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Abstract

Complementarity between different management practices has been argued to be one potential explanation for persistent performance differences across firms. Using detailed data on internal organization for a nationally representative sample of firms, we empirically test for the existence of complementary joint adoption of performance pay incentives and decentralization of decision-making authority for tasks. To address endogeneity concerns, we exploit regional variation in income tax progressivity as an instrument for the adoption of performance pay. We find systematic evidence of complementarity between performance pay and decentralization of decision-making from principals to employees. However, adopting performance pay also leads to centralization of decision-making authority from non-managerial to managerial employees. The findings suggest that performance pay adoption leads to a concentration of decision-making control at the managerial employee level, as opposed to a general movement towards more decentralization throughout the organization.

1 Introduction

Complementarity between different management practices within organizations has been highlighted as one important explanation for persistent performance differences across firms (Milgrom and Roberts 1995). By adopting practices that are interdependent and mutually reinforce each other in their contributions to overall firm performance, superior performance is argued to be more easily sustained and more difficult to imitate by competitors (Porter 1996). As a consequence, subsequent empirical work on complementarity has aimed to identify the specific practices adopted by firms that are complementary in nature (see Brynjolfsson and Milgrom 2013 for a review). However, empirical findings thus far have been limited in scope, consisting mainly of case studies of individual firms (Milgrom and Roberts 1995) or industry-specific tests (Ichniowski et al. 1997, Kretschmer et al. 2012). Efforts to provide more generalizable quantitative tests of complementarity have faced two significant challenges. First, the availability of large sample internal organization data has been limited. Second, even in studies that use larger samples such as Bloom and Van Reenen (2007), observed correlations in the adoption of management practices may be explained by positive correlations of unobserved adoption costs unrelated to complementarity, making causal inferences difficult (Athey and Stern 1998, Cassiman and Veugelers 2006).

In this study, we test for the existence of complementary joint adoption of performance pay and decentralization of decision-making for tasks within firms. Both practices have been studied extensively by scholars, but the potential complementarity between them has remained empirically untested. To address the empirical challenges of producing generalizable findings, we use unique establishment and firm-level panel data on management practices representing the population of businesses in the Canadian economy. The data provides detailed measures of task allocation to different members of the organizational hierarchy. To mitigate concerns of correlated unobserved adoption costs explaining our findings, we follow an instrumental variables estimation approach by exploiting variation in tax progressivity across Canadian provinces to establish causal estimates of complementarity.

Our study makes four main contributions. First, while substantial literatures have examined the efficiency and performance implications of adopting performance pay (see Lazear and Oyer 2013 for a review) and decentralization of decision-making (Chang and Harrington 2000, Baum and Wally 2003, Alonso et al. 2008), complementarity theory suggests that the mechanism determining their effectiveness may also be dependent on their joint adoption, and not only the effects of adopting each practice in isolation. Our study examines whether evidence exists that the complementarity of both practices should be considered when assessing the performance implications of implementing performance pay or decentralization. Second, theories regarding the potential complementarity between both practices have

produced conflicting predictions. Prendergast (2002) and Van Den Steen (2010) describe mechanisms through which performance pay and decentralization are complements, while Holmstrom and Milgrom (1991), Bester and Kremer (2008), and Krishna and Morgan (2008) predict that performance pay and decentralization are substitutes. By conducting a large sample test for potential complementarity, we provide empirical evidence to inform these competing theoretical predictions. Third, we contribute to the recent growing literature examining how differences in management practices may explain productivity differences across firms. While previous studies have established a positive relationship between the overall quality of management practices and firm productivity (Bloom and Van Reenen 2007, Bloom et al. 2013b), we build upon these findings by considering how different management practices may be interdependent in their adoption to improve firm performance. Finally, we provide novel empirical evidence of the mechanisms determining the adoption of performance pay and task allocation that highlights the unique importance of managerial employees within hierarchies, not fully explained by current theories. Specifically, we find evidence consistent with the notion that efforts to solve problems relevant for firm performance yield greater performance gains when exerted by managers within the hierarchy relative to non-managerial employees.[1]

To establish valid inferences regarding complementarity, we address the issues raised by Arora (1996) and Athey and Stern (1998) by considering potentially exogenous factors predicting the adoption of performance pay. For our main empirical estimations, we consider two instrumental variable approaches based upon the tax progressivity of Canadian provinces. By using variation in provincial tax progressivity as an instrument for performance pay adoption, the basic intuition is that greater personal income tax progressivity increases the cost of providing high-powered incentives, and hence reduces the likelihood of adoption of performance pay. The mechanism driving this intuition follows a standard principal agent framework consistent with Grossman and Hart (1983), where the principal must pay the agent a higher wage in high output states to incentivize the agent to exert hidden effort. Since progressive taxation by definition results in higher marginal tax rates for higher income, greater progressivity will tend to offset the incentive effects of performance pay. Consequently, to induce a given level of effort, the firm must pay the employee over-proportionally more in high output states to counter the effects of tax progressivity. Because of this increased cost relative to the marginal benefit, firms will be less likely to adopt performance pay practices when tax progressivity is greater.[2]

For our first estimation approach, we use the tax progressivity of the province where the firm operates. For our second estimation, we consider the sample of firms in our data that operate multiple establishments across different provinces, and use the tax progressivity of the province where the firm's

[1] This is implication is described formally in Appendix 1.

[2] We also examine possible mechanisms that may threaten our exclusion restriction assumption, which we discuss in the robustness checks section.

headquarters is located as an instrument. This second approach allows us to test for the possibility of unobserved regional factors confounding our results by allowing for the inclusion of province fixed effects in our estimation. By including province fixed effects, our second estimation approach considers variation among establishments within each Canadian province for identification, using the tax progressivity of other Canadian provinces outside of the province where each establishment is located as the relevant source of exogenous variation.[3]

In our results, we find that firms that adopt performance pay decentralize more tasks from principals, which we define as business owners and corporate headquarters, to employees within the establishment. The results provide evidence that performance pay and decentralization of decision-making are complements. In addition, we explore in greater detail the mechanisms governing our main finding by measuring decision-making control separately for managerial and non-managerial employees. We find that firms that adopt performance pay concentrate control at the management level, where decision-making is *decentralized* from headquarters and business owners to managerial employees at the establishment, but *centralized* from non-managerial to managerial employees. Consistent with this concentration of control at the manager level, we find that these firms have systematically greater hiring rates for managers but not greater overall employee hiring rates, and are also more likely to implement formal training programs for managerial employees. Our findings suggest that managers play a unique and critical role in efficient organizational design when firms implement performance-based incentives.

The remainder of the paper is organized as follows. Section 2 develops the theoretical mechanism that illustrates the incentive trade-offs that make decentralization and performance pay either complements or substitutes, and guides our empirical analysis. Section 3 describes our data and measures. Section 4 describes our instrumental variables strategy in greater detail and discusses our main empirical results. Section 5 examines the robustness of our findings, with concluding remarks in Section 6.

2 Theoretical considerations

To clarify the mechanism through which decentralization of decision-making and adoption of performance pay can be complements (or substitutes), we describe formally the trade-off between centralization and decentralization and how performance pay affects this trade-off. Following the recent literature on management practices and decentralization (Bloom et al. 2012, Bloom et al. 2013a), our model of decentralization is based on the logic developed by Garicano (2000) and Garicano and Rossi-Hansberg (2012). Specifically, more decentralization allows a firm to economize on the business owner's

[3] The reason why the relevant source of variation comes from outside of the establishment's province is because the covariance between province fixed effects and the instrument is removed when estimating the regression. If all establishments in the sample have their headquarters in the same province, the instrument is perfectly collinear with province fixed effects, and there is no independent variation to identify the regression.

time[4], thereby allowing them to focus only on complex and rare problems. However, decentralization involves effort costs to train employees and communication costs if employees encounter an unsolvable problem and need to explain it to the business owner. We extend this basic framework by assuming that part of the effort costs spent by employees to solve problems is unobservable. This creates a standard moral hazard problem (Grossman and Hart 1983), which can potentially be addressed using performance pay.

