2011

An Empirical Analysis of Risk, Incentives and The Delegation of Worker Authority

Jed Devaro
California State University-East Bay

Fidan Ana Kurtulus
University of Massachusetts Amherst

DEPARTMENT OF ECONOMICS

Working Paper

An Empirical Analysis of Risk, Incentives and The Delegation of Worker Authority

By

Jed Devaro
Fidan Ana Kurtulus

UNIVERSITY OF MASSACHUSETTS AMHERST

AN EMPIRICAL ANALYSIS OF RISK, INCENTIVES, AND THE DELEGATION OF WORKER AUTHORITY

BY

JED DEVARO

AND

FIDAN ANA KURTULUS

DeVaro is the Wang Family Professor in the Department of Management and the Department of Economics, College of Business and Economics, California State University, East Bay; Hayward, CA; 94542; USA. E-mail: jed.devaro@csueastbay.edu; Phone: (510)885-3289. Kurtulus is Assistant Professor in the Department of Economics at the University of Massachusetts, Amherst; 912 Thompson Hall; Amherst, MA; 01003; USA. E-mail: fidan@econs.umass.edu. Phone: (413)545-2512.

The notion of a tradeoff between risk and incentives is a key implication of the principal-agent model that has received significant attention in the literature since the original papers by Holmstrom (1979) and Shavell (1979). The intuition is that risk-averse workers are reluctant to accept output-contingent compensation contracts in production settings characterized by a high degree of risk, meaning situations in which output is determined largely by stochastic factors beyond the worker's control. The firm's response, therefore, is to decrease the amount of output-based pay as the degree of risk or uncertainty in the production environment increases. This theoretical prediction has been the subject of a vast number of empirical tests, and the collective evidence has been inconclusive. Some tests have found the predicted negative relationship, while others have found a positive relationship or no relationship.

Prendergast (2002) proposes a theory that potentially explains the inconclusive empirical evidence. At the heart of Prendergast's explanation is the delegation of worker authority which, he argues, is a key element that the standard agency model ignores. In production settings characterized by a low level of uncertainty, the firm has a clear sense of what tasks should be performed and how they should be performed. In such settings, the firm is content to monitor labor inputs. In contrast, when the production setting is characterized by a high level of uncertainty, the firm understands less what decisions need to be made and which tasks should be performed. The firm responds by delegating more authority to the worker, who is closer to the production process and often has better information than does the firm about what tasks should be performed.[1] The firm

---

[1] The argument that the agent should receive more authority the greater is his informational advantage was formalized by Aoki (1986). See also Dessein (2002) for a discussion of recent trends in firms pushing decision rights lower in their organizational hierarchies in order to profit from the local knowledge possessed by lower level managers.

1

accompanies this delegation of authority with output-based pay, to hold the worker

accountable for his decisions and to ensure that the worker does not misuse his discretion

by choosing the wrong tasks.[2] That is, when the degree of uncertainty increases, the firm

shifts from monitoring inputs and retaining control over tasks to monitoring outputs and

delegating authority over tasks.

This suggests a positive relationship between incentive pay and risk (operating

through the channel of worker authority), in contrast to the negative relationship

(operating through the channel of insurance) implied by standard agency theory. Thus,

the main testable result of Prendergast's model is that the predicted sign of the

relationship between risk and incentives is ambiguous. He states the empirical problem

as follows:

"The empirical difficulty here is that worker discretion is typically unobserved that could bias econometric estimates … without controlling for some measure of responsibility, we are likely to find a positive relationship between uncertainty and incentives; but if we can control for task assignment, we would expect to see no such relationship." (pp. 1096-1097)

Thus, Prendergast argues that controlling for worker authority in a regression of incentive

pay on risk should decrease the coefficient on risk.

Prendergast cites several empirical papers that provide indirect support for his

theory, but a direct test requires that worker authority be incorporated into the standard

risk-incentives regressions. A practical difficulty with implementing this test is that

measures of worker authority over task selection are rarely available in existing data sets.

---

[2] The argument that authority and incentives go hand in hand was formalized in the literature prior to Prendergast (2002). Jensen and Meckling (1992) analyzed how the decentralization of decision rights to agents with specific knowledge and abilities increases efficiency and argued that these decision rights should be accompanied by a control mechanism such as pay-for-performance in order to motivate individuals to use their decision rights optimally. Holmstrom and Milgrom (1994) derived a formal model in which the effectiveness of incentives is enhanced when simultaneously implemented with delegation of responsibility to agents.

2

Furthermore, measures of worker authority must be available in conjunction with measures of incentive pay and risk for the theory to be tested. Our empirical tests are based on a large, nationally-representative cross section of British establishments from the 1998 Workplace Employee Relations Survey (WERS98), containing information on risk, multiple dimensions of worker authority (both as perceived by workers and as perceived by employers), and incentive pay.

A potential concern is that a control for worker authority appearing on the right-hand side of a risk-incentives model might be endogenous; since it is chosen by the employer along with the structure of the compensation plan, the unobserved determinants of both choices are likely to be correlated, biasing the coefficients. To address this concern we estimate a bivariate probit model, treating both incentive pay and worker authority as endogenous variables. The parameters in the bivariate probit model with a dummy endogenous variable on the right-hand side are identified (except in pathological cases, such as one demonstrated in Maddala 1983, that do not apply here) even in the absence of exclusion restrictions (Heckman 1978, Wilde 2000, Monfardini and Radice 2008). An exogeneity test in this model reveals that the null hypothesis that worker authority is exogenous cannot be rejected.

We address four empirical questions in this paper. Is there empirical support for:

1) the risk-incentives tradeoff predicted by agency theory?

2) a positive relationship between authority and incentives?

3) a positive relationship between risk and authority?

4) the main testable implication of Prendergast's model, namely that the risk coefficient in an incentives regression should become smaller (i.e. less positive or

more negative) when delegation of worker authority is incorporated into the risk-incentives regression model?

Our empirical results support affirmative answers to all four questions, though in some cases the relevant parameters are estimated with low precision. Thus, our analysis contributes to the literature by providing empirical evidence clarifying the relationship between risk and incentive pay and how managers optimally bundle incentive pay and the delegation of worker decision rights to cope with risk. In particular, we attempt to reconcile the mixed nature of the empirical literature concerning evidence for a risk-incentives tradeoff by empirically addressing Prendergast's extension of the standard principal-agent model.

II. RELATED LITERATURE

A large number of empirical studies have aimed to test for the negative relationship between risk and incentives predicted by standard agency theory using data from a variety of industries and worker types. Some tests have found the predicted negative relationship (Lambert and Larcker 1987, Kawasaki and McMillan 1987, Aggarwal and Samwick 1999 and 2002, Mengistae and Xu 2004, Adams 2005, Gibbs, Merchant, Van der Stede and Vargus 2006, and Wulf 2007), while others have found a positive relationship (Rao 1971, Norton 1988, Leffler and Rucker 1991, Allen and Lueck 1992, Lafontaine 1992, Martin 1988, Core and Guay 1999 and 2002, Conyon and Murphy 2000, Ackerberg and Botticini 2002, Oyer and Schaefer 2005, Foss and Laursen 2005, Shi 2005) or no statistically significant relationship at all (Anderson and Schmittlein 1984, John and Weitz 1989, Yermack 1995, Bushman, Indjejikian and Smith

1996, Ittner, Larcker and Rajan 1997, Garen 1994, Nagar 2002).[3] The majority of these studies did not include a control for authority in the regressions of incentives on risk.

Turning to our second empirical question, previous empirical evidence tends to support the notion that incentive pay accompanies the delegation of authority (MacLeod and Parent 1999, Nagar 2002, Colombo and Delmastro 2004, Foss and Laursen 2005, Wulf 2007). Regarding our third empirical question, direct empirical evidence regarding a positive correlation between delegation and risk is rare since data spanning multiple firms and industries typically do not contain information on the extent of authority delegated to workers. Nonetheless, some empirical support can be found from franchises, sharecropped farms, retail banking, and Danish firms (Lafontaine 1992, Rao 1971, Nagar 2002, Foss and Laursen 2005).

