.0]	*QC*	28.5
I^{TECC}	70.3	*#GOODS* (%)		*AB*	9.1
I^{NTECH}	64.5	0–2	18.4	*BC*	12.2
I^{PD-MK}	61.8	2–4	23.4	*ROC*	8.3
I^{PC-OG}	71.5	5–7	15.1	*HQ* (%)	
CAP * ($M)	0.08 [0.2]	8–9	2.3	*HQ_CA*	88.2 [0.5]
RD **** ($M)	0.90 [12.6]	10–19	16.0	*HQ_US*	7.6 [0.4]
ADVTECH	1.64 [3.8]	20–49	10.2	*HQ_EU*	3.1 [0.3]
%UNIV † (%)	11.1 [2.7]	50–100	3.6	*HQ_ROW*	1.1 [0.2]
MULTI (%)	15.5	100+	11.2		
MNE (%)	66.0 [1.1]	*NAICS* (%)			
ENTRY (%)	31.1 [1.1]	*MANU_1*	16.7		
LERNER ***	0.28	*MANU_2*	30.4		
		MANU_3	52.9		

When available, standard error is in brackets.

† Coefficients of variation are reported in brackets.

* Sample size: N = 2,534 (manufacturing); N = 1,001 (non-manufacturing).

** Sample size: N = 2,584 (manufacturing); N = 1,142 (non-manufacturing).

*** Sample size: N = 2,730 (manufacturing); N = 1,129 (non-manufacturing).

**** Mean (> 0) N = 806 (manufacturing); N = 170 (non-manufacturing).

Sources: Statistics Canada SIBS, GIFI, LEAP, RDCI and BR.

Appendix C (continued)

– Non-Manufacturing [*] N = 2,890 –					
MP	0.45 [1.4]	*#COMP* (%)		*SIZE* (%)	
sales [*] ($M)	0.18 [1.0]	1	2.9 [1.5]	*SMALL*	59.1
profits [**] ($M)	0.05 [0.3]	2	6.1 [3.4]	*MEDIUM*	18.8
INNO (%)	63.6 [5.4]	3	13.9 [2.3]	*LARGE*	17.0
I^{PRCS}	27.9 [3.9]	4–5	9.8 [1.5]	*XLARGE*	5.1
I^{ORGZ}	30.2 [4.2]	6–10	28.9 [4.4]	*PROV* (%)	
I^{PRDT}	31.6 [4.2]	11–20	17.4 [4.4]	*ON*	36.2
I^{MRKT}	34.3 [4.3]	20+	21.1 [3.2]	*QC*	27.1
I^{TECC}	47.3	*#GOODS* (%)		*AB*	12.1
I^{NTECH}	47.0	0–2	24.4	*BC*	11.8
I^{PD-MK}	44.1	2–4	22.7	*ROC*	12.9
I^{PC-OG}	45.3	5–7	12.6	*HQ* (%)	
CAP [*] ($M)	0.09 [1.2]	8–9	4.1	*HQ_CA*	95.4 [0.9]
RD [****] ($M)	3.26 [40.1]	10–19	18.2	*HQ_US*	3.8 [0.9]
ADVTECH	0.97 [9.5]	20–49	9.2	*HQ_EU*	0.5 [0.1]
% UNIV [†] (%)	16.9 [7.7]	50–100	3.1	*HQ_ROW*	0.3 [0.1]
MULTI (%)	21.1	100+	5.7		
MNE (%)	46.4 [5.5]	*NAICS* (%)			
ENTRY (%)	32.7 [5.2]	*SERV*	75.5		
LERNER [***]	0.45	*RES*	24.5		

When available, standard error is in brackets.

[†] Coefficients of variation are reported in brackets.

[*] NAICS 11, 21, 22, 23, 41, 44–45, 48–49, 51, 52, 53, 54, 55 and 56.

[*] Sample size: N = 2,534 (manufacturing); N = 1,001 (non-manufacturing).

[**] Sample size: N = 2,584 (manufacturing); N = 1,142 (non-manufacturing).

[***] Sample size: N = 2,730 (manufacturing); N = 1,129 (non-manufacturing).

[****] Mean (> 0) N = 806 (manufacturing); N = 170 (non-manufacturing).

Sources: Statistics Canada SIBS, GIFI, LEAP, RDCI and BR.

Sample size for sales and profits regressions are smaller than the full SIBS sample (4,227). There are four explanations to this. First, sales and profits (GIFI) have some missing records. Second, as mentioned in Section 2.3, the ROBUSTREG SAS procedure assigned a weight—not the sampling weights—of zero to some outliers and bad leverage points which effectively removed them. Third, enterprises with a sales to employment ratio equals to zero were removed. Negative profits, however, are permitted. Fourth, the Lerner index was bounded between -10 and 0.