There are two players in our model, a principal P who can be considered the business owner and an agent A, who is an employee. Firms face a unit measure of problems $z \in [0,1]$ in their operations with cumulative distribution $F(z)$ and density $f(z)$. As is standard, we assume that these are ordered by frequency and complexity so that lower indices of z denote simple and very frequent problems and high values of z very complex and rare problems. This is formalized by assuming $f'(z) < 0$. Problems z need to be solved to produce output, and every unsolved problem reduces output and ultimately firm performance.

To solve problems, both P and A have to exert effort to acquire knowledge to deal with a problem. This cost is higher the more complex the problem, and we denote the overall cost of solving problem z by $a_i \cdot z$, where $i \in \{P, A\}$ and $a_i > 0$. Similar to Bloom et al. (2013a), we assume that P knows all production tasks that A knows so that knowledge overlaps. If A cannot solve a particular problem, they will communicate the problem up the hierarchy to P. This entails a communication cost, which is denoted by h. To introduce a basic moral hazard problem into this framework, we assume that the agent's effort costs have two parts. First, $a_{1,A} \cdot z$ are costs associated with observable effort as in Bloom et al. (2012). Second, there is a part of the effort costs denoted by $a_{2,A} \cdot z$ that is associated with unobservable effort. Employee A has a hidden effort choice $e \in \{0,1\}$ so that if they incur effort $e = 1$, they pay an additional cost $a_{2,A} \cdot z$. While the effort choice e itself is hidden, the level of effort costs $a_{2,A} \cdot z$ is common knowledge.

Production. Output is generated as a result of solving problems, where z_A denotes the most complex problem that employee A is engaged in solving. We note that z_A is the point that defines whether a task is decentralized to employees or centralized to the principal, and also serves as a measure of decentralization of decision-making. If principal P is confronted with a problem, we assume they are able to solve it by incurring costs a_P. However, for employees, even for problems they in principle could solve, there is a random chance that the problem remains unsolved, due to issues that are unforeseeable or out of their control. Let x_A denote an indicator for whether the employee solved the problems they were confronted with. As is standard in principal agent problems, we assume that the employee can increase output by

[4] The model applies to a firm's headquarters as well, but we omit this here for brevity of writing.

exerting the hidden effort choice e. In other words, if the employee exerts effort, the fraction of problems that they can solve increases. Therefore, production for the principal and the employee is defined as the fraction of tasks solved by each, defined as

$$1-\ F(z_A) \text{ for the principal and}$$
$$F(z_A) \cdot P(x_A = 1|e) \text{ for the agent.}$$

Preferences. Business owner P is assumed to be risk neutral and the residual claimant of profit flows. Employee A is assumed to exhibit the following utility function

$$U_A(w_A, z_A, e) = \ln(w_A) - a_{1,A} z_A - e \cdot a_{2,A} z_A,$$

where w_A is their wage, which can be state-contingent. Since the effort associated with cost $a_{1,A} z_A$ is observable, we assume that this is directly paid for by the principal.

Timing. The general timing of our model can be described as follows. At *t*=0, P decides first on the degree of decentralization and then implements the optimal wage contract. If performance pay is available, P will determine the optimal state-contingent wage payments, otherwise they will set a constant wage to meet the agent's outside option, which we denote as U_A^R. At *t*=1, the employee faces the organizational choices made by P and decides whether to exert effort. Production occurs and wage payments are made at the end of period 1.

Performance Pay. We begin with the solution of the moral hazard problem. If performance pay is available, P chooses to condition wage payments on whether the agent solved a given problem. The optimal contract is designed to minimize expected wage payments subject to incentive-compatibility and participation constraints,

$$\min_{w_A^1; w_A^o} P(x_A = 1|e = 1) \cdot w_A^H + P(x_A = 0|e = 1) \cdot w_A^L$$

subject to: (1)

$$\text{(IC) } E[U_A(w_A, z_A, e = 1)|e = 1] \geq E[U_A(w_A, z_A, e = 0)|e = 0] \text{ and}$$
$$\text{(IR) } E[U_A(w_A, z_A, e = 1)|e = 1] \geq U_A^R$$

To facilitate exposition, we assume that

$$P(x_A = 1|e = 0) = 1 - k \text{ and}$$
$$P(x_A = 1|e = 1) = 1 - k + q,$$

where k is the probability that a random event renders the problem unsolvable and q is the incremental gain in successful "problem solving" if the agent exerts effort, with $q < k$. Wages w_A are contingent on problems being solved, so that $w_A = w_A^1$ if $x_A = 1$ and $w_A = w_A^0$ if $x_A = 0$.

The solution to the contract design problem reduces to (IC) and (IR) holding exactly, solving for contingent wages (w_A^1, w_A^0). Given the functional form assumptions on utility and probabilities, performance pay is given by

$$w_A^1(z_A) = exp\left\{U_A^R + \frac{k}{q} \cdot a_{2,A} z_A\right\} \text{ and}$$

$$w_A^0(z_A) = exp\left\{U_A^R - \frac{1-k}{q} \cdot a_{2,A} z_A\right\}.$$

For notational convenience, we define

$$\overline{w}(z_A) = E[w_A(z_A)|e = 1].$$

Here, we highlight an important property of the optimal contract. In particular, the more complex the agent's tasks are (the higher z_A), the higher the costs of incentive pay. In Appendix 1, we show that the following inequality holds:

$$\overline{w}'(z_A) > 0. \tag{2}$$

The reason for this relationship is that for more complex problems, the employee's effort costs are higher. Therefore, to induce A to incur this effort, the principal has to strengthen the high-powered incentives, which increases the costs of performance pay.

Decentralization without Performance Pay. The baseline case of our model without performance pay simplifies to the decentralization model of Bloom et al. (2012) and Bloom et al. (2013a). The degree of decentralization, z_A, is chosen to maximize profits:

$$\Pi(z_A, 0) = \left[1 - F(z_A) + F(z_A) \cdot P(x_A = 1|e = 0) - h \cdot a_P \cdot [1 - F(z_A)] - a_{1,A} z_A - w_A^R\right].$$

The optimal degree of decentralization is implicitly determined by

$$f\left(z_A^{*,0}\right) = \frac{a_{1,A}}{h \cdot a_P - k}, \tag{3}$$

where $z_A^{*,0}$ denotes the optimal degree of decentralization in a firm without performance pay. The comparative statics of this case follow from the fact that $f'(z) < 0$.

Decentralization with Performance Pay. The equilibrium choice of decentralization under the existence of performance pay maximizes

$$\prod(z_A, 1) = [1 - F(z_A)] + F(z_A) \cdot P(x_A = 1|e - 1) - h \cdot a_P \cdot [1 - F(z_A)] - a_{1,A} z_A - \overline{w}(z_A)$$

In particular, the optimal degree of decentralization under performance pay $z_A^{*,1}$ is given by

$$f\left(z_A^{*,1}\right) = \frac{a_{1,A} + \overline{w'}(z_A)}{h \cdot a_P - k + q} \tag{4}$$

Complementarity of Decentralization and Performance Pay. Whether decentralization and performance pay are complements or substitutes depends on the balance of two margins. First, performance pay can induce employees to make more efficient decisions by exerting more effort. This margin enters through the term $q = P(x_A = 1|e = 1) - P(x_A = 1|e = 0)$ and is a force toward decentralization. The reason is that performance pay incentivizes exertion of unobservable effort, which in turn makes higher output more likely. Second, optimal performance pay will depend on the degree of decentralization, as shown in equation (2). More decentralization (higher z_A) will increase effort costs of agents, and require more high-powered incentives to induce effort. This is a force toward centralization, since decentralized decision-making becomes more costly. If the incremental gain from hidden effort of employees q is relatively high, and the marginal performance pay costs of decentralization $\overline{w}'(z_A)$ are low, then $z_A^{*,1} > z_A^{*,0}$ and decentralization and performance pay are complements. However, if marginal performance pay costs of decentralization $\overline{w}'(z_A)$ are high and q is low, decentralization and performance pay will be substitutes, or $z_A^{*,1} < z_A^{*,0}$. The following proposition summarizes the empirical implications.