While the evidence on these first three questions from the broad nationally-representative sample of British establishments we study in this paper complements the evidence from previous analyses, in our view the main contribution of our study is the evidence we present on the fourth empirical question. Our data are particularly well suited for testing Prendergast's model, given the availability of an authority measure that closely matches the notion of authority discussed by Prendergast. Several previous studies have incorporated authority into a risk-incentives regression model, and these are most closely related to our paper as we now discuss.

Foss and Laursen (2005) studied 993 Danish firms sampled in 1996. While their measures of incentive pay and authority are roughly similar to ours, their main risk measure, which they refer to as "within-industry variance in profitability", differs

---

[3] A table that summarizes the variables, data and econometric models used in these papers is available from the authors upon request.

5

substantially. To construct this variable, they assigned each firm in their sample to one of 70 industry categories. Within each of these 70 groups, they computed the variance of firm profits. Each firm's value for the risk measure is the variance that was computed for all firms belonging to the same industry category, so that the risk variable in their analysis assumes only 70 possible values. They then estimated an ordered probit model using incentive pay as the dependent variable and the 70-valued risk measure as an independent variable, along with a set of controls.

Estimating the Foss and Laursen model using their risk measure is computationally identical to estimating a more general model that includes 70 industry dummies (in lieu of their risk measure) but that also imposes 70 parametric restrictions, so that the ratio of every pair of coefficients on the industry dummies is constrained to equal a constant that the researcher specifies. The 70 restrictions implicitly imposed in the Foss and Laursen model are testable but are not tested in their paper. Implicit in these 70 restrictions is the strong assumption that the coefficients of each industry dummy reflect the effect of risk and nothing else. Since that assumption is unlikely to be correct, there is reason to suspect that the test might fail. Our risk measure, which we describe shortly, does not impose such restrictions on industry dummies.

Adams (2005) analyzed the manufacturing establishments from the 1998 WERS (a subsample of 166 establishments of the 1590 we consider). Adams treated the unit of observation as the worker rather than the establishment, but incentive pay is not observed in the 1998 WERS at the level of individual workers, so he attempted to infer the measure using establishment-level questions about what fraction of the workers in the given worker's occupation receives either profit-related pay or ESOPs (if more than 80%

6

of the workers receive such payments, the given worker is assumed to receive it, if less than 20% of the workers receive such payments, the given worker is assumed not to receive it, and if between 20% and 80% of the workers receive such payments, the given worker is dropped from the sample). We prefer to conduct the analysis at the establishment level because the risk measure available in the WERS only varies across establishments and not across workers within an establishment. So for the purpose of measuring the risk-incentives tradeoff, no additional information comes from disaggregating to the worker level, since this parameter is identified only by variation across establishments.

Wulf (2007) used a panel of 250 publicly-traded U.S. firms to show that in the presence of a control for whether division managers have officer status (such as president, CFO, VP) the tradeoff between division-level risk and managerial incentives is stronger than when the control is omitted. This result is consistent with the notion of authority as a mitigating factor in the risk-incentives relationship. However, one aspect of the analysis that complicates an interpretation of this as a direct test of Prendergast's main implication is that the set of covariates in the regressions which omit authority are different from those that include authority.

Nagar (2002) used a cross section of 100 retail banks in the U.S. in 1994 to show that, holding constant the authority delegated from top bank management to branch managers (in terms of hiring, promotions, hours and investment decisions), there is a negative but statistically insignificant relationship between uncertainty (as proxied by volatility in earnings and bank growth) and incentive pay (as reflected by the proportion of bank managers' pay comprised of bonuses). Since that study did not estimate models

7

that omit authority, we are unable to make a comparison of the relationship between risk and incentives when authority is controlled as opposed to when it is not, so the study does not provide a test of our fourth empirical question.

Shi (2005) used data on 2900 CEO's from the Compustat Execucomp database in 1992-2001, providing evidence consistent with Prendergast's main testable prediction if we interpret Shi's notion of CEO ability to respond to risk broadly as Prendergast's notion of decision-making authority. Specifically, Shi found that CEO incentives, as measured by the share of firm profits held by the CEO, increase with industry-wide risk measured as variance of industry stock return, which Shi argued is risk to which the CEO can respond by collecting industry information and making decisions based on it, and this positive relation diminishes as the definition of industry is broadened, so that the CEO is less able to act on collected information. An advantage of our analysis is that while Shi focuses only on CEOs, our study is based on a broad sample of employee-types, both managerial and non-managerial.

Finally, Ben-Ner, Kong, and Lluis (2007) analyzed 640 observations from the Minnesota Human Resources Management Practices, a survey in 1994-1995 of private, for-profit, Minnesota-based firms. Their binary incentives measure indicates the "existence of an individual incentives plan", and they used an authority measure similar to ours. Their analysis considered two measures of risk or uncertainty, namely "external uncertainty" and "internal uncertainty". The external uncertainty measure is similar to that constructed by Foss and Laursen (2005), as described earlier. The internal uncertainty measure is the sum of 3 components that the authors argue should be related to internal uncertainty (i.e. complexity, variability, and routine, each of which is

measured on a Likert scale). Some of the evidence in Ben-Ner, Kong, and Lluis is consistent with ours (e.g. positive relationships between incentives and delegation and between delegation and risk). However, as was the case with Wulf (2007), one aspect of their analysis that complicates an interpretation of the results as a direct test of Prendergast's main implication is that the specifications in the regressions that omit authority are different from those that include authority.

While Prendergast's model is one of the earliest and probably the best known in the theoretical literature aiming to reconcile agency theory with the mixed empirical support for a risk-incentives tradeoff, alternative theoretical approaches for explaining the empirical puzzle have been proposed (e.g., Zabojnik 1996, Core and Qian 2002, Baker and Jorgensen 2003, Raith 2003, Oyer 2004, Adams 2005, Raith 2005, Serfes 2005, Shi 2005). Many of these alternative theories do not concern issues of delegation of authority, and some of them are based on ideas that our data are ill-equipped to address (e.g. distinguishing between two alternative types of risk, as in Zabojnik 1996 and Baker and Jorgensen 2003), so we do not address them in this paper. However, the empirical support for Prendergast's model that we find in this paper does not cast doubt on the validity of these alternative theories.

III. THEORETICAL ANALYSIS AND HYPOTHESES

In Prendergast's model, the risk-neutral agent exerts effort on one of n tasks. The principal chooses either an input-based or an output-based compensation contract, and either assigns the agent a task or delegates authority to the agent to choose a task. Thus, in a literal interpretation of the model the worker who has been delegated authority

9

chooses *what* task to perform. In real-world organizations, it is often the upper-level managers who have the authority to choose the tasks, while front line workers are granted authority not over *what* tasks to perform but rather over *how and when* to perform them; i.e. the actual tasks – *what* is supposed to be done – are determined higher up in the organization. We argue that a broader interpretation of the term "task delegation" (extending to *how and when*) in Prendergast's model is appropriate, and in that case his model is also applicable to non-managerial workers. For example, a worker doing a job consisting of multiple tasks can choose the emphasis to place on each, so Prendergast's assumption that a worker chooses one out of n tasks could be interpreted to mean the emphasis the worker places on a particular task or the frequency with which it is performed.

As in earlier work (e.g. Holmstrom 1979, Holmstrom and Milgrom 1991) Prendergast interprets risk as uncertainty in the economic environment. The firm's output is $y_i = e_i + \varepsilon_i$, where i denotes the agent's task, and e_i is the agent's effort. The n random variables, ε_i, have common variance, σ^2, but differ in their means, with an increase in σ^2 implying a more uncertain production environment.

The agent knows the true value of ε_i whereas the principal only knows its distribution, and this asymmetry justifies the delegation of authority, given that the worker frequently has more accurate information than does the manager about the idiosyncrasies of the production process by virtue of being closer to it. For example, a sales clerk would be better informed concerning customers' impressions about a new product (i.e., demand variability) than would be the store manager. Likewise, a line worker is more likely to know whether the particular machine he operates is about to

10

break down and lead to a production bottleneck (i.e., supply variability) than the plant manager.

When σ^2 is sufficiently low the principal assigns the agent a task and compensates using an input-based contract, whereas when σ^2 is sufficiently high the principal allows the agent to choose the task but compensates using an output-based contract. If agents are risk-averse, the standard risk-incentives tradeoff is also present, and the net effect of risk on incentives is ambiguous in sign. From this discussion, four points emerge that can be addressed empirically:

1. In the absence of a control for delegation of worker authority, the sign of the risk-incentive relationship is theoretically ambiguous.