Figure 5: Distributions of MP^{index} for NAICS 31, 32 and 33

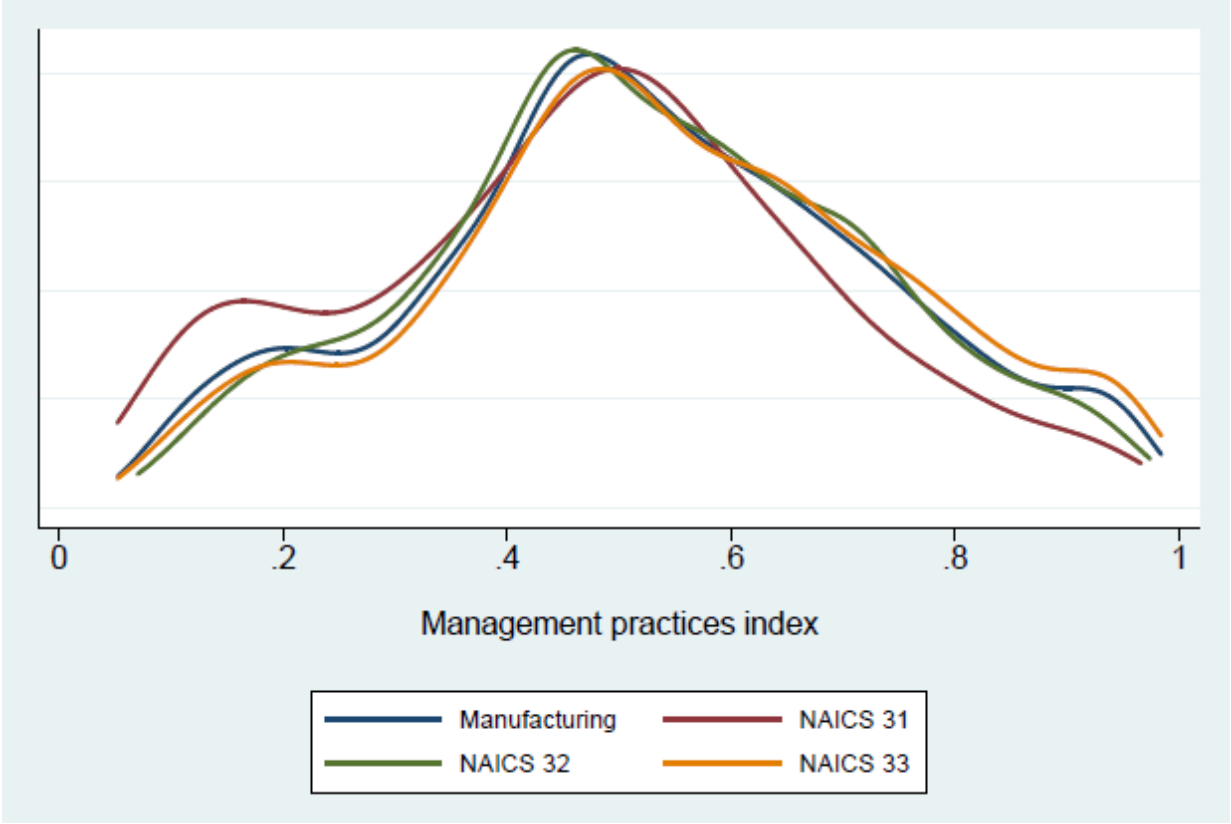


Figure 6: Distributions of MP^{index} for NAICS 21 and 22