> **Proposition.** Suppose there is exogenous variation in performance pay. Let $z_A^{*,0}$ denote the optimal degree of decentralization without performance pay and $z_A^{*,1}$ the optimal degree of decentralization with performance pay. Then,
>
> $$z_A^{*,1} > z_A^{*,0} \text{ if and only if } \frac{q}{h \cdot a_P - k} > \frac{\overline{w}'(z_A^{*,1})}{a_{1,A}}.$$

In response to a change in performance pay induced by an exogenous change in the cost of providing high-powered incentives, decentralization of real decision authority increases if the incremental efficiency gain from effort outweighs the increased cost of performance pay. The comparative static in the proposition clarifies the theoretical mechanism underlying our empirical approach, and predicts that decentralization and performance pay can be either complements or substitutes. As an additional step, we also examine how task allocation and performance pay adoption are related among managerial and non-managerial levels of the hierarchy in Appendix 1. Task allocation between managerial and non-managerial employees is found to ultimately depend upon which level of the hierarchy has greater returns to unobservable effort in solving problems, where tasks will be allocated to the level with greater performance gains from effort.

3 Data and Measurement

3.1 Data

The data for our study comes from the Workplace and Employee Survey (WES), developed and administered by the Business and Labour Market Analysis Division and the Labour Statistics Division at

Statistics Canada, and contains comprehensive information on firm management practices. The survey is a random stratified sample, representative of the population of businesses in the Canadian economy in each year. There are several advantages of this data compared to other existing microdata on management practices and firm internal organization. First, the WES data allows for direct measurement of task allocation not only between principals and agents, but also between different types of agents, such as managerial and non-managerial employees. Second, the WES data has much broader sectoral coverage compared to data used in industry-specific studies such as Ichniowski et al. (1997) or studies such as Bloom et al. (2014) based on the manufacturing sector, allowing for greater generalizability. Third, since the target population is the universe of Canadian businesses, the WES is not biased towards certain firm size classes, in contrast to similar data such as the World Management Survey Data by Bloom and Van Reenen (2007). Finally, an important strength of the WES is that responding to the survey was mandatory under Canadian law, which resulted in regular response rates of approximately 90 percent, mitigating concerns of non-response bias in our analysis. The sample used for this study consists of a panel of approximately 5,800 for-profit business establishments, with the variables of interest for this study collected during the years 2003 and 2005.[5]

3.2 Measurement

Decentralization of Real Decision Authority. Measuring decentralization of decision-making within firms requires actual measurement of decision-making authority. While occupational titles or organizational charts can indicate where decision-making authority lies, managers higher up in the hierarchy often only “rubberstamp" decisions actually made by non-managerial employees (Aghion and Tirole 1997). As a consequence, an observed increase in the range of formal responsibilities and reporting relations using these types of measures can either imply increased control or even more limited attention to certain decisions and more rubberstamping, resulting in a de facto reduction in control.

In contrast to measures based on organizational charts, the WES data contains detailed information regarding actual decision-making authority on 12 tasks across different layers in the organizational hierarchy. The survey questions are similar to those used by Bresnahan et al. (2002) and Bloom et al. (2013a) measuring worker autonomy to capture the degree to which principals or agents are making decisions across different critical operating tasks within the firm. The survey data we use asks “who normally makes decisions with respect to the following activities?” The 12 operating tasks in the survey range from “daily planning of individual work” to “product and service development.” We consider the following five possible responses to the question of who makes decisions, which we call decision

[5] The data consists of 5,802 establishments in 2003 and 5,951 establishments in 2005.

"layers": 1) non-managerial employees, 2) work supervisors, 3) senior managers, 4) individuals or groups outside the workplace (typically headquarters for multi-establishment firms), and 5) business owners.

Table 1 summarizes the patterns of task allocation across layers. To present summary statistics for each of the 12 tasks considered in the survey, we assign increasing integer values with increments of one to the layer of the hierarchy where decisions are made, where non-managerial employees have a value of 1, work supervisors have a value of 2, senior managers have a value of 3, and both business owners and headquarters have a value of 4 since they represent principals. The sample means in Table 1 indicate how high, on average, in the levels of the hierarchy decisions are made and the number of layers involved. Decision-making for routine tasks like daily work planning is relatively more decentralized, while more complex tasks, such as product or service development, are typically decided at higher levels in the hierarchy. When comparing the differences between the first and second column of average decision layers, we note that this pattern becomes stronger if we exclude firms that have any involvement of business owners in decisions. By excluding those firms where business owners are involved in decision-making, we remove the group of very small firms that are naturally centralized and business owners are typically involved in all firm activities, while larger firms take advantage of the division of labor in order to economize on the business owner's time. The third column of Table 1 shows that, on average, slightly more than one layer is involved in decision-making for most tasks, suggesting that the survey's layer definitions are sufficiently distinct to provide variation for empirical analysis.

Because of the distinction between business owners, headquarters, and senior management in the WES survey, we can identify principals as residual claimants of profit flows from the firm. Since most firms in the sample are single-establishment entities, the separation between professional senior managers and business owners is especially important for identifying principals. For multi-unit firms, decision-makers outside the establishment are typically the corporate headquarters, so we are able to identify the principal as the firm's headquarters in such cases. Agents are defined as any type of employee within the establishment, and include both managerial and non-managerial employees.

Since the WES data on the allocation of tasks to organizational layers is multi-dimensional, we use three distinct measures of allocation of real decision-making authority. For the precise definition of our three measures of the degree of decentralization, we begin by defining the following sets: $D^{\text{Principal}}$ is the set of tasks that principals are involved in, D^{Manager} the set of tasks that management is involved in, $D^{\text{NonManager}}$ the set of tasks that non-managerial employees are involved in, and $D^{\text{Agent}} = D^{\text{Manager}} \cup D^{\text{NonManager}}$ the set of tasks that agents—including both managerial and non-managerial employees—are

involved in. Our three measures of the allocation of decision control within the firm are defined formally as follows,[6]

$$\text{PrincipalControl}_{it} = \sum_{d=1}^{12} 1\{d \in \text{D}_{it}^{\text{Principal}} \backslash \text{D}_{it}^{\text{Agent}}\}$$
$$= \sum_{d=1}^{12} 1\{d \in \text{D}_{it}^{\text{Principal}} \backslash (\text{D}_{it}^{\text{Manager}} \cup \text{D}_{it}^{\text{NonManager}})\},$$
$$\text{ManagerControl}_{it} = \sum_{d=1}^{12} 1\{d \in \text{D}_{it}^{\text{Manager}} \backslash (\text{D}_{it}^{\text{Principal}} \cup \text{D}_{it}^{\text{NonManager}})\}, \text{ and}$$
$$\text{NonManagerControl}_{it} = \sum_{d=1}^{12} 1\{d \in \text{D}_{it}^{\text{NonManager}} \backslash (\text{D}_{it}^{\text{Principal}} \cup \text{D}_{it}^{\text{Manager}})\}$$

The indicator function $1\{d \in X\}$ equals one if condition X is satisfied by d. $\text{PrincipalControl}_{it}$ counts the number of tasks that are exclusively carried out by the principal (business owners or headquarters) and is thus a measure of *centralization* of real decision authority. In contrast, the measures $\text{ManagerControl}_{it}$ and $\text{NonManagerControl}_{it}$ count the number of tasks exclusively allocated to agents, either to managerial employees (i.e., work supervisors and senior management) or non-managerial employees, respectively. We note, however, that the survey allows decision tasks to be decided by multiple layers within a firm. Since it is unclear how to capture the actual decision control in such instances, we exclude such cases in our count of tasks for each of the three measures.[7]

Performance Pay. The WES survey data offers a variety of information on performance-based compensation in firms. Specifically, it allows us to measure four different types of performance pay: 1) individual incentive pay, such as bonuses, commissions, and piece-rates, 2) group or team incentives, 3) firm profit sharing agreements, and 4) stock-based compensation. Given that standard principal agent analysis characterizes very general forms of state contingent compensation contracts to solve the moral hazard problem, we measure the presence of performance pay with an indicator equal to one if any form of performance pay is present. To examine the accuracy of the survey responses on performance pay, we regress average compensation, defined as total payroll divided by the total number of employees, against our measure of performance pay, and include the same controls as our complementarity test regression specifications. As an additional step, we also include an indicator variable equal to one if skill-based pay unrelated to output or performance is given, such as from the completion of training or obtaining a degree from an educational institution. As shown in Table 2, establishments with performance pay systematically

[6] We also analyzed the aggregate measure of tasks exclusively carried out by agents, $\sum_{d=1}^{12} 1\{d \in D_{it}^{\text{Agent}} \backslash D_{it}^{\text{Principal}}\}$. The results are similar to $\text{PrincipalControl}_{it}$ but with opposite sign. However, since in the data the concept of the "agent" is much more ambiguous than that of the "principal," we focus on the two disaggregated agent measures of managers and non-managers.