2. Incentive pay and delegation of worker authority should be positively correlated.

3. Authority and risk should be positively correlated.

4. When a control for worker authority is included in a regression of incentive pay on risk, the risk coefficient should decrease (i.e. become less positive or more negative).

IV. METHODS

Data

Our sample is drawn from both the management and worker questionnaires in the 1998 British Workplace Employee Relations Survey (WERS98), jointly sponsored by the Department of Trade and Industry, ACAS, the Economic and Social Research Council, and the Policy Studies Institute. Distributed via the UK Data Archive, the WERS data are a nationally representative stratified random sample covering British workplaces with at least ten employees, except for those in the following 1992 Standard Industrial

11

Classification (SIC) divisions: agriculture, hunting, and forestry; fishing; mining and quarrying; private households with employed persons; and extra-territorial organizations. Some of the 3192 workplaces targeted were found to be out of scope, and the final sample size of 2191 implies a net response rate of 80.4% (Cully et al., 1999) after excluding the out-of-scope cases.[4] Data were collected between October 1997 and June 1998 via face-to-face interviews. The respondent in the management questionnaire was usually the most senior manager at the workplace with responsibility for employment relations. In addition, a random sample of up to 25 employees per establishment was surveyed, producing the responses for the employee questionnaire.

The "risk" question was only asked of establishments in the private sector, producing 1591 responses. Of these, 1590 establishments responded to the questions about performance-related pay. Descriptive statistics for all variables in our analysis are displayed in Table 1 for the analysis sample of 1590 establishments. In Table 1 and in all of our analysis we use establishment weights; in most cases worker weights yield the same qualitative results. Some of the variables in our analysis contain missing values, and we estimate all of our models using list-wise deletion. The main source of missing information is the measure of worker authority, since only 1277 of the 1590 establishments reported any worker responses to the authority question. A table of means on this smaller subsample of N = 1277 closely matches Table 1.

---

[4] The "scope" is workplaces with 10 or more employees located in Great Britain (England, Scotland and Wales) and engaged in activities within Sections D (Manufacturing) to O (Other Community, Social and Personal Services) of the 1992 Standard Industrial Classification. The survey covers both private and public sectors. If a case is sampled that does not meet these parameters, it is called "out of scope."

Measures

Incentive Pay

In the principal-agent model, the firm consists of a single worker whose individual output (or net revenue) coincides with that of the firm. Taken literally, the model abstracts from some relevant details of the workplace, such as the fact that most firms are comprised of more than one worker, and a broader interpretation is therefore required if the theory is to be helpful in understanding behavior in a large sample of employers. In practice, employers rarely design incentive compensation systems tailored to the characteristics of individual workers. In the typical workplace, the employer designs the incentive pay system to apply to broad groups of workers (such as all workers within an establishment or perhaps all workers in a particular occupation within the establishment) rather than an individual worker. Thus, from the standpoint of empirical work that aims to test the theory, a measure of pay-for-performance at the level of the establishment (as opposed to the level of the individual worker) is acceptable. We use the following measure from the management survey:

Performance Pay = 1 if any employees at the workplace receive payments or dividends from individual or group performance-related schemes
= 0 otherwise[5]

In the principal-agent model the relevant notion of incentive pay is a linear piece rate, or the slope of the relationship between the agent's compensation and output, whereas our binary measure of performance pay describes whether performance-related pay is used at all, providing no information on its intensity. From the standpoint of

---

[5] The wording of the question permits group-based as well as individual-based schemes, whereas the relevant theories pertain to individual-based schemes. This does not present a problem for our analysis. The majority of establishments reporting pay-for-performance use individual-based schemes in our data, and restricting the incentive pay measure to equal one only when it is certain that individual-based performance pay is used yields results very similar to those we report here.

13

testing Prendergast's specific model, however, our binary measure actually matches the theory better than would a continuous measure of incentive pay within the establishment. The reason is that the prediction of Prendergast's model (taken literally) is that the principal chooses either output-based pay or input-based pay and never a mix of the two, though the basic logic of Prendergast's argument should extend to the proportion of compensation that is output-based. Furthermore, since we have a large sample of establishments, with plenty of variation in the use of incentive pay, our binary measure provides valuable information, though more detailed data on a continuous measure of incentive pay within each establishment would be even more informative.

Risk or Uncertainty

In the principal-agent model, the agent's output or net revenue (which equals the output or net revenue of the entire single-worker firm) is determined both by the agent's effort level and by a stochastic component. The variance of the stochastic component of output is referred to as risk or uncertainty. Consider the piece-rate system used to compensate the installers of automobile windshields at Safelite Glass Corporation. Safelite designs a "one size fits all" piece-rate scheme that is applied uniformly to all workers in the job, in consideration of broad, market-level risks that are expected to influence the outputs of large groups of workers. Our measure from the management survey is as follows:

Risk = 1 if the current state of the market for the main product or service of the
      establishment is described as "turbulent"
  = 0 otherwise

14

While the potential for such market-level turbulence to affect managerial output is clear, it is perhaps less obvious how the behavior of non-managerial workers might be affected. At Safelite Glass Corporation, market turbulence can be expected to affect the productivity (output) of non-managerial workers even if they have some authority over the work process, as overall demand uncertainty for windshields trickles down to the typical windshield installer. This captures Prendergast's notion of uncertainty in the production environment, but since it is a broad measure it is also likely to capture measurement noise.

Worker Authority

Prendergast (2002) draws a key "distinction between instances in which an employer tells his agent what to work on and situations in which the agent is given ***discretion over the activities that he spends time on***. [emphasis added]" (p. 1072) Prendergast's notion of authority therefore corresponds to delegating workers the power to make their own decisions about which tasks to perform.[6] The WERS employee survey contains a question that closely corresponds to this notion. At each establishment, up to 25 employees are randomly sampled and asked the following question:
"In general, how much influence do you have about the range of tasks you do in your job?" Responses are recorded on a four-point scale (1 = "none", 2 = "a little", 3 = "some", 4 = "a lot"). We code all responses of "don't know" as missing. Since our measures of incentive pay, risk, and firm characteristics are measured at the establishment level, for the authority measure we aggregate the worker authority

---

[6] Other studies that formalize the notion of the delegation of authority in the agency framework include Aghion and Tirole (1997) and Al-Najjar (2001).

15

responses to the establishment level by taking the modal worker response.[7] The idea is

that the most frequently occurring worker response to the authority questions within an

establishment reflects the degree of authority experienced by the typical worker in that

establishment. In the main analysis we use the following four-valued authority measure

and the four binary indicators implied by it:

Authority = 1 if establishment's modal worker response is "none"
       = 2 if establishment's modal worker response is "a little"
       = 3 if establishment's modal worker response is "some"
       = 4 if establishment's modal worker response is "a lot"
Authority1 = 1 if establishment's modal worker response is "none"
       = 0 otherwise
Authority2 = 1 if establishment's modal worker response is "a little"
       = 0 otherwise
Authority3 = 1 if establishment's modal worker response is "some"
       = 0 otherwise
Authority4 = 1 if establishment's modal worker response is "a lot"
       = 0 otherwise

We also consider some alternative measures of authority in our sensitivity analysis.

In addition to our key variables (i.e. risk, incentives, and authority), we include a

large set of controls for firm characteristics in our models, including establishment size,

main activity of the establishment, industry, whether the establishment is a single

independent establishment or one of multiple establishments, ownership (private versus

public, franchise versus non-franchise, publicly traded versus non-publicly traded),

whether the establishment produces a single product or multiple products, fraction of

part-time workers, presence of temporary workers, presence of fixed-term workers under

one year, presence of fixed-term workers over one year, number of recognized unions,

fraction of establishment that is unionized, and whether the establishment has been in

---

[7] We also aggregated using the median rather than the mode throughout the paper, finding very similar
results to those we report here. These are available upon request. The median results are virtually
insensitive to how the median is defined when the number of workers sampled at the establishment is even
(i.e. whether observation n/2 or observation n/2 + 1 is defined as the median).