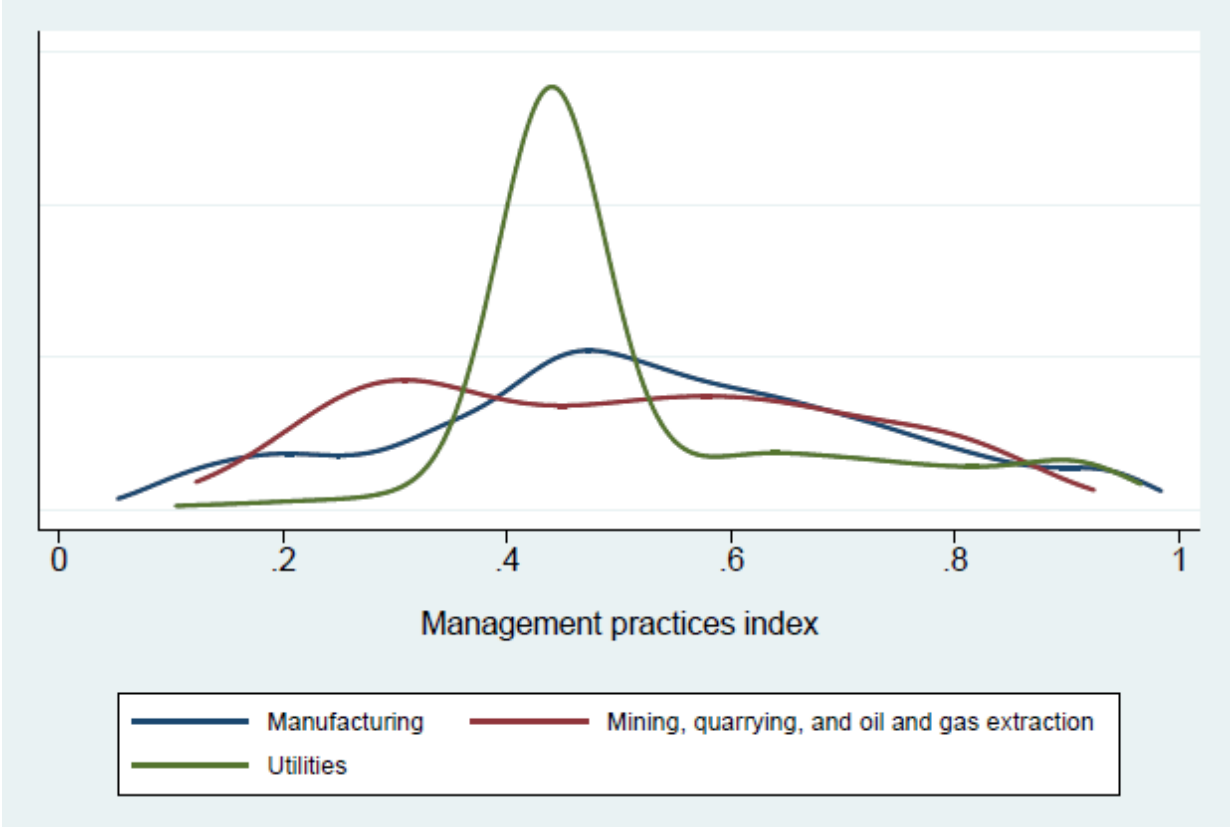


Figure 7: Distributions of MP^{index} for NAICS 51, 52 and 54

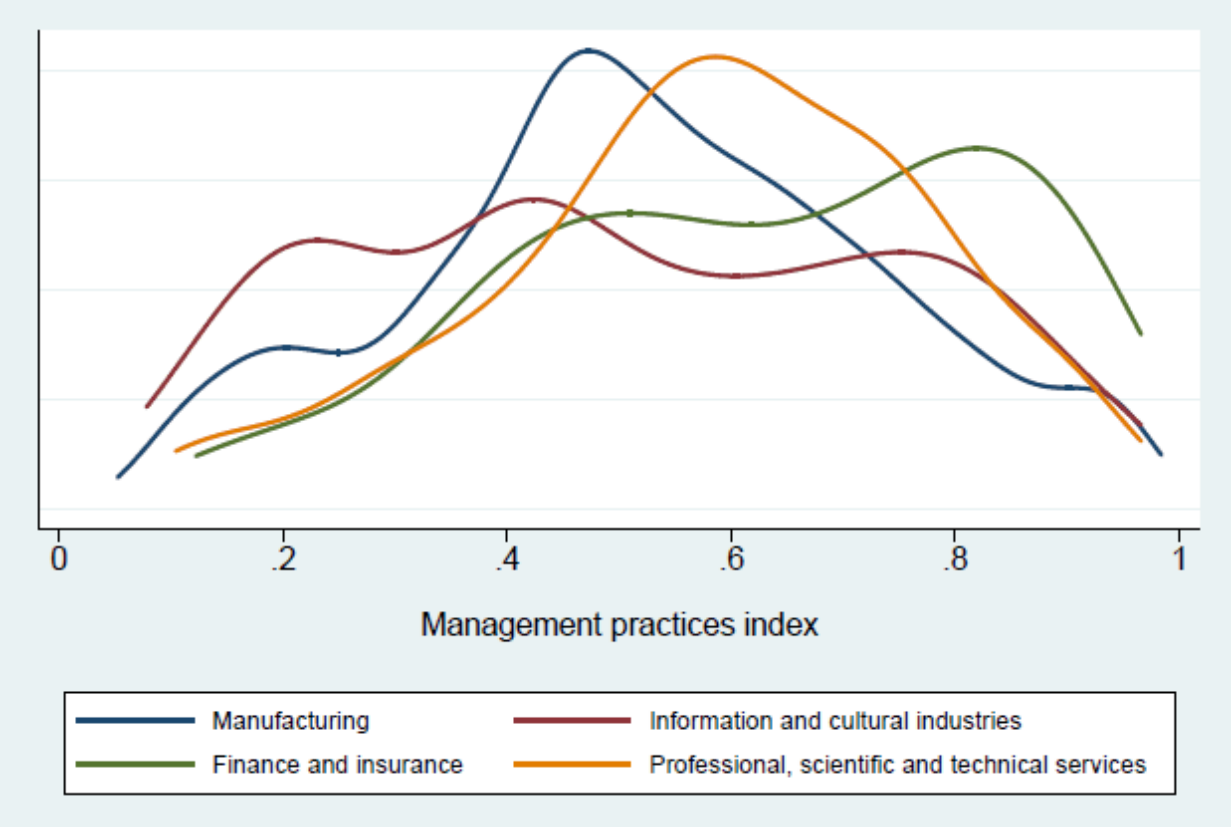
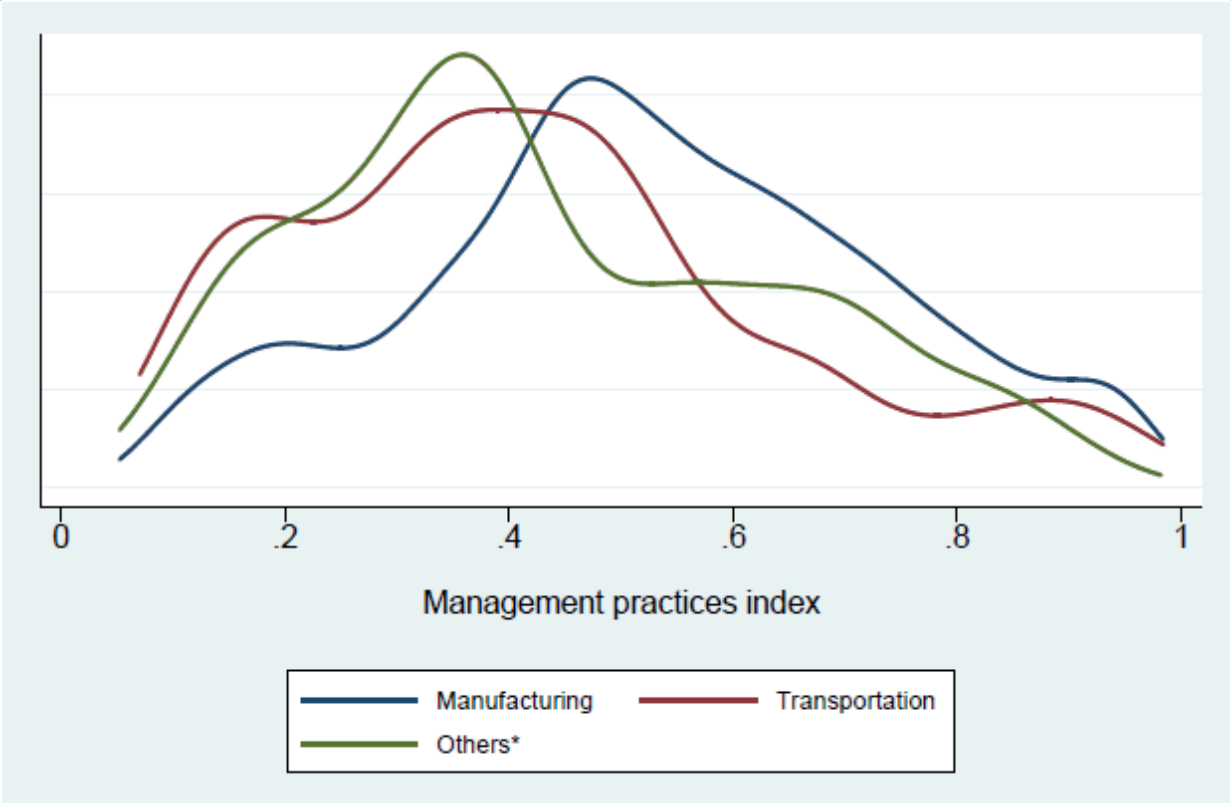