[7] However, we note that we also obtain similar results with non-exclusive categorizations of decision control.

pay higher average compensation, lending support to the internal validity of our data. However, skill-based pay unrelated to output or performance does not predict higher average wages.

4 Identification and Estimation

4.1 Instrumental variables strategy

Endogeneity concerns. As highlighted by Athey and Stern (1998), observing correlations in the adoption of different management practices provides insufficient evidence of their complementarity. Firms are likely to differ in their costs and benefits from adopting management practices, which may bias OLS estimates either upwards or downwards depending upon the source of heterogeneity. One source of possible unobserved heterogeneity includes variation in the skills of principals or employees across firms. For example, if very skilled employees allow firms to decentralize more tasks and at the same time lower the costs of adopting performance pay, then OLS estimates of the complementarity of decentralization and performance pay would be upward biased. Firms would adopt these two management practices together not because they are complementary, but because the costs of adoption are positively correlated through unobserved employee skill. Also, productivity differences across principals could bias OLS estimates of complementarity downward. Highly productive business owners or headquarters might be able to more effectively implement performance pay and at the same time might be more productive in making decisions, so more tasks would be centralized. In this case, firms with highly skilled principals might not decentralize decision making while adopting performance pay. If true, the benefits of decentralization and performance pay would be negatively correlated through unobserved principal skill, and OLS estimates of complementarity would be downward biased.

Tax progressivity instrument. To empirically test for complementarity between performance pay and decentralization, we begin by exploiting regional variation of income tax progressivity across Canadian provinces as an instrument for the adoption of performance pay. Income tax distortions increase the cost of incentive provision through performance pay, where firms must pay additional costs when income taxes are higher to obtain a given level of effort (Roberts 2004). In progressive tax regimes, marginal increases in income are taxed at progressively higher rates, increasing the marginal costs to firms of obtaining incremental gains in effort (Alford 2003). Given that performance pay contracts are nonlinear because they provide higher marginal reward in high output states, progressive income tax regimes similarly offset this nonlinear incentive because of the higher marginal tax rates levied on additional income (Gentry and Hubbard 2004). When tax progressivity is greater, marginal increases in income are more heavily taxed relative to low tax progressivity regimes, which reduces the likelihood of performance pay adoption. Within Canada, provincial variation in income taxes is greater than in many comparable

countries, with Canadians on average paying a greater share of their total income taxes to their provincial governments than to the federal government (Murphy et al. 2013).

Construction of the instrumental variable. To construct our instrument, we use information on income tax progression of Canadian provinces collected from the annual publication *Finances of the Nation* by the Canadian Tax Foundation, which provides income tax data by province. Our measure of tax progressivity is residual income progression, a standard measure used in the public finance literature to measure tax progressivity (Jakobsson 1976, Musgrave and Musgrave 1989). Our measure is defined as

$$\rho = \frac{1-MTR}{1-ATR},$$

where *MTR* is the marginal income tax rate applicable for the average income level and ATR the average income tax rate for each province. In this measure, $\rho = 1$ corresponds to a flat tax system, while $\rho < 1$ implies that the tax system exhibits progressivity. Consequently, higher values of ρ imply less progressivity and imply a higher incentive to adopt performance pay.

We adjust this measure of tax progression in two ways. First, we smooth annual fluctuations in provincial tax progressivity, which exhibit only negligible changes over time, by taking the 10-year historical average of the tax progressivity measure. Second, for firms that operate in multiple provinces, we use the tax progressivity of the province where the firm's headquarters is located as our relevant measure. In our data, we find that the adoption of management practices is typically implemented firm-wide irrespective of the location of the firm's establishments, suggesting that adoption decisions made at headquarters are likely to be implemented throughout the entire firm. [8][9]

Exploiting multi-province firms. For the second part of our instrumental variables strategy, we consider the subsample of firms in our data that operate in multiple provinces, and use the tax progressivity of the province where the firm's headquarters is located as our instrumental variable. This allows for the additional inclusion of province fixed effects as controls along with our tax progressivity instrument, and effectively compares establishments which are part of multi-province firms within the same province as the relevant identifying variation. Establishments with headquarters located in regions with high tax progressivity are predicted to be less likely to adopt performance pay than establishments in the same province that have headquarters in regions with low tax progressivity. By including province fixed effects, this second estimation approach uses the tax progressivity of other Canadian provinces

[8] The fact that management practices in general and performance pay in particular do not vary much across region for multi-establishment, multi-regional firms suggests that other internal frictions such as equity concerns and social norms might prevent firms from writing optimal contracts given the local tax schedules.

[9] As an additional piece of analysis to validate our approach, we also conducted regression analyses after assigning tax progressions based on actual establishment locations. When tax progression variables based on actual location and on headquarters location are included together to predict performance pay, only headquarter-based tax progression measures are highly significant, while tax progression based on actual establishment location is statistically insignificant.

outside of the province where each establishment is located as the relevant source of exogenous variation, and addresses concerns of potential unobserved heterogeneity across provinces that may explain our results.

4.2 Specification

As discussed earlier, the potentially endogenous variable of interest is the adoption of performance pay. Our measure is denoted by $\text{PerformancePay}_{i,t}$, for establishment *i* in year *t*, capturing the existence of any form of performance pay. We are interested in the effect of performance pay adoption on our three measures for task allocation. The first stage of the two-stage regression is

$$\text{PerformancePay}_{i,t} = \alpha_p \cdot \rho_{i,t} + \text{Controls}_{i,t} + \varepsilon_{1,i,t},$$

where $\rho_{i,t}$ is our tax progressivity measure. Since higher values of $\rho_{i,t}$ capture less progressive income taxes, one would expect that $\alpha_p > 0$, implying that lower progressivity increases the likelihood of adopting performance pay. This first stage is then used to obtain the following second stage instrumental variable (IV) coefficient estimates from the following specification

$$\text{PrincipalControl}_{i,t} = \beta_{PP} \cdot \text{PerformancePay}_{i,t_{i,t}} + \text{Controls}_{i,t} + \varepsilon_{2,i,t}$$

where β_{PP} represents the causal relationship between the adoption of performance pay and the degree of decentralization of real decision authority. In particular, $\beta_{PP} > 0$ implies that adoption of performance pay increases decision control by the principal. In this case, decentralization and performance pay would be substitutes. On the other hand, if $\beta_{PP} < 0$, adoption of performance pay leads to less control by the principal and more delegation of decisions to employees, implying that decentralization and performance pay would be complements. We repeat this analysis using ManagerControl and NonManagerControl as dependent variables to examine how tasks are allocated among agents when performance pay is adopted.

A number of control variables are also included in our analysis. We include industry fixed effects at the four digit NAICS code level and year fixed effects to control for industry differences and economy-wide shocks or trends. We control for firm size, measured by the logged total number of employees, and establishment age. We also include separate dummy variable controls for establishments that are part of a multi-establishment enterprise, export their goods or services abroad, have an organized union, or are foreign-owned, which we define as having over 50 percent of the organization's assets owned by a foreign interest.

4.3 Results

Summary statistics are displayed in Table 3, and Table 4 provides results from the first stage estimation to ensure that our tax progressivity instrument is sufficiently strong to provide reliable estimates of complementarity.[10] The F-test statistic of the excluded tax progressivity instrument is 34.40 for our full sample analysis and 17.08 for our analysis on the sample of multi-province firms, mitigating concerns that weak instruments may confound estimation (Stock et al. 2002, Semadeni et al. 2014). For both samples, the coefficient estimate also shows the expected sign for α_ρ, with increasing values of ρ (less progressivity) associated with a greater likelihood of observing performance pay adoption.