16

operation for more than five years. These controls are defined in the appendix. Most are

included simply to absorb employer attributes that may be correlated with the main

variables of interest, though a few are included because of a clear theoretical rationale, in

particular unionization and establishment size. Given that unions exert considerable

influence over both the level of compensation and its composition, the number of

recognized unions at the establishment and also the fraction of the workforce that is

unionized can be expected to influence the probability that an establishment will use

incentive pay. Regarding establishment size, monitoring difficulty increases as the

number of employees gets larger, making the establishment more likely to grant

employees pay for performance as a substitute for costly monitoring. Coordinating and

directing workers also becomes more costly as the number of employees increases, so

larger organizations are more likely to resort to decentralization of decision-making and

delegation.

Empirical Analysis

To investigate whether a tradeoff between risk and incentives, as predicted by

standard agency theory, can be identified in the WERS data, we estimate the following

probit model:

Prob($Performance\ Pay_i = 1$) = $\Phi(\alpha Risk_i + \mathbf{X_i}\boldsymbol{\beta})$

where $\mathbf{X}_i$ is a vector of controls for firm characteristics, and i indexes establishments.

Agency theory predicts $\alpha < 0$. Our results in Table 2 support this prediction, though they

are estimated with modest precision. In the first specification the effect is statistically

insignificant. As revealed in the second and third specifications, however, once industry

17

controls are included in the model the effect is statistically significant at the ten percent

significance level on a one-tailed test. [8] Based on the third specification that includes the

full set of controls, the change in the predicted probability that incentive pay is offered

when *Risk* increases from 0 to 1 (evaluating other covariates at their means) is -0.051.

This magnitude is substantial, given that the mean of *Performance Pay* is 0.196. On

average, an increase in *Risk* from 0 to 1 is associated with a decrease of 26 percent in the

predicted probability that performance-related pay is used.

We next investigate whether empirical support can be found for a positive

relationship between authority and incentives. The rationale for a positive correlation is

that in risky settings the principal wants to switch from monitoring labor inputs to

monitoring outputs. In such settings, the firm delegates decision-making authority to the

worker but accompanies this authority with output-based pay. To test this empirically,

we estimate the following probit model:

$$\text{Prob}(\textit{Performance Pay}_i = 1) = \Phi(\beta_2 \textit{Authority}_{2i} + \beta_3 \textit{Authority}_{3i} + \beta_4 \textit{Authority}_{4i} + \mathbf{X_i\beta}).$$

Empirical support for a positive correlation between authority and incentives would be

implied by positive and statistically significant estimates of β_2, β_3, and β_4; furthermore,

there should be a monotonic pattern in the marginal effects, so that (relative to

Authority₁) the effect of *Authority₃* is higher than the effect of *Authority₂*, and the effect

of *Authority₄* is highest of all. As seen in Table 3, in the first specification the relevant

effects are statistically insignificant. However, once industry controls are included in the

model, the estimated effect of *Authority₄* is positive and significant at the five percent

---

[8] Since the negative relationship between risk and incentives predicted by the principal-agent model is a
directional hypothesis, we use one-tailed hypothesis tests as the criterion for statistical significance. We
adhere to this convention throughout the paper whenever a directional hypothesis is implied by the theory.

level on a one-tailed test, though the estimated effects of *Authority₂* and *Authority₃* remain statistically insignificant. Finally, our results support a monotonic pattern in the marginal effects, though only the effect of *Authority4* is statistically significant.

We next investigate whether empirical support can be found for a positive relationship between risk and delegation of authority. A component of Prendergast's model is that delegation of authority is more likely in risky settings, so that authority and risk are positively related. To test this empirically, we estimate an ordered probit model in which the four-valued dependent variable is *Authority*, and *Risk* is the key independent variable. The results, displayed in Table 4, clearly support a positive relationship between authority and risk. In the most controlled specification, on average, the increase in the probability of the highest degree of authority being delegated that is associated with *Risk* is 11.9 percentage points, amounting to a 37.5% increase in the probability that the highest level of authority is delegated.

Finally, we address the central empirical question of this paper, namely whether there is empirical support for the main testable implication of Prendergast's model. Prendergast argues that if controls for worker authority are added to risk-incentives regressions, the coefficient on risk should decrease. That is, if the coefficient were positive without controls for authority, it should be less positive once authority is added as a control, and if the coefficient were negative in the absence of the authority control, it should be greater in magnitude once authority is added. As a starting point we augment the model in Table 2 with controls for worker authority as follows:

Prob(*Performance Pay_i* = 1) = $\Phi(\alpha Risk_i + \beta_2 Authority_{2i} + \beta_3 Authority_{3i} + \beta_4 Authority_{4i} + \mathbf{X_i\beta})$

Prendergast's argument suggests that the relatively weak statistical evidence of a risk-incentives tradeoff that we found at the start of the section should strengthen when

19

authority controls are added to the model. Table 5 displays the marginal effects. The first six columns of the table should be read in pairs (i.e. columns 1 and 2 correspond to one specification, which is presented both with and without authority controls, columns 3 and 4 correspond to another specification that includes industry controls, and columns 5 and 6 correspond to a third specification that includes both industry and firm controls). When industry controls are included in the model, a statistically significant effect of *Risk* emerges. In the third and most controlled specification, when authority is omitted from the model, *Risk* is associated with a 5.7 percentage point decrease in the probability of incentive pay being used, whereas when authority is included as a control, this magnitude increases to 6.8 percentage points, strengthening the evidence of a risk-incentives tradeoff as Prendergast's model predicts. A statistical test of the null hypothesis that the *Risk* coefficient is equal between the model that includes authority controls and the model that excludes authority controls (versus the alternative hypothesis that the *Risk* coefficient is lower in the model that includes authority controls than in the model that excludes authority controls) in the most controlled specification reveals that the null can be rejected at the ten percent significance level, and nearly at the five percent significance level (p-value = 0.052). Furthermore, the marginal effect of $Authority_4$ in that specification is positive and statistically significant, confirming the positive relationship between authority and incentive pay that we documented earlier in this section.

The results thus far appear supportive of the main testable implication of Prendergast's model. However, as mentioned in the introduction, worker authority is potentially endogenous in a risk-incentives regression. Our results in the sixth column of Table 5 suggest that $Authority_4$ is the authority variable that matters the most. We thus

20

aggregate authority to two categories (i.e. we use only the dummy variable *Authority$_4$*)

and estimate a bivariate probit model of incentives and authority to account for this

endogeneity, allowing for correlation between the unobserved determinants of both

variables. The bivariate probit model includes a dummy endogenous regressor (i.e.

Authority$_4$) in the incentives equation. Note that in this model, except in rare cases that

do not apply here, identification of the parameters is attained even in the absence of

exclusion restrictions (Heckman 1978, Wilde 2000, Monfardini and Radice 2008). The

recursive structure of the model is consistent with Prendergast's theory, e.g. "So

uncertain environments result in the delegation of responsibilities, which in turn

generates incentive pay based on output" (Prendergast, p. 1072).

Results from the bivariate probit are presented in the last two columns of Table 5.

Marginal effects are displayed, along with the point estimates (in square brackets) and

their standard errors (in parentheses below the point estimates). The essential point to

note from the bivariate probit results is that an exogeneity test reveals that the null

hypothesis that worker authority is exogeneous cannot be rejected. That is, the null

hypothesis that $\rho = 0$ cannot be rejected, where ρ is the correlation in the disturbances in

the incentives and authority equations. This means that in the empirical tests it is

reasonable to use a comparison of columns 5 and 6 of Table 5 that treated authority as

exogenous in evaluating the main testable prediction of Prendergast's model. Our

conclusion is that when authority controls are added to the risk-incentives model, the

evidence of a risk-incentives tradeoff strengthens, supporting Prendergast's main testable

implication.