Figure 8: Distributions of MP^{index} for NAICS 48 and other



* All covered industries except NAICS 21, 22, 31-33, 48, 51, 52 and 54.

Appendix D. Detailed Results

Table 4: Detailed Results of Equation (2)
– Dep. var.: MP^{index}, weighted OLS regressions –
(*Characteristics*)

Variable	Manufacturing		Non-manufacturing	
		– Characteristics –		
CONS	0.4032 *	0.4067 *	0.2514 *	0.3127 *
	(0.0001)	(0.0001)	(0.0002)	(0.0001)
MEDIUM	0.1025 *	0.1001 *	0.1544 *	0.1539 *
	(0.0004)	(0.0004)	(0.0003)	(0.0001)
LARGE	0.1083 *	0.1060 *	0.1827 *	0.1855 *
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
XLARGE	0.1873 *	0.1851 *	0.2378 *	0.2465 *
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
%UNIV	0.0018 *	0.0019 *	0.0026 *	0.0027 *
	(0.0003)	(0.0001)	(0.0001)	(0.0001)
HQ_US	0.0586 *	0.0602 *	0.0943 *	0.0606
	(0.0003)	(0.0001)	(0.0081)	(0.1111)
HQ_EU	0.0668 *	0.0671 *	−0.0121	0.02690
	(0.0006)	(0.0004)	(0.8326)	(0.6497)
HQ_ROW	0.0199	0.0199	0.0543	0.1040
	(0.4080)	(0.389)	(0.5673)	(0.2006)
MULTI	0.0083	0.0080	−0.0994 *	−0.1031 *
	(0.5735)	(0.5698)	(0.0188)	(0.0046)
SERV			−0.0211	−0.0215
			(0.6316)	(0.5758)
MANU_2	0.0489 *	0.0459 *		
	(0.0004)	(0.0006)		
MANU_3	0.0579 *	0.0550 *		
	(0.0004)	(0.0006)		
QC	−0.0331 **	−0.0303 **	0.0373	0.0292
	(0.0660)	(0.0863)	(0.3890)	(0.4438)
AB	−0.007	−0.0058	0.0210	0.0368
	(0.7708)	(0.7975)	(0.6766)	(0.3742)
BC	−0.0212	−0.0156	−0.0530	−0.0556
	(0.3229)	(0.4534)	(0.3054)	(0.2627)
ROC	−0.0101	−0.0118	−0.0109	0.0293
	(0.6409)	(0.5826)	(0.7510)	(0.3104)

P-values are between parenthesis.

* Significant at a 0.05 level.