Our baseline results for our coefficients of interest are presented in Table 5. Columns 1 through 3 provide OLS estimates of our measures of decision control and the adoption of performance pay. On average, adopting performance pay is associated with principals controlling two tasks less and managerial agents carrying out roughly one task more, while non-managerial agents' control has no statistically significant relationship with performance pay. However, as noted earlier, the OLS results do not provide reliable evidence of complementarity, since unobserved factors may bias the coefficient estimates. Columns 4 through 6 report instrumental variable (IV) estimates.[11] In Column 4, the coefficient estimate for our performance pay measure is negative and significant, providing evidence for the presence of complementarity between performance pay and the decentralization of decisions from principals to agents. In response to the adoption of performance pay, firms systematically reallocate real decision authority away from principals down to lower levels in the organizational hierarchy.

In Columns 5 and 6, the coefficient for performance pay is positive and significant for agents who are managerial employees, but negative and significant for non-managerial employees. Taken together, the results from Columns 4 through 6 suggest that while adoption of performance pay does lead to principals decentralizing decision-making to agents at lower levels in the hierarchy, tasks are also centralized away from non-managerial to managerial employees, resulting in the concentration of decision-making at the management level of the organization. Our results run counter to several commonly proposed mechanisms of performance pay and decentralization. First, since performance pay enables more efficient decision-making at all levels of the organization, the adoption of performance pay might have induced a general movement toward decentralization at all layers of the hierarchy. This prediction would have implied that the performance pay coefficients for both ManagerControl and NonManagerControl should be positive. Also, a popular view among many management practitioners is that middle management is an

[10] We note that probit specification results are similar to the OLS estimates in Table 4.

[11] We also note that the coefficient estimates for the IV estimates are generally larger in magnitude than the OLS estimates, implying that the correlation between decentralization and performance pay in the OLS error term is negative, and that unobservable factors may confound simple correlation tests for the adoption of performance pay and decentralization.

inefficient bureaucratic layer within hierarchies (Hamel 2011). This view emphasizes the importance of worker empowerment at lower levels in the hierarchy as the prescriptive solution to the proposed inefficiency, and might have predicted that firms reallocate tasks from managerial to non-managerial employees. If true, the coefficient for ManagerControl would have been negative, while the coefficient on NonManagerControl would have been positive.

Columns 1 through 3 of Table 6 display the results from the second part of our instrumental variables strategy, where we repeat our analysis on the sample of establishments that are part of multi-province firms and include province fixed effects. The results are consistent with our full sample IV estimates, and we again find evidence that performance pay leads to decentralization of decision-making authority from principals to agents, but centralization from non-managerial to managerial employees. The consistency of results also suggests that unobserved heterogeneity across provinces is unlikely to explain our findings.

To investigate the mechanism driving our basic findings on the concentration of decision control at the management level in greater detail, we examine occupational composition, hiring, and training patterns in firms that adopt performance pay. Because of the significant number of observations left-censored at zero, we estimate Tobit models for our occupational composition and hiring regression specifications, and use the same control variables as in our complementarity tests. Columns 1 through 5 of Table 7 show the relationship between performance pay adoption and the occupational composition of firms. Our dependent variable is the proportion of the workforce at the establishment that comprises each of the following occupational classes: 1) managers, 2) production workers, 3) professionals, 4) sales representatives, and 5) administrative staff. Production workers are defined in the survey as positions in production or maintenance requiring no vocational training, professionals are employees whose duties require at least an undergraduate university degree, sales representatives are engaged in the marketing and sales of products and services, and administrative staff provide clerical services.[12] The key finding is that establishments implementing performance pay employ more managers as a proportion of their workforce. We note, however, that performance pay adoption is also correlated with greater proportions of professionals and salespeople in the organization, and smaller proportions of production workers and administrative staff, consistent with the notion that incentive pay adoption may be associated with workforce compositions with higher skill levels.

Columns 6 and 7 of Table 7 show the relationship between performance pay adoption and hiring practices. To measure hiring activity, we calculate the total number of relevant new hires (either only managers or all employees) divided by the total number of employees at the establishment. As the contrast between both columns for the performance pay coefficient shows, adopting performance pay

[12] Professionals refer only to non-managerial employees. Production workers, sales representatives, and administrative staff do not hold undergraduate university degrees.

predicts greater hiring of managers, but does not predict greater hiring of employees generally. Column 8 of Table 7 shows probit estimation results predicting the existence of a formal managerial training program, which is recorded separately as a response in the WES survey. Here, the dependent variable is a dummy equal to one if the WES survey response indicates that a managerial training program has been implemented within the establishment. The coefficient for performance pay adoption is positive and significant, suggesting that firms that implement performance pay are also more likely to implement managerial training programs. Taken together with our baseline results, we find that not only do firms that adopt performance pay allocate more decision responsibility to managerial employees, they also maintain larger pools of managers to meet these responsibilities, and implement formal practices to invest in developing their capabilities.

Overall, our findings are compatible with the view that the largest gains from implementation of performance pay occur through more efficient decision making of managers, and that managerial activities are likely to play a more critical role in determining firm performance outcomes than activities at other levels in the organizational hierarchy. We formally describe the implications of our results in Appendix 1 by extending our theoretical model to include the possibility of task allocation between principals, managers, and non-managerial employees.[13] Our findings are also supportive of the hypothesis proposed by Atalay et al. (2013) that the nature of firms is intimately connected to their role in "mediating managerial supervision and control."

5 Robustness checks

Here, we consider several alternative explanations for our results. For all regression specifications, we include the same firm controls used in our complementarity tests.

Tax progressivity improving worker skills. One possible threat to the exclusion restriction of our instrument is that tax progressivity may be used to provide better education and training of the labor force, giving workers a higher level of skills within a province. As a consequence, firms in provinces with higher tax progressivity may be more decentralized because of a higher average level of worker ability, if employee skills lower costs of both decentralization and performance pay adoption. Highly skilled employees might be more likely to require little training to make decisions on relatively complicated tasks, and performance pay may provide high wage payments to very skilled workers to induce sorting towards high-skill employees, as shown by Lazear (2000). If true, this would invalidate the exclusion restriction of our instrument, since tax progressivity would affect decentralization through

[13] We note that one important implication of our extended model is that the interpretations of our empirical findings are independent of whether managers may receive greater performance pay incentives than non-managerial employees. This is discussed in greater detail on the fourth page of Appendix 1.

increased worker skills and not only performance pay, and we do not control for worker ability. To address this concern, we begin by including the average compensation per employee for each establishment as an additional control variable, to proxy for the average ability of workers within each organization. As shown in Column 1 of Tables 8, 9, and 10, the inclusion of this additional control variable does not change our results.

Also, as an additional step to examine whether higher tax progressivity may affect our decentralization results through increased worker skills, we plot the relationship between our tax progressivity measure and the average educational expenditure per student in each province for pre-postsecondary and postsecondary education. To obtain educational expenditure data, we use the *Education Indicators in Canada in 2003* report produced jointly by the Council of Ministers of Education and Statistics Canada.[14] If tax progressivity affects decentralization through greater education of the labor force, then progressivity should be positively related to the average educational expenditure per student. However, as shown in Figures 1.1 and 2.1, we find no evidence of a systematic positive relationship. Instead, tax progressivity appears to be at least weakly negatively related to average educational expenditure per student. We note, however, that we do find evidence of a positive relationship between average tax rates and average educational expenditure (see Figures 1.2 and 2.2), suggesting that exclusion restriction concerns regarding tax progressivity may not be analogous with similar concerns when using average tax rates as an instrumental variable.