Sensitivity Analysis: Alternative Measures of Authority and Incentive Pay

Although the measure of worker authority we use throughout the analysis closely matches the notion described in Prendergast (2002), we also consider some alternative authority measures. These are measures of worker discretion over how tasks are executed (as opposed to the range of tasks performed). The questions are asked both of the employer and of the workers, allowing us to construct the following employer-perceived and worker-perceived measures of authority over how tasks are executed:

Worker-Perceived Worker Authority Measures

$AUTHORITY_{HOW}(W)1$ = 1 if the establishment's modal worker response to the amount of worker discretion over how tasks are executed is "none" or "a little"
= 0 otherwise
$AUTHORITY_{HOW}(W)2$ = 1 if the establishment's modal worker response to the amount of worker discretion over how tasks are executed is "some"
= 0 otherwise
$AUTHORITY_{HOW}(W)3$ = 1 if the establishment's modal worker response to the amount of worker discretion over how tasks are executed is "a lot"
= 0 otherwise

Firm-Perceived Worker Authority Measures

$AUTHORITY_{HOW}(F)1$ = 1 if firm-perceived worker discretion over how tasks are executed is "none"
= 0 otherwise
$AUTHORITY_{HOW}(F)2$ = 1 if firm-perceived worker discretion over how tasks are executed is "a little"
= 0 otherwise
$AUTHORITY_{HOW}(F)3$ = 1 if firm-perceived worker discretion over how tasks are executed is "some"
= 0 otherwise
$AUTHORITY_{HOW}(F)4$ = 1 if firm-perceived worker discretion over how tasks are executed is "a lot"
= 0 otherwise

22

The variable names include "(W)" or "(F)" to indicate which worker authority measures reflect worker perceptions and which reflect firm perceptions. The lowest two categories of the worker-perceived measure are aggregated from four categories to three due to an extremely small count in the lowest cell. One difference between the worker-perceived measures and the firm-perceived measures is that the question in the employer survey pertains to the discretion of workers in the establishment's largest occupational group, whereas the question from the worker survey is based on a random sample of workers in the establishment. That is, in the employer survey the respondent employer is asked to rate the level of worker authority in the establishment's "largest occupational group" rather than in the establishment as a whole.

We estimate models that include different combinations of authority controls (authority over range of tasks performed, worker-perceived authority over how tasks are executed, employer-perceived authority over how tasks are executed). Results are displayed in Table 6. When reading Table 6, compare the marginal effect of *Risk* in the first column to the marginal effect of *Risk* in each of the remaining columns, to see how the risk-incentives relationship changes when different configurations of authority controls are added to the model. The results reveal that the authority measure that individually suggests the strongest empirical support for Prendergast's theory is also the measure that best matches the notion of authority discussed in his paper (namely authority over the range of tasks performed), since the risk effect decreases by the most when these particular authority measures are included as controls.

Statistical tests of the null hypothesis that the *Risk* coefficient is equal between the model that includes authority controls (i.e. column 2, 3, 4, 5, or 6) and the model that

excludes authority controls (i.e. column 1), versus the alternative hypothesis that the *Risk*

coefficient is lower in the model that includes authority controls than in the model that

excludes authority controls, reveals that the null is virtually always rejected when the

main measures of authority are used but not when the alternative measures are used.

More precisely, the null can be rejected at the ten percent significance level in columns 1

versus 2 (p-value = 0.057) and in columns 1 versus 6 (p-value = 0.088), and it narrowly

misses rejection at the ten percent significance level in columns 1 versus 4 (p-value =

0.107). When only the alternative measures are used, the null is not at all close to

rejection; the p-value is 0.440 for columns 1 versus 3, and the p-value is 0.283 for

columns 1 versus 5. Thus, statistical evidence supporting Prendergast's main prediction

emerges only for the main authority measure and not for the alternative authority

measures.

Turning now to alternative measures of incentive pay, a potential drawback of our

measure is that it refers to group performance-related schemes as well as individual

performance-related schemes, whereas the theory we address in this paper pertains to

individual performance-related schemes. To explore this issue, we use some further

information in the WERS employer survey. If the respondent reports that performance-

related pay is used at the establishment and that "any non-managerial occupations [are]

eligible", the respondent is then asked what measures of performance are used to

determine the amount of performance-related pay. Respondents can list as many of the

following responses as they wish, in addition to providing their own responses not on the

list: "1 = Individual performance / output", "2 = Group or team performance / output", "3

= Workplace-based measures", "4 = Organisation-based measures". The most common

response is "1", either alone or in combination with other choices. Using this information we modify the binary performance measure we have used throughout the analysis. If an establishment reports the use of performance-related pay but does not include "1 = Individual performance / output" in its list of responses to the above question, we reclassify the binary performance pay measure for this observation from 1 to 0. The idea behind this reclassification is to create a binary incentive pay measure that equals one only if it can be determined with certainty (abstracting from reporting and coding errors) that performance-related pay is used *and* at least some of it is based on individual performance or output.

Two points are worth noting about this modified measure. First, when the respondent lists more than one answer to the question of what type of performance-related scheme is used at the establishment, there is no way to discern the relative importance of the responses listed. Second, because the question is only asked if performance-pay is used and "any non-managerial occupations [are] eligible", if performance pay is used at the establishment but no non-managerial occupations are eligible for it we have no information on what type of performance pay is used. Thus, we only have information on the type of performance-related pay used for 357 of the 418 establishments that report the use of performance-related pay. For the remaining 61 establishments we define the binary incentive measure as "1" even though in some of these cases the performance-pay might not be based on individual performance / output. The mean of the modified incentive pay measure is 0.151, as opposed to 0.196 for the unmodified measure we use throughout the paper. Replicating all of our analysis in the

paper using the modified measure yields no qualitative changes to our conclusions. All of these results are available upon request.

V. DISCUSSION

In this study we use a large, nationally representative cross section of British establishments, containing responses both from employers and from multiple workers in each establishment, to shed light on the four empirical questions posed in the introduction. In answer to the first question, we find statistically weak evidence of the negative relationship between risk and incentives predicted by the standard principal-agent model. On average, greater turbulence in the market for the establishment's main product or service is associated with a lower probability of performance-related pay for the establishment as a whole. In answer to the second and third questions, we find evidence supporting a positive relationship between performance-related pay and the degree of worker authority over the range of tasks performed, and evidence supporting a positive relationship between risk and the degree of worker authority.

In answer to the fourth question, our results suggest that when measures of worker authority are included in a risk-incentives model, the relationship between risk and incentives becomes more negative, and the potential endogeneity of authority in this model does not appear to be a concern. We interpret the overall evidence in this empirical test of Prendergast's theory as supportive. The evidence from the WERS data suggests that Prendergast's theory is at least part of the reason why a vast empirical literature has failed to uncover the negative relationship between risk and incentives that has been central to agency theory for nearly three decades.

26

We conclude with four comments. First, while some of our main results are estimated with high precision, others are not. Throughout the analysis, we rely on one-tailed hypothesis tests since the relevant theory implies directional hypotheses. However, in some cases our results would not achieve statistical significance at conventional levels if the more stringent two-tailed tests were used instead.

Second, while our results on the risk-incentives tradeoff represent only one study in a vast empirical literature that has found mixed evidence, we believe the breadth of our sample (which is nationally representative of all British establishments) makes our results particularly interesting. While many analyses of the risk-incentives tradeoff have been conducted, the heavy focus has been on a relatively small set of worker groups, in particular groups that, it is fair to say, are atypical. For example, while the number of jobs held by either CEOs or sharecroppers is negligible, the majority of previous empirical studies focus on these two groups. The general point is that it is difficult to know what relative weights to assign to the various empirical studies in forming an overall evaluation. We think the present study, based on a broad and nationally representative sample of establishments, contributes to forming such an overall evaluation.

Third, we hope that our results will stimulate further research in this area using other data sets. Panel data would be particularly helpful to convincingly identify causal parameters; the cross sectional nature of our data is a limitation of our analysis. Also, since we have focused only on Britain, due to the strengths of the WERS data for testing Prendergast's theory, it would be useful for future tests to use data from the United States and other countries. While we cannot rule out the possibility that the empirical support of

27

Prendergast's model is specific to Britain, we will be rather surprised if this is confirmed

in future work. We see nothing peculiar to Britain in the fundamental workplace issues

Prendergast's model addresses, and we therefore expect the empirical support for his

model in Britain to generalize to data sets from other countries. Furthermore, though our

binary measure of incentive pay proved to be quite informative, more detailed

information concerning how the intensity of incentive pay varies across organizations

would also be interesting.

Finally, while we believe our results suggest that Prendergast's theory at least

partially explains why the empirical literature has failed to uncover a risk-incentives

tradeoff, this does not rule out that alternative theories may also play a role. Our focus on

Prendergast's theory in this analysis is driven largely by the availability of an authority

measure that corresponds closely to the notion discussed by Prendergast. Though we

believe our evidence is supportive of Prendergast's theory, we do not see it as casting

doubt on the alternative models, and we see investigation of these alternatives as a

promising direction for future work with other data sets.