** Significant at a 0.10 level.

Appendix D (continued)

Table 4: Detailed Results of Equation (2) – (*continued*) – Dep. var.: MPindex, weighted OLS regressions – (*Competition variables*)

Variable	Manufacturing		Non-manufacturing	
		– *Competition variables* –		
MNE	0.0587 *	0.0597 *	0.1022 *	0.0995 *
	(0.0001)	(0.0001)	(0.0029)	(0.0011)
#COMP	−0.0081 *	−0.0086 *	−0.0006	−0.0062
	(0.0135)	(0.0070)	(0.9490)	(0.4647)
ENTRY	0.0143	0.0146	−0.0306	−0.0261
	(0.3395)	(0.3139)	(0.4013)	(0.4101)
#GOODS	0.0006	0.0008	0.0106	0.0134 *
	(0.8277)	(0.7718)	(0.1104)	(0.0354)
LERNER	−0.0063		0.0998 *	
	(0.8168)		(0.0129)	
N	2,730	2,890	1,129	1,337
R-SQUARE	0.2128	0.4361	0.2086	0.3951

P-values are between parenthesis.

* Significant at a 0.05 level.

Appendix D (continued)

Table 5: Detailed Results of Equations (3) and (4)

– Dep. var.: sales[1], profits[1] and INNO regressions – Characteristics

Variable	Manufacturing			Non-manufacturing		
	sales	*profits*	*INNO*	*sales*	*profits*	*INNO*
			–Characteristics –			
CONS	0.0751 *	0.0162 *	−0.6298 *	0.1673 *	0.0314 *	−1.2375 *
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0170)
cap	0.3117 *	0.0507 *		0.0939 *	0.0950 *	
	(0.0000)	(0.0000)		(0.0000)	(0.0000)	
MP^{index}	0.0494 *	0.0232 *	2.1554 *	−0.0116	−0.0011 *	0.7406
	(0.0000)	(0.0000)	(0.0000)	(0.1928)	(0.7063)	(0.2590)
RD			0.1060			0.0782
			(0.2240)			(0.3830)
ADV_TECH			0.2320 *			0.4232 *
			(0.0000)			(0.0000)
MEDIUM	0.0145 *	0.0031 *	−0.0218	0.0021	−0.0125 *	−0.1451
	(0.0000)	(0.0009)	(0.8420)	(0.4898)	(0.0000)	(0.6820)
LARGE	0.0138 *	−0.0042 *	−0.0629	−0.0034	−0.0149 *	1.1507 *
	(0.0011)	(0.0110)	(0.5680)	(0.3348)	(0.0000)	−0.0040
XLARGE	0.0159 **	−0.0120 *	−0.2490 **	−0.1177 *	−0.0270 *	0.8465 *
	(0.0765)	(0.0004)	(0.0640)	(0.0000)	(0.0000)	(0.0440)
%UNIV	(0.0000)	0.0002 *	0.0054	0.0004 *	0.0003 *	−0.0035
	(0.8533)	(0.0000)	(0.1050)	(0.0000)	(0.0000)	(0.4450)
HQ_US	0.0057 *	0.0059 *	−0.1072	0.1082 *	0.0692 **	0.5129
	(0.0000)	(0.0107)	(0.4130)	(0.0000)	(0.0000)	(0.2020)
HQ_EU	0.0102 *	0.0105 *	−0.1117	0.0241	0.0076	0.0171
	(0.0000)	(0.0100)	(0.5620)	(0.8543)	(0.8071)	(0.9780)
HQ_ROW	0.0216	−0.0188 *	−0.3737	−0.1444	−0.0177	0.1221
	(0.2594)	(0.0172)	(0.1590)	(0.3149)	(0.6231)	(0.8360)
MULTI	0.0118 *	0.0045 *	−0.1773 **	0.3147 *	0.0140 *	−0.6923 *
	(0.0027)	(0.0026)	(0.0920)	(0.0000)	(0.0000)	(0.0200)
SERV				−0.0824 *	−0.0001	0.5240
				(0.0000)	(0.9095)	(0.1190)
MANU_2	0.0172 *	0.0043 *	0.2798 *			
	(0.0000)	(0.0019)	(0.0130)			
MANU_3	0.0232 *	0.0048 *	0.2188 *			
	(0.0000)	(0.0001)	(0.0370)			
QC	−0.0187 *	−0.0063 *	−0.0111	0.0177 *	0.0029 *	0.3758
	(0.0000)	(0.0000)	(0.9140)	(0.0000)	(0.0153)	(0.2080)
AB	0.0067 **	0.0068 *	−0.4310 *	−0.0554 *	0.0091 *	0.3256
	(0.0772)	(0.0000)	(0.0020)	(0.0000)	(0.0000)	(0.4550)
BC	−0.0115 *	−0.0026 *	−0.0121	−0.0411 *	−0.0045 *	−0.1816
	(0.0005)	(0.0430)	(0.9290)	(0.0000)	(0.0299)	(0.6540)
ROC	−0.0174 *	−0.0073 *	−0.1189	−0.0517 *	−0.0188 *	−0.3666
	(0.0000)	(0.0000)	(0.3960)	(0.0000)	(0.0000)	(0.3870)

$N_{w=0}$: Number of observations for which the ROBUSTREG procedure weight is set to zero
N_{REG}: Final number of observations for ROBUSTREG regressions.
P-values are between parenthesis.

[1] The ROBUSTREG procedure in SAS (MM-estimator) was used.

* Significant at a 0.05 level.