Provincial labor contracting environment. Another possible threat to our exclusion restriction is that greater tax progressivity may also be related to labor contracting institutions that favor employees over firms. Regulations that favor employees may increase the degree of decentralization of firms, and confound our estimation since we do not control for the labor contracting regulations in our full sample analysis. To examine whether this might be the case, we plot the relationship between labor contracting regulations and our tax progressivity measure for each province, using an index measure of the strength of labor contracting institutions by Block, Roberts, and Clarke (2003), where greater values of the index indicate a contracting environment that favors employees over firms. As Figure 3.1 shows, instead of finding a positive relationship between greater tax progressivity and strength of labor contracting institutions, we find a negative relationship, suggesting that this is unlikely to explain our results. However, similar to our educational expenditure analysis, average tax rates and the contracting environment measure are positively related, as shown in Figure 3.2, suggesting the two tax measures are conceptually and meaningfully distinct.

[14] Average is calculated for the years 1998-2000. Data after the year 2000 was unavailable in the report.

Performance pay focused only on managers. Our finding that tasks are concentrated at the level of managerial employees may be driven by the adoption of performance pay incentives only at the managerial level. If non-managerial employees do not receive performance pay incentives while managerial employees do, then concentration of tasks at the managerial level may be driven by this difference. To examine whether our results might be driven primarily by differences in performance pay adoption across levels within the organization, we drop the set of establishments that adopt performance pay only at the managerial level, which is recorded separately as a response in the WES survey. As the results in Column 2 of Tables 8, 9, and 10 show, both the magnitude and statistical significance of our main findings remain similar after dropping these establishments.[15]

Industry trends in technology or competition. Another factor influencing performance pay and decentralization that may confound our results are unobserved industry trends in technology and competition. For example, firms may adopt better computer technology that allows firms to decentralize tasks more easily. At the same time, this technology might provide an independent signal of the effort of employees, effectively lowering the cost of performance pay. Consequently, firms might implement decentralization and performance pay due to industry trends in technology adoption. An alternative plausible industry trend is an increase in the intensity of competition. Competition may lead to decentralization of decision making, as argued by Bloom, Sadun and Van Reenen (2010), and may induce principals to adopt performance pay (Raith 2003). To control for these types of mechanisms, we include a full set of industry-year interactions to capture unobserved industry trends in competition and technology. To control for competition in the local area where the establishment is located, we include an indicator variable equal to one if the firm responds in the WES survey as perceiving local competition, distinct from foreign or nation-wide competition. The results are shown in Columns 3 and 4 of Tables 8, 9, and 10. The inclusion of these controls does not change our findings.

Total number of tasks and decision layers. Firms might also differ in the complexity of the problems they typically have to solve. For example, some firms with simple business processes may not have to formally allocate certain decisions, such as customer service, to the business owner or employees. By contrast, other firms with complicated production processes may need to assign a large number of tasks to decision-makers, and decentralization might thus be natural. Furthermore, such firms may also tend to implement performance pay because of moral hazard problems that arise for these more complex business processes. We include two additional control variables to address this concern. The first is a direct measure of the overall number of tasks the firm is involved in. The second is a proxy for the number of

[15] We note, however, that it is possible that managers may be given more performance-based incentives than non-managerial employees. This is considered explicitly in the model extension in Appendix 1 (discussion on fourth page), and does not change the implications of our empirical results here.

decision layers the firm has, based on the notion proposed by Garciano (2000) that organizations with more layers economize on managers' time, and therefore are able to solve more complex problems. To construct this measure, for each possible decision layer we record whether the firm has assigned any of the 12 decision tasks in the survey to the layer. If it has done so, we infer that the layer exists and sum the total number of layers we observe for each organization. As shown in Column 5 of Tables 8, 9, and 10, the inclusion of these controls does not change our results.

Risk. In response to empirical studies that find a positive correlation between risk and performance pay, theoretical models such as Prendergast (2002) have argued that risk can drive both decentralization and performance pay. Therefore, a potential confounding variable potentially biasing our results could be risk. To address this concern, we include the standard deviation of operating margin at the establishment level as an explicit measure of risk. As shown in Column 6 of Tables 8, 9, and 10, including an additional control for risk does not affect our results.

French culture. Within Canada, the province of Quebec is a distinct cultural outlier with French origins. There are several ways in which the presence of French culture in Canada could have an influence on our results. First, regarding decentralization, Bloom et al. (2012) note that there is a tendency to centralize decision-making in the French culture. Second, French culture as part of continental European culture has been argued to exhibit a larger degree of inequity aversion based on different equilibrium beliefs regarding luck vs. meritocracy (Alesina and Angeletos 2005). This inequity aversion might prevent firms under French influence to implement performance pay. We directly control for the effects of French culture by including an indicator equal to one if the establishment is located in Quebec. Results of our analysis are displayed in Column 7 of Tables 8, 9, and 10. The inclusion of this additional control does not change our results.

7 Conclusion

Complementarity between management practices has been argued to be a critical factor in explaining persistent performance differences across firms. Our results provide empirical evidence consistent with the existence of complementarity between performance pay and decentralization of decision-making. However, we find that current theories do not fully explain our findings. While performance pay adoption does lead to decentralization of decision-making from principals to agents, we find that, among agents, the adoption of performance pay also leads to centralization of authority from non-managerial to managerial employees. The results suggest that managerial activities play a critical role in determining the performance outcomes of firms, and that current arguments for and against decentralization may need to explicitly consider the function of specific layers, such as management, within organizational

hierarchies. Future work should also examine whether diversified multi-establishment, multi-sector firms deploy managerial resources differently from multi-establishment, single-sector or single-establishment firms. Also, while we have provided generalizable results at the level of a national economy, further examination of how specific contexts might affect our results is also needed (Cassiman and Veugelers 2006). This research would not only complement the decentralization patterns we find in this study, but contribute to extending current theories about how the internal organization of firms can lead to sustainable competitive advantage.

Also, our estimates of the average degree of complementarity between performance pay and decentralization are potentially useful to calibrate quantitative models of endogenous productivity and management practices. One example of such models are agent-based models, such as Rivkin (2000). Future work should also provide direct estimates of the importance of complementarity for productivity. As argued by Athey and Stern (1998), management practice complementarity should have important consequences for productivity estimation. In principle, complementary management practices should be evaluated together to recover valid estimates of the productivity gains from adopting management practices. Combining an instrumental variables strategy with the structural estimator proposed by Athey and Stern (1998) and Kretschmer et al. (2012) would help to fully characterize the impact of performance pay and decentralization on productivity. Overall, our findings suggest that identifying and understanding the mechanisms driving complementarity between management practices in greater detail is a fruitful area for future research.

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Table 1. Summary statistics of average decision layer for each task

Task/Activity	Average Layer: All Layers	Average Layer: Excluding Bus. Owners	Avg. No. of Layers
1. Daily work planning	2.98	2.15	1.05
2. Weekly work planning	3.05	2.25	1.06
3. Purchase of supplies	3.06	2.29	1.07
4. Equipment maintenance	3.14	2.41	1.05
5. Customer relations	3.20	2.47	1.16
6. Follow-up of results	3.27	2.46	1.08
7. Quality control	3.28	2.56	1.15
8. Training	3.32	2.66	1.11
9. Filling Vacancies	3.53	2.76	1.03
10. Setting staffing levels	3.57	2.81	1.03
11. Product or Service Development	3.62	2.92	1.06
12. Production technology choice	3.62	2.94	1.02
N = 11,753			

Note: All descriptive statistics use survey sampling weights to be representative of the Canadian economy.

Table 2. Performance pay and average compensation

Dependent variable: Average Compensation	(1) OLS	(2) OLS
Firm size (logged total employees)	0.832*	0.797
	(0.465)	(0.516)
Establishment age	0.058**	0.059**
	(0.024)	(0.025)
Multi-unit enterprise	0.759	0.650
	(1.840)	(1.670)
Exporter	2.466**	2.477**
	(1.055)	(1.049)
Unionized	4.115**	4.153**
	(1.737)	(1.769)
Foreign-owned	8.733***	8.687***
	(2.631)	(2.648)
PerformancePay	6.459***	6.302***
	(0.928)	(0.964)
Skill-based pay		0.771
		(1.764)
Year fixed effects	Y	Y
Industry fixed effects	Y	Y
Observations	11,753	11,753
Adj R-squared	0.30	0.30

Standard errors in parentheses, clustered by province-year. All regressions use sampling weights. *** p<0.01, ** p<0.05, * p<0.1

Table 3. Descriptive statistics

	Variable	Mean	σ
1.	PrincipalControl	6.00	4.96
2.	ManagerControl	2.65	3.99
3.	NonManagerControl	0.77	1.87
4.	PerformancePay	0.30	0.46
5.	Firm size (total employees), logged	2.05	0.98
6.	Establishment age (in years)	14.02	12.61
7.	Multi-unit enterprise	0.04	0.20
8.	Foreign-owned	0.03	0.18
9.	Exporter	0.16	0.37
10.	Unionized	0.11	0.31
11.	Residual Income Progression	0.89	0.04
	N = 11,753		

Note: All descriptive statistics use survey sampling weights to be representative of the Canadian economy.