APPENDIX

FIRM CHARACTERISTICS USED AS CONTROL VARIABLES:

Single-Establishment Firm = 1 if the establishment is either a single independent
establishment not belonging to another body, or the sole
UK establishment of a foreign organization
= 0 if the establishment is one of a number of different
establishments within a larger organization

Establishment Size = total number of full time, part time, and temporary workers at the
establishment (measured in thousands)

Fraction of Part Time Workers = number of part time workers at the establishment as a
fraction of establishment size

Temporary Workers = 1 if there are temporary agency employees working at the establishment at the time of the survey
= 0 otherwise

Fixed Term Workers Under One Year = 1 if there are employees who are working on a temporary basis or have fixed-term contracts for less than one year
= 0 otherwise

Fixed Term Workers Over One Year = 1 if there are employees who have fixed term contracts for one year or more
= 0 otherwise

Number of Recognized Unions = total number of recognized unions at the workplace

100% Workers Unionized = 1 if 100% of all employees, including managers, are covered by collective bargaining either at this workplace or at a higher level (employee-perceived measure)
= 0 otherwise

80-99% Workers Unionized = 1 if 80-99% of all employees, including managers, are covered by collective bargaining either at this workplace or at a higher level (employee-perceived measure)
= 0 otherwise

60-79% Workers Unionized = 1 if 60-79% of all employees, including managers, are covered by collective bargaining either at this workplace or at a higher level (employee-perceived measure)
= 0 otherwise

40-59% Workers Unionized = 1 if 40-59% of all employees, including managers, are covered by collective bargaining either at this workplace or at a higher level (employee-perceived measure)
= 0 otherwise

20-39% Workers Unionized = 1 if 20-39% of all employees, including managers, are covered by collective bargaining either at this workplace or at a higher level (employee-perceived measure)
= 0 otherwise

1-19% Workers Unionized = 1 if 1-19% of all employees, including managers, are covered by collective bargaining either at this workplace or at a higher level (employee-perceived measure)
= 0 otherwise

29

0% Workers Unionized = 1 if 0% of all employees, including managers, are covered by collective bargaining either at this workplace or at a higher level (employee-perceived measure)
= 0 otherwise

Main Activity of Establishment = 1 if the main activity of the establishment is to produce goods or services for consumers
= 0 for any of the following other possibilities: supplier of goods or services to other companies; supplier of goods or services to other parts of the organization to which we belong; do not produce goods or provide services for sale in the open market; an administrative office only

Single Product = 1 if the establishment is concentrated on one product or service
= 0 if it is concentrated on several different products or services

Private Sector Franchise = 1 if the establishment is a private sector company and a franchise
= 0 otherwise

Private Sector Non-franchise = 1 if the establishment is a private sector company but not a franchise
= 0 otherwise

Private Sector Publicly-Traded Franchise = 1 if the establishment is a publicly-traded private sector unit and a franchise
= 0 otherwise

Private Sector Publicly-Traded Non-franchise = 1 if the establishment is a publicly-traded private sector unit but not a franchise
= 0 otherwise

Operation Over Five Years = 1 if the workplace has been operating at its present address for 5 years or more
= 0 otherwise

Industry Controls: (Manufacturing; Electricity, Gas, and Water; Construction; Wholesale and Retail; Hotels and Restaurants; Transport and Communication; Financial Services; Other Business Services; Public Administration; Education; Health; Other Community Services)

REFERENCES

Ackerberg, Daniel A., and Maristella Botticini (2002). "Endogenous Matching and the Empirical Determinants of Contract Form." *Journal of Political Economy*, Vol. 110, No. 3, pp. 564-591.

Adams, Christopher P. (2005). "Worker Discretion, Adverse Selection, and the Risk-Incentive Trade-off." May 2005. FTC Working Paper.

Aggarwal, Rajesh K., and Andrew A. Samwick (1999). "The Other Side of the Tradeoff: The Impact of Risk on Executive Compensation." *Journal of Political Economy* Vol. 107, No. 1 (February 1999): 65-105.

Aggarwal, Rajesh K., and Andrew A. Samwick (2002). "The Other Side of the Tradeoff: The Impact of Risk on Executive Compensation—A Reply." Working Paper, Dartmouth College.

Aghion, Philippe and Tirole, Jean (1997). "Formal and Real Authority in Organizations." *Journal of Political Economy*, Vol. 105, No. 1. (February 1997), 1 – 29.

Al-Najjar, Nabil I. (2001). "A reputational model of authority". *Journal of Economic Behavior and Organization,* Vol. 46, pp. 165-191.

Allen, Douglas and Dean Lueck (1992). "Contract Choice in Modern Agriculture: Cash Rent versus Cropshare." *Journal of Law and Economics* Vol. 35, No. 2 (October 1992): 397-426.

Anderson, Erin and David C. Schmittlein (1984). "Integration of the Sales Force: An Empirical Examination." *RAND Journal of Economics* Vol. 15, No. 3 (Autumn 1984): 385-395.

Aoki, Masahiko (1986). "Horizontal versus Vertical Information Structure of the Firm," *American Economic Review*, 76: 971 – 983.

Baker, George, and Bjorn Jorgensen (2003). "Turbulence, Risk, and Incentives." Working Paper, Harvard University.

Ben-Ner, Avner, Fanmin Kong, and Stephanie Lluis (2007). "Uncertainty and Organization Design." Working paper, University of Minnesota.

Colombo, Massimo G. and Delmastro, Marco (2004). "Delegation of Authority in Business Organizations: An Empirical Test". *Journal of Industrial Economics*, Vol. LII, No. 1: 53-80.

31

Conyon, Martin J. and Kevin J. Murphy (2000). "The Prince and the Pauper? CEO Pay in the United States and United Kingdom." *The Economic Journal* 110 (November 2000): 640-671.

Core, John and Wayne Guay (1999). "The Use of Equity Grants to Manage Optimal Equity Incentive Levels*." Journal of Accounting and Economics* 28: 151-184.

Core, John and Wayne Guay (2002). "The Other Side of the Tradeoff: The Impact of Risk on Executive Compensation. A Revised Comment." Working Paper, University of Pennsylvania.

Core, John and Jun Qian (2002). "Project Selection, Production, Uncertainty, and Incentives." Working Paper, University of Pennsylvania (January 2002).

Cully, M., Woodland, S., O'Reilly, A., and Dix, G. (1999). *Britain at Work: As Depicted by the 1998 Workplace Employee Relations Survey*. London: Routledge.

Department of Trade and Industry, Advisory, Conciliation and Arbitration Service, Workplace Employee Relations Survey: 1998 [computer file]. Colchester, Essex: The Data Archive [distributor], 22 March 1999.

Dessein, Wouter (2002). "Authority and Communication in Organizations." *Review of Economic Studies 69*: 811-838.

Foss, Nicolai J., and Keld Laursen (2005). "Performance Pay, Delegation and Multitasking Under Uncertainty and Innovativeness: An Empirical Investigation." *Journal of Economic Behavior and Organization* Vol. 58, 246 – 276.

Garen, John E. (1994). "Executive Compensation and Principal-Agent Theory." *Journal of Political Economy* Vol. 102, No. 6 (December 1994): 1175-1199.

Gibbs, Michael, Merchant, Kenneth A., Van der Stede, Wim A. and Vargus, Mark E (2006). "Performance Measure Propoerties and Incentives." (September 2006). Working Paper.

Heckman, James J. (1978). "Dummy Endogenous Variables in a Simultaneous Equation System." *Econometrica* 46, 931-959.

Holmstrom, Bengt (1979). "Moral Hazard and Observability," *Bell Journal of Economics,* 1979,10 (1), 74 – 91.

Holmstrom, Bengt, and Paul Milgrom. (1991). "Multitask Principal-Agent Analyses: Incentive Contracts, Asset Ownership, and Job Design." *Journal of Law, Economics, and Organization*, Vol. 7 (Supplement 1991): 24-52.

32

Holmstrom, Bengt, and Paul Milgrom. (1994). "The Firm as an Incentive System", *American Economic Review*, Vol. 84, No. 4 (September 1994): 972-991.

Ittner, Christopher D., Larcker, David F., and Madhav V. Rajan (1997). "The Choice of Performance Measures in Annual Bonus Contracts." *The Accounting Review* Vol. 72, No. 2 (April 1997): 231-255.