** Significant at a 0.10 level.

Table 5: Detailed Results of Equations (3) and (4) – (*continued*)
– *Dep. var.: sales*[1], *profits*[1] *and INNO regressions* –
(*Competition variables*)

Variable	Manufacturing			Non-manufacturing		
	sales	*profits*	*INNO*	*sales*	*profits*	*INNO*
			– *Competition variables* –			
MNE	0.0118 *	0.0046 *	0.2123 *	−0.0033	−0.0097 *	0.8614 *
	(0.0000)	(0.0000)	(0.0180)	(0.2134)	(0.0000)	(0.002)
#COMP	−0.0029 *	−0.0003	−0.0425 **	0.0047 *	0.0042 *	0.0417
	(0.0000)	(0.2062)	(0.0980)	(0.0000)	(0.0000)	(0.5850)
ENTRY	−0.0011	0.0000	0.3650 *	−0.0036	−0.0018 *	0.9936 *
	(0.6232)	(0.9951)	(0.0000)	(0.1473)	(0.0399)	(0.0020)
#GOODS	0.0003	0.0001	0.0222	−0.0029 *	−0.0018 *	−0.1174 *
	(0.4532)	(0.6915)	(0.2440)	(0.0007)	(0.0000)	(0.0280)
N_{TOTAL}	2,688	2,707	1,104	1,208		
$N_{w=0}$	154	123	103	66		
N_{REG}	2,534	2,584	1,001	1,142	2,890	1,337

$N_{w=0}$: Number of observations for which the ROBUSTREG procedure weight is set to zero
N_{REG}: Final number of observations for ROBUSTREG regressions.
P-values are between parenthesis.

1 The ROBUSTREG procedure in SAS (MM-estimator) was used.

* Significant at a 0.05 level.

** Significant at a 0.10 level.

Appendix D (continued)

Table 6: Detailed Results of Equations (5) – Dep. var.: I^{TECH}, $I^{NON\text{-}TECH}$, $I^{PD\text{-}MK}$ and $I^{PC\text{-}OG}$ weighted Biprobit – (*Characteristics*)

Variable	Manufacturing				Non-Manufacturing			
	I^{TECH}	$I^{NON\text{-}TECH}$	$I^{PD\text{-}MK}$	$I^{PC\text{-}OG}$	I^{TECH}	$I^{NON\text{-}TECH}$	$I^{PD\text{-}MK}$	$I^{PC\text{-}OG}$
– Characteristics –								
CONS	–0.6765 *	–1.6133 *	–0.9958 *	–0.9958 *	–1.2980 *	–1.4362 *	–1.8312 *	–2.2768 *
	(0.0000)	0.0	0.0	0.0	(0.0190)	(0.0060)	(0.0010)	0.0
MP^{index}	1.7467 *	2.6589 *	0.9284 *	2.2058 *	0.5456	1.8365 *	1.1644 *	2.3178 *
	(0.0000)	0.0	(0.010)	0.0	(0.3590)	(0.0010)	(0.030)	0.0
RD	0.0318	–0.0060	0.0042	0.0195	0.1112 *	0.0119	0.0085	0.0009
	(0.4630)	(0.1850)	(0.6680)	(0.2840)	(0.0460)	(0.6550)	(0.5960)	(0.970)
ADV_TECH	0.2234 *	0.1646 *	0.1824 *	0.2070 *	0.3061 *	0.0886	0.1099	0.4023 *
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.2430)	(0.180)	(0.0000)
MEDIUM	–0.0538	–0.0533	–0.2077 **	0.0401	0.1792	–0.2415	0.2386	–0.0027
	(0.5970)	(0.5750)	(0.0740)	(0.6820)	(0.5960)	(0.4150)	(0.4720)	(0.9940)
LARGE	0.0130	–0.1907 *	–0.0325	–0.0340	–0.0076	0.7307 *	0.5528 **	0.4802
	(0.8960)	(0.0410)	(0.7280)	(0.730)	(0.9810)	(0.0270)	(0.0960)	(0.1240)
XLARGE	–0.0369	–0.2931 *	–0.1640	–0.1525	0.3593	0.5537	0.9272 *	0.5116
	(0.7560)	(0.0090)	(0.1360)	(0.1950)	(0.3750)	(0.1570)	(0.010)	(0.1720)
%UNIV	0.0041	0.0048 *	0.0114 *	–0.0001	–0.0067	0.0039	0.0035	–0.0047
	(0.1550)	(0.0450)	(0.0020)	(0.9730)	(0.1020)	(0.2970)	(0.2920)	(0.3120)
HQ_US	–0.3205 *	–0.0663	–0.0137	–0.1171	0.0313	0.5603	0.0074	0.9015 *
	(0.0130)	(0.5640)	(0.9090)	(0.3480)	(0.9460)	(0.1480)	(0.9870)	(0.0110)
HQ_EU	–0.2037	–0.0274	–0.0901	–0.0114	–0.0334	0.2686	0.1417	0.4095
	(0.2500)	(0.8690)	(0.5790)	(0.9480)	(0.9330)	(0.5260)	(0.7450)	(0.460)
HQ_ROW	–0.4840 *	–0.4585 *	–0.1836	–0.4398 *	–0.0381	–0.1424	–0.7232	0.2596
	(0.0240)	(0.0310)	(0.420)	(0.0430)	(0.9370)	(0.8430)	(0.3220)	(0.580)
MULTI	–0.1537	–0.0205	–0.0395	–0.1111	–0.4203	–0.2184	–0.0370	–1.3776 *
	(0.1050)	(0.8220)	(0.6770)	(0.240)	(0.1390)	(0.5030)	(0.9060)	0.0
SERV					0.3677	0.7463 *	0.8700 *	0.1605
					(0.2490)	(0.0250)	(0.0150)	(0.5560)
MANU_2	0.1751 **	0.0576	0.0388	0.2439 *				
	(0.0820)	(0.5630)	(0.6860)	(0.0170)				
MANU_3	0.1560 **	0.0446	0.0061	0.1191				
	(0.0990)	(0.6330)	(0.950)	(0.2110)				
QC	0.0810	0.1486 **	0.1962 *	0.0795	–0.1634	0.5942 *	0.5393 **	0.1118
	(0.3840)	(0.0960)	(0.0440)	(0.3850)	(0.5670)	(0.0460)	(0.0690)	(0.6590)
AB	–0.4756 *	–0.0838	–0.2624 **	–0.210	0.0206	–0.2266	–0.4468	0.4930
	(0.0000)	(0.4910)	(0.0530)	(0.1010)	(0.960)	(0.5130)	(0.2290)	(0.1710)
BC	–0.0627	0.1824	0.1030	0.0478	–0.0686	–0.0363	0.1013	0.3182
	(0.6180)	(0.110)	(0.4090)	(0.6940)	(0.8560)	(0.9290)	(0.7970)	(0.3360)
ROC	–0.0955	–0.0665	0.0603	–0.1195	–0.3637	–0.5107	–0.0939	–0.4863 **
	(0.4560)	(0.5850)	(0.6510)	(0.3380)	(0.3310)	(0.1150)	(0.8030)	(0.0950)