Table 4. First stage estimation: Performance pay adoption on tax progressivity

Dependent variable: PerformancePay	(1)	(2)
	OLS	OLS
	Full sample	Multi-Province Sample
Residual Income Progression	1.641***	2.319***
	(0.280)	(0.558)
Firm size (logged total employees)	0.134***	0.048*
	(0.008)	(0.025)
Establishment age	-0.001**	-0.001
	(0.001)	(0.002)
Multi-unit enterprise	0.176***	0.077
	(0.021)	(0.098)
Exporter	0.004	0.102*
	(0.025)	(0.053)
Unionized	-0.027	-0.068
	(0.030)	(0.050)
Foreign-owned	0.126***	0.008
	(0.040)	(0.054)
Year fixed effects	Y	Y
Industry fixed effects	Y	Y
Observations	11,753	1,544
Adj R-squared	0.27	0.48

Standard errors in parentheses, clustered by province-year. All regressions use sampling weights. *** p<0.01, ** p<0.05, * p<0.1

Table 5. Decentralization and performance pay

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS			IV		
Dependent variable: Control by	Principal	Manager	Non-Manager	Principal	Manager	Non-Manager
PerformancePay	-1.962***	1.315***	0.077	-6.454***	6.129***	-1.884**
	(0.168)	(0.131)	(0.062)	(1.150)	(1.039)	(0.752)
Firm size	-1.598***	1.162***	-0.142*	-0.974***	0.493***	0.131
(logged total employees)	(0.101)	(0.081)	(0.078)	(0.198)	(0.126)	(0.133)
Establishment age	0.008	0.004	0.006**	0.001	0.011*	0.003
	(0.005)	(0.006)	(0.003)	(0.004)	(0.006)	(0.003)
Multi-unit enterprise	0.127	-0.345	-0.382***	0.977***	-1.256***	-0.011
	(0.174)	(0.334)	(0.106)	(0.247)	(0.418)	(0.181)
Exporter	0.344	-0.415	0.042	0.376	-0.450	0.056
	(0.249)	(0.238)	(0.119)	(0.267)	(0.294)	(0.148)
Unionized	-1.374***	0.003	0.099	-1.562***	0.204	0.017
	(0.400)	(0.172)	(0.214)	(0.457)	(0.256)	(0.202)
Foreign-owned	-1.964***	1.721***	0.081	-1.446***	1.166***	0.307
	(0.398)	(0.431)	(0.154)	(0.416)	(0.294)	(0.242)
Year fixed effects	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y
Observations	11,753	11,753	11,753	11,753	11,753	11,753
Adj R-squared	0.31	0.26	0.12	-	-	-

Standard errors in parentheses, clustered by province-year. Instrumental variable results use a limited information maximum likelihood IV estimator. All regressions use sampling weights. *** p<0.01, ** p<0.05, * p<0.1

Table 6. Decentralization and performance pay – Multi-province firms only

	(1)	(2)	(3)
		IV	
Dependent variable: Control by	Principal	Manager	NonManager
PerformancePay	-7.945***	6.906***	-1.744**
	(2.047)	(1.968)	(0.841)
Firm size	-0.017	0.227	0.050
(logged total employees)	(0.206)	(0.249)	(0.093)
Establishment age	0.001	0.009	-0.005
	(0.009)	(0.009)	(0.004)
Exporter	0.567	-1.269	-0.026
	(0.533)	(0.838)	(0.153)
Unionized	0.541	-0.930	-0.180
	(0.528)	(1.049)	(0.258)
Foreign-owned	-0.372	0.570	0.071
	(0.596)	(0.531)	(0.299)
Year fixed effects	Y	Y	Y
Industry fixed effects	Y	Y	Y
Province fixed effects	Y	Y	Y
Observations	1,544	1,544	1,544
Adj R-squared	0.31	0.44	0.09

Standard errors in parentheses, clustered by province-year. The multi-unit enterprise control is omitted since the entire sample consists of multi-unit firms. Instrumental variable results use a limited information maximum likelihood IV estimator. All regressions use sampling weights. *** p<0.01, ** p<0.05, * p<0.1

Table 7. Occupational composition, hiring, and training on performance pay adoption

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Tobit	Tobit	Tobit	Tobit	Tobit	Tobit	Tobit	Probit
Dependent variable:	Manager Fraction	Prod. worker Fraction	Prof. Fraction	Sales rep. Fraction	Admin. staff Fraction	Mgr. Hiring Rate	Overall Hiring Rate	Mgr. Training
PerformancePay	0.037**	-0.053**	0.102***	0.225***	-0.065**	0.104***	0.138	0.457***
	(0.017)	(0.027)	(0.027)	(0.033)	(0.028)	(0.028)	(0.085)	(0.074)
Firm size	-0.009	0.158***	0.111***	0.094***	0.078***	0.099***	0.223***	0.485***
(logged total employees)	(0.016)	(0.014)	(0.029)	(0.013)	(0.021)	(0.008)	(0.023)	(0.039)
Establishment age	0.000	0.003***	-0.000	-0.002	-0.000	-0.001	-0.003*	0.005
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.004)
Multi-unit enterprise	-0.030	-0.103*	0.016	0.023	-0.087**	-0.052***	-0.100*	0.368***
	(0.024)	(0.058)	(0.053)	(0.041)	(0.037)	(0.017)	(0.061)	(0.081)
Exporter	-0.007	-0.041	0.121***	0.081***	-0.016	0.015	0.048	-0.253***
	(0.014)	(0.046)	(0.045)	(0.026)	(0.025)	(0.034)	(0.067)	(0.094)
Unionized	-0.045**	0.124**	0.034	-0.209***	-0.117***	-0.008	-0.129**	0.212***
	(0.023)	(0.063)	(0.056)	(0.067)	(0.029)	(0.016)	(0.055)	(0.080)
Foreign-owned	-0.021	0.184***	0.037	0.024	-0.020	-0.022	-0.312***	0.310***
	(0.018)	(0.053)	(0.053)	(0.033)	(0.024)	(0.028)	(0.106)	(0.117)
Year fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Observations	11,753	11,753	11,753	11,753	11,753	11,753	11,753	11,616
Pseudo R-squared	0.19	0.26	0.22	0.36	0.29	0.37	0.06	0.27

Standard errors in parentheses, clustered by province-year. All regressions use sampling weights. *** p<0.01, ** p<0.05, * p<0.1

Table 8. Robustness checks, Principal Control

	Dependent variable: PrincipalControl						
	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV	(7) IV
PerformancePay	-6.366***	-6.038***	-6.265***	-6.503***	-4.955***	-6.481***	-9.745***
	(1.257)	(1.162)	(1.181)	(1.159)	(1.001)	(1.057)	(2.117)
Average compensation	-0.004						
	(0.006)						
Local competition				-0.019			
				(0.176)			
Total number of tasks					0.881***		
					(0.030)		
Total decision layers					-2.040***		
					(0.126)		
Std. Dev. of Operating Margin						0.450	
						(0.707)	
Quebec							-0.907***
							(0.327)
Firm controls	Y	Y	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	N	Y	Y	Y	Y
Industry fixed effects	Y	Y	N	Y	Y	Y	Y
Dropped manager-only performance pay	N	Y	N	N	N	N	N
Industry-Year fixed effects	N	N	Y	N	N	N	N
Observations	11,753	10,498	11,753	11,674	11,753	10,488	11,753