Jensen, Michael C. and Meckling, William H. (1992). "Specific and General Knowledge, and Organizational Structure". In *Contract Economics*, edited by Lars Werin and Hans Wijkander. Blackwell, Oxford, 251 – 274.

John, George and Weitz, Barton (1989). "Salesforce Compensation: An Empirical Investigation of Factors Related to Use of Salary Versus Incentive Compensation". *Journal of Marketing Research*, Vol. XXVI, 1 – 14.

Kawasaki, Seiichi and John McMillan (1987). "The Design of Contracts: Evidence from Japanese Subcontracting." *Journal of the Japanese and International Economies* 1: 327-349.

Lafontaine, Francine (1992). "Agency Theory and Franchising: Some Empirical Results." *RAND Journal of Economics* Vol. 23, No. 2 (Summer 1992): 263-283.

Lambert, Richard A. and David F. Larcker (1987). "An Analysis of the use of Accounting and Market Measures of Performance in Executive Compensation Contracts." *Journal of Accounting Research* Vol. 25, Studies on Stewardship Uses of Accounting Information: 85-125.

Leffler, Keith B. and Randal R. Rucker (1991). "Transactions Costs and the Efficient Organization of Production: A Study of Timber-Harvesting Contracts." *Journal of Political Economy* Vol. 99, No. 5: 1060-1087.

MacLeod, W. Bentley and Daniel Parent (1999). "Job Characteristics and the Form of Compensation." In *Research in Labor Economics* Vol. 18, edited by Solomon Polacheck. Stamford, Conn.: JAI, 1999.

Maddala, G.S. (1983). *Limited-Dependent and Qualitative Variables in Econometrics*. Cambridge University Press, Cambridge.

Martin, Robert E. (1988). "Franchising and Risk Management." *The American Economic Review* Vol. 78, No. 5 (December 1988): 954-968.

Mengistae, Taye and Lixin Colin Xu (2004). "Agency Theory and Executive Compensation: The Case of Chinese State-Owned Enterprises." *Journal of Labor Economics*, Vol. 22, No. 3, 615 – 637.

33

Monfardini, Chiara, and Rosalba Radice (2008). "Practioner's Corner: Testing Exogeneity in the Bivariate Probit Model: A Monte Carlo Study." *Oxford Bulletin of Economics and Statistics*, 70, 271-282.

Nagar, Venky (2002). "Delegation and Incentive Compensation." *The Accounting Review* Vol. 77, No. 2 (April 2002): 379-395.

Norton, Seth W. (1988). "An Empirical Look at Franchising as an Organizational Form." *Journal of Business* Vol. 61, No. 2: 197-218.

Oyer, Paul (2004). "Why Do Firms Use Incentives That Have No Incentive Effects." *Journal of Finance*, Vol. LIX, No. 4, pp. 1619-1649.

Oyer, Paul, and Scott Schaefer (2005). "Why Do Some Firms Give Stock Options to All Employees?: An Empirical Examination of Alternative Theories." *Journal of Financial Economics* 76: 99-133.

Prendergast, Canice (2002). "The Tenuous Tradeoff Between Risk and Incentives." *Journal of Political Economy* Vol. 110, No. 5 (October 2002): 1071-1102.

Raith, Michael (2003). "Competition, Risk, and Managerial Incentives." *American Economic Review*, Vol. 93, 1425 – 1436.

Raith, Michael (2005). "Specific Knowledge and Performance Measurement." Working Paper, University of Rochester (November 2005).

Rao, C. H. Hanumantha (1971). "Uncertainty, Entrepreneurship, and Sharecropping in India." *Journal of Political Economy* Vol. 79, No. 3 (May-June 1971): 578-595.

Serfes, Konstantinos (2005). "Risk Sharing vs. Incentives: Contract Design Under Two-sided Heterogeneity." *Economics Letters*, Vol. 88, 343 – 349.

Shavell, S. (1979). "Risk Sharing and Incentives in the Principal and Agent Relationship,"*Bell Journal of Economics*, 1979, 10 (1), 55–73.

Shi, Lan (2005). "Respondable Risk and Incentives for CEOs: the Role of Information-collection and Decision-making." Working Paper, University of Washington (November 2005).

Wilde, Joachim (2000). "Identification of Multiple Equation Probit Models with Endogenous Dummy Regressors." *Economics Letters* 69, 309-312.

Wulf, Julie (2007). "Authority, Risk, and Performance Incentives: Evidence from Division Manager Positions Inside Firms." *Journal of Industrial Economics*, Volume 55, Issue 1, 169-196.

34

Yermack, David (1995). "Do Corporations Award CEO Stock Options Effectively."
    Journal of Financial Economics 39: 237-269.

Zabojnik, Jan (1996). "Pay-Performance Sensitivity and Production Uncertainty.
    Economic Letters 53: 291-296.

Table 1: Descriptive Statistics

	Mean	Min	Max	Median	Std. Dev.
Basic Firm Characteristics:					
Risk	0.218	0	1	0	0.388
Single-Establishment Firm	0.350	0	1	0	0.435
Fixed Term Workers Over One Year	0.140	0	1	0	0.401
Fixed Term Workers Under One Year	0.233	0	1	0	0.493
Operation Over Five Years	0.899	0	1	1	0.297
Main Activity of Establishment	0.686	0	1	1	0.457
Temporary Workers	0.193	0	1	0	0.483
Establishment Size	0.062	0.002	28.971	0.106	0.928
Fraction of Part Time Workers	0.310	0	1	0.132	0.287
Number of Recognized Unions	0.637	0	10	1	1.893
100% Workers Unionized	0.236	0	1	0	0.444
80-99% Workers Unionized	0.045	0	1	0	0.323
60-79% Workers Unionized	0.035	0	1	0	0.251
40-59% Workers Unionized	0.018	0	1	0	0.178
20-39% Workers Unionized	0.007	0	1	0	0.097
1-19% Workers Unionized	0.016	0	1	0	0.132
0% Workers Unionized	0.644	0	1	0	0.500
Firm Ownership:					
Private Sector Publicly-Traded Non-franchise	0.016	0	1	0	0.122
Private Sector Publicly-Traded Franchise	0.329	0	1	0	0.495
Private Sector Non-franchise	0.027	0	1	0	0.109
Private Sector Franchise	0.469	0	1	0	0.473
Industry:					
Manufacturing	0.166	0	1	0	0.376
Electricity, Gas, and Water	0.002	0	1	0	0.176
Construction	0.041	0	1	0	0.209
Wholesale and Retail	0.235	0	1	0	0.382
Hotels and Restaurants	0.088	0	1	0	0.256
Transport and Communication	0.048	0	1	0	0.246
Financial Services	0.039	0	1	0	0.232
Other Business Services	0.115	0	1	0	0.315
Public Administration	0.020	0	1	0	0.176
Education	0.098	0	1	0	0.293
Health	0.110	0	1	0	0.297
Other Community Services	0.038	0	1	0	0.209
Largest Occupational Group at Workplace:					
Managers and Administrators	0.006	0	1	0	0.075
Professional Occupations	0.099	0	1	0	0.326
Associate Professional and Technical Operations	0.056	0	1	0	0.267
Clerical and Secretarial Occupations	0.145	0	1	0	0.349
Craft and Skilled Service Occupations	0.132	0	1	0	0.324
Personal and Protective Service Occupations	0.170	0	1	0	0.333
Sales Occupations	0.162	0	1	0	0.343
Plant and Machine Operatives	0.138	0	1	0	0.365
Other Occupations	0.092	0	1	0	0.319
Incentive Pay:					
Performance Pay	0.196	0	1	0	0.440
Worker Authority:					
Authority1	0.078	0	1	0	0.277
Authority2	0.078	0	1	0	0.244
Authority3	0.526	0	1	1	0.495
Authority4	0.317	0	1	0	0.451
$\text{AUTHORITY}_{\text{HOW}}(\text{W})1$	0.032	0	1	0	0.141

AUTHORITY$_{HOW}$(W)2	0.307	0	1	0	0.443
AUTHORITY$_{HOW}$(W)3	0.660	0	1	1	0.453
AUTHORITY$_{HOW}$(F)1	0.072	0	1	0	0.276
AUTHORITY$_{HOW}$(F)2	0.209	0	1	0	0.445
AUTHORITY$_{HOW}$(F)3	0.441	0	1	0	0.496
AUTHORITY$_{HOW}$(F)4	0.278	0	1	0	0.410
Sample Size = 1590					

Note: Tabulations are for the 1590 establishments in the private sector for which data on both risk and incentives are non-missing and excluding those establishments in public administration. Some of the above statistics are based on a smaller sample, however, due to missing values. *Establishment Size* is measured in thousands.