P-values are between parenthesis.

* Significant at a 0.05 level.

** Significant at a 0.10 level.

Appendix D (continued)

Table 6: Detailed Results of Equations (5) – (continued) – Dep. var.: I^{TECH}, $I^{NON\text{-}TECH}$, $I^{PD\text{-}MK}$ and $I^{PC\text{-}OG}$ weighted Biprobit – (*Competition variables*)

Variable	Manufacturing				Non-Manufacturing			
	I^{TECH}	$I^{NON\text{-}TECH}$	$I^{PD\text{-}MK}$	$I^{PC\text{-}OG}$	I^{TECH}	$I^{NON\text{-}TECH}$	$I^{PD\text{-}MK}$	$I^{PC\text{-}OG}$
– Competition variables –								
MNE	0.0882	0.0920	0.1353 **	0.0257	1.0230 *	0.1318	0.0496	0.8919 *
	(0.2770)	(0.2440)	(0.0940)	(0.7530)	(0.0000)	(0.5940)	(0.8410)	(0.0000)
#COMP	–0.0582 *	0.0207	–0.0335	–0.0019	0.0358	–0.1326 **	–0.0226	0.0435
	(0.0170)	(0.3720)	(0.140)	(0.9350)	(0.6710)	(0.0520)	(0.7640)	(0.4580)
ENTRY	0.3330 *	0.3186 *	0.3157 *	0.1446 **	0.9473 *	1.1182 *	1.1408 *	0.3007
	(0.0000)	(0.0000)	(0.0000)	(0.0770)	(0.0020)	(0.0000)	(0.0000)	(0.2060)
#GOODS	0.0336 *	0.0264	0.0391 *	0.0151	–0.0986 *	–0.0450	–0.0745	–0.0116
	(0.0440)	(0.1160)	(0.0220)	(0.3710)	(0.0340)	(0.3250)	(0.1190)	(0.7920)
N	2,890		2,890		1,337		1,337	
ρ	0.4132 *		0.3988 *		0.4007 *		0.3190 *	

P-values are between parenthesis.

* Significant at a 0.05 level.

** Significant at a 0.10 level.

Appendix D (continued)

Table 7: Detailed Results of Equations (5)
– Dep. var.: I^{PRCS}, I^{ORGZ}, I^{PRDT} and I^{MRKT} weighted multivariate Probit –
(*Characteristics*)