Standard errors in parentheses, clustered by province-year. Instrumental variable results use a limited information maximum likelihood IV estimator. All regressions use sampling weights. *** p<0.01, ** p<0.05, * p<0.1

Table 9. Robustness checks, Manager Control

	Dependent variable: ManagerControl						
	(1) IV	(2) IV	(3) IV	(4) IV	(5) IV	(6) IV	(7) IV
PerformancePay	6.255***	5.309***	5.830***	6.163***	6.038***	5.645***	8.765***
	(1.175)	(1.074)	(0.909)	(1.031)	(1.064)	(0.974)	(2.626)
Average compensation	-0.006						
	(0.005)						
Local competition				-0.261			
				(0.214)			
Total number of tasks					0.233***		
					(0.036)		
Total decision layers					0.132		
					(0.145)		
Std. Dev. of Operating Margin						0.452	
						(0.292)	
Quebec							0.726*
							(0.410)
Firm controls	Y	Y	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	N	Y	Y	Y	Y
Industry fixed effects	Y	Y	N	Y	Y	Y	Y
Dropped manager-only performance pay	N	Y	N	N	N	N	N
Industry-Year fixed effects	N	N	Y	N	N	N	N
Observations	11,753	10,498	11,753	11,674	11,753	10,488	11,753

Standard errors in parentheses, clustered by province-year. Instrumental variable results use a limited information maximum likelihood IV estimator. All regressions use sampling weights. *** p<0.01, ** p<0.05, * p<0.1

Table 10. Robustness checks, NonManager Control

	Dependent variable: NonManager Control						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	IV	IV	IV	IV	IV	IV	IV
PerformancePay	-2.025**	-2.128**	-1.937***	-1.894**	-2.289***	-1.915***	-3.298**
	(0.827)	(0.958)	(0.670)	(0.763)	(0.778)	(0.726)	(1.314)
Average compensation	0.006**						
	(0.003)						
Local competition				-0.009			
				(0.050)			
Total number of tasks					-0.022		
					(0.023)		
Total decision layers					0.557***		
					(0.083)		
Std. Dev. of Operating Margin						-0.505***	
						(0.174)	
Quebec							-0.390**
							(0.169)
Firm controls	Y	Y	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	N	Y	Y	Y	Y
Industry fixed effects	Y	Y	N	Y	Y	Y	Y
Dropped manager-only performance pay	N	Y	N	N	N	N	N
Industry-Year fixed effects	N	N	Y	N	N	N	N
Observations	11,753	10,498	11,753	11,674	11,753	10,488	11,753

Standard errors in parentheses, clustered by province-year. Instrumental variable results use a limited information maximum likelihood IV estimator. All regressions use sampling weights. *** p<0.01, ** p<0.05, * p<0.1

Figure 1.1. Postsecondary educational expenditure vs. income tax progressivity

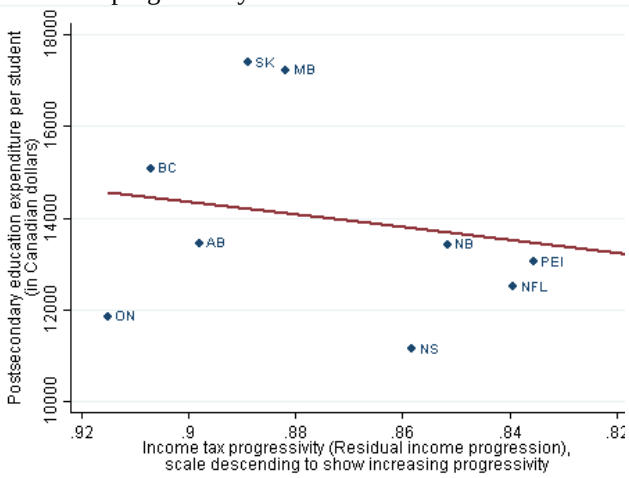

Figure 1.2. Postsecondary educational expenditure vs. avg. income tax rate

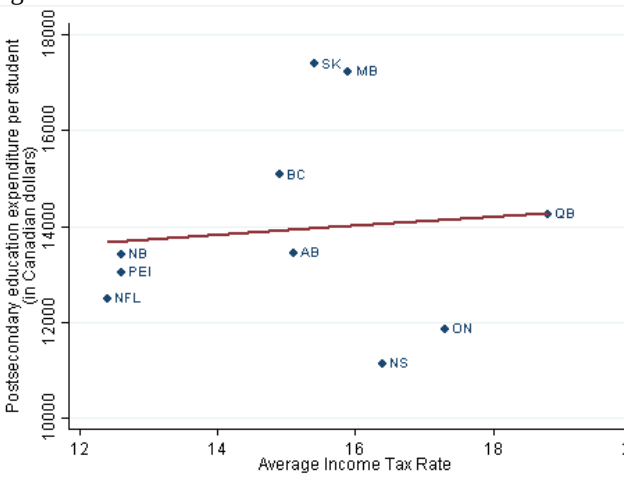

Figure 2.1. Pre-postsecondary educational expenditure vs. income tax progressivity

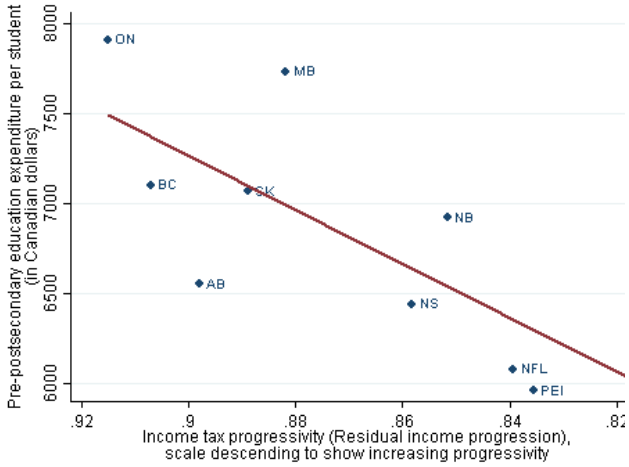

Figure 2.2. Pre-postsecondary educational expenditure vs. avg. income tax rate

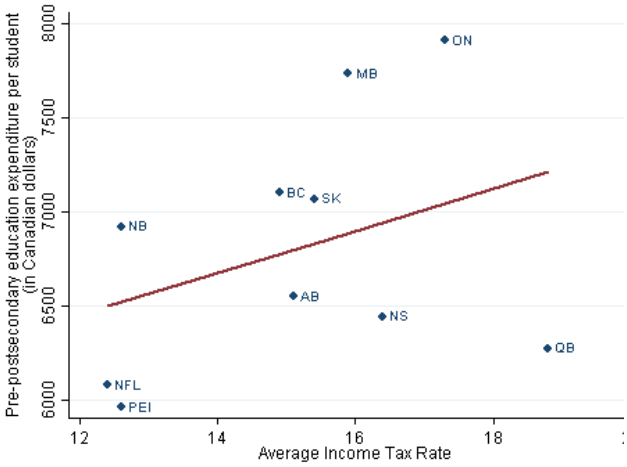

Figure 3.1. Labor contracting regulations vs. income tax progressivity

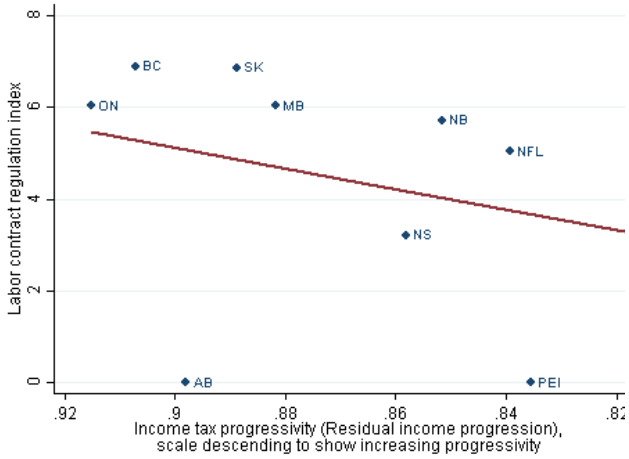

Figure 3.2. Labor contracting regulations vs. avg. income tax rate