Table 2: Evidence of a Tradeoff Between Risk and Incentives

Independent Variables:	Dependent Variable: Performance Pay		
Risk	-0.039	-0.061*	-0.051*
	(0.046)	(0.039)	(0.036)
Industry Controls:			
Manufacturing		-0.123***	-0.108***
		(0.027)	(0.026)
Electricity, Gas, and Water		-0.060	-0.100***
		(0.045)	(0.018)
Construction		-0.120***	-0.107***
		(0.027)	(0.023)
Hotels and Restaurants		-0.128***	-0.108***
		(0.026)	(0.022)
Transport and Communication		-0.078*	-0.083***
		(0.042)	(0.027)
Financial Services		0.115	0.064
		(0.087)	(0.083)
Other Business Services		-0.095***	-0.078***
		(0.031)	(0.028)
Public Administration		-0.109***	-0.111***
		(0.033)	(0.022)
Education		-0.171***	-0.156***
		(0.023)	(0.026)
Health		-0.194***	-0.167***
		(0.023)	(0.021)
Other Community Services		-0.121***	-0.101***
		(0.024)	(0.021)
Firm Controls:			
Single-Establishment Firm			0.003
			(0.033)
Fixed Term Workers Over One Year			-0.011
			(0.048)
Fixed Term Workers Under One Year			0.041
			(0.029)
Private Sector Publicly-Traded Non-franchise			0.058
			(0.123)
Private Sector Publicly-Traded Franchise			-0.017
			(0.068)
Private Sector Non-franchise			0.089
			(0.173)
Private Sector Franchise			-0.093
			(0.070)
Operation Over Five Years			0.040
			(0.032)
Main Activity of Establishment			0.083**
			(0.032)
Temporary Workers			0.017
			(0.029)
Establishment Size			0.036
			(0.024)
Fraction of Part Time Workers			-0.130**
			(0.056)
Number of Recognized Unions			0.017
			(0.013)
100% Workers Unionized			-0.070

38

			(0.047)
80-99% Workers Unionized			-0.045
			(0.041)
60-79% Workers Unionized			-0.005
			(0.045)
40-59% Workers Unionized			-0.106
			(0.068)
20-39% Workers Unionized			0.035
			(0.102)
1-19% Workers Unionized			-0.169
			(0.106)
Sample Size	1546	1546	1546

Note: Results are probit marginal effects evaluated at the mean of the independent variable or, for binary independent variables, the change in predicted probabilities when the independent variable increases from 0 to 1 (evaluating all other covariates at their means). Robust standard errors are in parentheses; *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, using a one-tailed test for *Risk* and two-tailed tests for all other covariates. Reference group for industry dummies is *Wholesale and Retail*. Reference group for % unionized dummies is *0% Workers Unionized*.

Table 3: Relationship Between Incentive Pay and Worker Authority

Independent Variables:	Dependent Variable: Performance Pay		
Authority2	0.028	-0.037	-0.025
	(0.110)	(0.083)	(0.069)
Authority3	-0.012	0.014	0.000
	(0.087)	(0.064)	(0.052)
Authority4	0.069	0.110**	0.100**
	(0.090)	(0.066)	(0.057)
Industry Controls	NO	YES	YES
Firm Controls	NO	NO	YES
Sample Size	1245	1245	1245

Note: Results are probit marginal effects evaluated at the mean of the independent variable or, for binary independent variables, the change in predicted probabilities when the independent variable increases from 0 to 1 (evaluating all other covariates at their means). Robust standard errors are in parentheses; *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, using a one-tailed test for *Authority2, Authority3, Authority4*. See Appendix for definitions of industry and firm controls.

Table 4: Relationship Between Worker Authority and Risk

Independent Variables:	Dependent Variable: Authority		
Risk	0.084*	0.094**	0.119**
	(0.055)	(0.052)	(0.053)
Industry Controls	NO	YES	YES
Firm Controls	NO	NO	YES
Sample Size	1245	1245	1245

Note: Results are probit marginal effects for Prob($Authority$ = 4) evaluated at the mean of the independent variable or, for binary independent variables, the change in the predicted Prob($Authority$ = 4) when the independent variable increases from 0 to 1 (evaluating all other covariates at their means). Robust standard errors are in parentheses; *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, using a one-tailed test for $Risk$. See Appendix for definitions of industry and firm controls.

TABLE 5: Testing the Main Prediction of Prendergast (2002)

	Probit						Bivariate Probit	
	Dependent Variable: Performance Pay						Dependent Variable: Performance Pay	Dependent Variable: Authority4
Independent Variables:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Risk	-0.051	-0.057	-0.065*	-0.074*	-0.057*	-0.068**	-0.075 [-0.412]**	0.139 [0.405]**
	(0.052)	(0.052)	(0.043)	(0.041)	(0.040)	(0.039)	(0.235)	(0.174)
Authority2		0.025		-0.043		-0.032		
		(0.110)		(0.084)		(0.070)		
Authority3		-0.013		0.010		-0.001		
		(0.088)		(0.067)		(0.055)		
Authority4		0.071		0.113*		0.104**	0.172 [0.947]	
		(0.092)		(0.069)		(0.060)	(0.757)	
Industry Controls	NO	NO	YES	YES	YES	YES	YES	YES
Firm Controls	NO	NO	NO	NO	YES	YES	YES	YES
P							-0.209	
							(0.437)	
Sample Size	1245	1245	1245	1245	1245	1245	1245	1245

Note: Results in the first 6 columns are probit marginal effects for Prob(*Performance Pay* = 1) evaluated at the mean of the independent variable or, for binary independent variables, the change in the predicted Prob(*Performance Pay* = 1) when the independent variable increases from 0 to 1 (evaluating all other covariates at their means), with robust standard errors in parentheses. For the bivariate probit results in the last 2 columns, marginal effects are displayed to the left of the parameter estimates and their robust standard errors (in square brackets and parentheses, respectively); ρ denotes the correlation between the disturbances in the two equations. In the entire table, *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, using a one-tailed test for *Risk, Authority2, Authority3, and Authority4*. See Appendix for definitions of industry and firm controls.

Table 6: Test of Prendergast's Main Prediction with Alternative Measures of Worker Authority

Independent Variables:	Dependent Variable: Performance Pay					
	(1)	(2)	(3)	(4)	(5)	(6)
Risk	-0.057* (0.040)	-0.067** (0.039)	-0.057* (0.040)	-0.065** (0.039)	-0.059* (0.039)	-0.067** (0.038)
Authority2		-0.032 (0.070)		-0.029 (0.067)		-0.023 (0.066)
Authority3		-0.001 (0.055)		0.000 (0.054)		0.007 (0.055)
Authority4		0.105** (0.060)		0.113** (0.059)		0.119** (0.059)
$\text{Authority}_{HOW}(W)2$			0.007 (0.101)	0.014 (0.103)		0.003 (0.103)
$\text{Authority}_{HOW}(W)3$			0.018 (0.098)	-0.009 (0.100)		-0.025 (0.100)
$\text{Authority}_{HOW}(F)2$					0.087** (0.050)	0.089** (0.047)
$\text{Authority}_{HOW}(F)3$					0.038 (0.048)	0.042 (0.047)
$\text{Authority}_{HOW}(F)4$					0.071* (0.050)	0.055 (0.047)
Firm and industry controls	YES	YES	YES	YES	YES	YES
Sample Size	1241	1241	1241	1241	1241	1241

Note: Results are probit marginal effects for Prob(*Performance Pay* = 1) evaluated at the mean of the independent variable or, for binary independent variables, the change in the predicted Prob(*Performance Pay* = 1) when the independent variable increases from 0 to 1 (evaluating all other covariates at their means). Robust standard errors are in parentheses; *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively, using one-tailed tests. Firm and industry controls are those listed in Table 2; see the Appendix for their definitions.