Variable	Manufacturing				Non-manufacturing			
	PRDT	ORGZ	PRDT	MRKT	PRDT	ORGZ	PRDT	MRKT
				– *Characteristics* –				
CONS	-1.0364 *	-1.9299 *	–0.9625 *	-1.2442 *	-1.9216 *	-2.5825 *	-1.7676 *	-1.9739 *
	(0.0000)	0.0000	0.0000	0.0000	0.0000	0.0000	–0.0010	0.0000
MPindex	1.8407 *	2.6694 *	0.6937 *	1.1656 *	0.8562 **	2.7276 *	0.7409	1.2384 *
	(0.0000)	0.0000	–0.0140	0.0000	–0.0970	0.0000	–0.1830	–0.0110
RD	0.0076	–0.0010	0.0193	0.0006	0.0000	–0.0035	0.0147	0.0208
	(0.4520)	–0.8490	–0.1510	–0.8930	–0.9960	–0.7050	–0.2210	–0.1490
ADVTECH	–0.0217	–0.0090	–0.1835 *	–0.1128	0.3478 *	0.2003 *	0.1951 *	–0.0174
	(0.8220)	–0.9240	–0.0740	–0.2780	0.0000	–0.0040	–0.0120	–0.7810
MEDIUM	–0.0467	–0.1560 **	0.0525	–0.0719	–0.2673	0.3136	0.5614 **	–0.0559
	(0.6040)	–0.0800	–0.5570	–0.4130	–0.4260	–0.2880	–0.0800	–0.8490
LARGE	–0.0679	–0.2733 *	–0.0893	–0.2020 **	–0.0585	0.5997 *	0.0001	0.6742 *
	(0.5330)	–0.0150	–0.4120	–0.0640	–0.8630	–0.0230	-1.0000	–0.0290
XLARGE	0.2315 *	0.1500 *	0.1738 *	0.1514 *	0.2761	0.7148 *	0.7894 *	0.1917
	(0.0000)	0.0000	0.0000	0.0000	–0.4460	–0.0280	–0.0250	–0.6100
%UNIV	–0.0030	0.0028	0.0102 *	0.0056 *	–0.0049	0.0044	0.0020	–0.0012
	(0.2100)	–0.1890	0.0000	–0.0300	–0.3080	–0.1900	–0.5100	–0.7140
HQUS	–0.4647 *	–0.0632	0.0092	–0.1693	0.5480	1.2791 *	0.4407	–0.2119
	(0.0000)	–0.5930	–0.9360	–0.1490	–0.2390	0.0000	–0.3250	–0.6120
HQEU	–0.2752 **	0.1438	0.0396	–0.1822	–0.0519	0.2798	–0.2781	–0.0202
	(0.0840)	–0.3590	–0.7910	–0.2180	–0.8900	–0.4840	–0.4680	–0.9630
HQROW	–0.3801 **	–0.4642 *	–0.3653 **	–0.1109	0.2865	0.0554	–0.8006	–0.2358
	(0.0620)	–0.0140	–0.0850	–0.6110	–0.4280	–0.9250	–0.2680	–0.7020
MULTI	–0.1030	0.0290	–0.0678	0.0700	–0.6982 *	–0.9863 *	–0.1215	0.0374
	(0.2470)	–0.7480	–0.4660	–0.4670	–0.0030	0.0000	–0.6680	–0.9000
SERV					–0.0605	0.4740 **	0.8704 *	0.9717 *
					(0.8330)	–0.0920	–0.0130	–0.0060
MANU2	0.1313	0.1357	0.0643	–0.1028				
	(0.1700)	–0.1720	–0.5070	–0.2680				
MANU3	0.0488	0.0955	0.0185	–0.1863 *				
	(0.5920)	–0.3120	–0.8460	–0.0440				
QC	0.0642	0.1648 **	0.2001 *	0.1048	–0.4710 **	0.4666 *	0.3214	0.4472
	(0.4620)	–0.0550	–0.0250	–0.2420	–0.0970	–0.0500	–0.2400	–0.1000
AB	–0.2618 *	–0.1483	–0.3305 *	–0.1085	0.2341	–0.0632	–0.1259	–0.4815
	(0.0410)	–0.2190	–0.0090	–0.4240	–0.5460	–0.8320	–0.7250	–0.1500
BC	–0.0696	0.1150	0.0146	0.1665	–0.3708	0.5167	0.3947	0.0269
	(0.5410)	–0.3050	–0.9020	–0.1470	–0.2420	–0.1350	–0.2990	–0.9480
ROC	–0.0583	0.0304	–0.0279	–0.0951	–0.4455	–0.2113	0.2105	–0.4242
	(0.6400)	–0.8030	–0.8230	–0.4550	–0.1380	–0.4650	–0.5860	–0.1700

P-values are between parenthesis.

* Significant at a 0.05 level.

** Significant at a 0.10 level.

Appendix D (continued)

Table 7: Detailed Results of Equations (5) – (*continued*) – Dep. var.: I^{PRCS}, I^{ORGZ}, I^{PRDT} and I^{MRKT} weighted multivariate Probit – (*Competition variables*)

Variable	Manufacturing				Non-manufacturing			
	PRDT	ORGZ	PRDT	MRKT	PRDT	ORGZ	PRDT	MRKT
				– Competition variables –				
MNE	–0.0559	0.0388	0.1735 *	–0.0141	0.7933 *	0.284	0.5025 *	0.1515
	–0.478	–0.613	–0.027	–0.86	–0.001	–0.145	–0.029	–0.514
#COMP	–0.0058	0.032	–0.0506 *	–0.0058	0.1699 *	–0.1275 *	–0.1682 *	–0.0552
	–0.796	–0.158	–0.022	–0.794	–0.027	–0.016	–0.025	–0.443
ENTRY	0.2032 *	0.2623 *	0.3076 *	0.2975 *	–0.16	0.7168 *	1.3516 *	1.1618 *
	–0.008	–0.001	0	0	–0.499	0	0	0
#GOODS	0.014	0.01	0.0503 *	0.0366 *	–0.0731 **	0.0125	–0.0553	–0.0367
	–0.367	–0.545	–0.002	–0.023	–0.077	–0.75	–0.222	–0.404
N	2,890				1,337			
ρ12	0.4217 *				0.2087 **			
ρ13	0.3842 *				0.2726 *			
ρ14	0.2368 *				–0.0518			
ρ23	0.2547 *				0.5523 *			
ρ24	0.3565 *				0.5062 *			
ρ34	0.4040 *				0.6603 *			

P-values are between parenthesis.

* Significant at a 0.05 level.

** Significant at a 0.10 level.