

## Testing Agency Theory with Entrepreneur Effort and Wealth

MARIANNE P. BITLER, TOBIAS J. MOSKOWITZ,  
and ANNETTE VISSING-JØRGENSEN\*

### ABSTRACT

We develop a principal-agent model in an entrepreneurial setting and test the model's predictions using unique data on entrepreneurial effort and wealth in privately held firms. Accounting for unobserved firm heterogeneity using instrumental-variables techniques, we find that entrepreneurial ownership shares increase with outside wealth and decrease with firm risk; effort increases with ownership; and effort increases firm performance. The magnitude of the effects in the cross-section of firms suggests that agency costs may help explain why entrepreneurs concentrate large fractions of their wealth in firm equity.

THE THEORY OF THE FIRM HAS PAID EXTENSIVE ATTENTION to the moral hazard conflict between managers and outside shareholders (e.g., Jensen and Meckling (1976)). Resolution of agency conflicts through optimal contracting has been the focus of much of the literature, which makes predictions concerning

1. The nature of the optimal contract—the design of managerial compensation to increase the manager's incentive to maximize shareholder value.
2. The effect of the contract on the actions of managers—better-aligned incentives, measured as either higher managerial equity ownership or

\*Bitler is from the Public Policy Institute of California, the RAND Corporation, and IZA; Moskowitz is from University of Chicago and NBER; and Vissing-Jørgensen is from Northwestern University CEPR, and NBER. We are grateful to an anonymous referee, Bill Gentry, Rick Green, Steven Haider, John Heaton, Dirk Jenter, Arthur Kennickell, John Krainer, Nicole Maestas, Jay Ritter, Antoinette Schoar, Per Stromberg, John Wolken, Bilge Yilmaz, and seminar participants at Carnegie Mellon University, University of Wisconsin (Milwaukee and Madison), University of British Columbia, Ohio State University, the Board of Governors of the Federal Reserve, the Federal Reserve Bank of Minneapolis, the Department of Justice, the Center for Economic Studies at the Census, the Society of Economic Dynamics, the 2002 Western Finance Association meetings, the 2002 SOLE meetings, the University of Chicago Macro lunch, the NBER Entrepreneurship and Corporate Finance meetings, and the 2004 AEA session on entrepreneurship in San Diego for helpful comments and suggestions. We also thank Troy Andre for outstanding research assistance in numerically solving the model. Bitler thanks the National Institute for Child Health and Development, the National Institute on Aging, the Federal Reserve Bank of San Francisco, and the RAND Corporation, for financial support. Moskowitz thanks the Center for Research in Security Prices and the James S. Kemper Faculty Research Fund at the University of Chicago for financial support. Vissing-Jørgensen thanks the National Science Foundation for support. Much of this work was completed while the first author was at the Board of Governors of the Federal Reserve and the last author was at the Department of Economics, University of Chicago. The views expressed here are those of the authors and not necessarily those of the Federal Reserve.

heightened pay–performance sensitivity, should increase managerial effort and decrease perquisite consumption.

### 3. The effect of managerial actions on firm performance.

We apply agency theory to an entrepreneurial setting by augmenting the standard principal-agent framework. We then test the model's implications using unique data on entrepreneurial effort and wealth in privately held firms. We find direct evidence supporting the model's predictions from two different data sources, using instrumental-variables techniques to address endogeneity issues.

In the model, a risk-averse entrepreneur seeking financing wishes to sell part of his equity stake to outside investors concerned with moral hazard. The ownership structure, entrepreneurial effort, and size of the firm are determined endogenously. The model confirms that the standard predictions of agency theory apply in an entrepreneurial setting and in the presence of endogenously chosen firm size. A few novel testable implications are generated as well.

We then test the model's predictions using a three-stage approach. The data used provide previously unexplored measures of entrepreneurial effort and wealth. This allows us to test additional implications of the theory not emphasized in previous empirical articles. In the first stage, we examine the nature of the optimal contract. Consistent with theory, managerial equity ownership shares decline with firm risk and increase with entrepreneurial wealth. In addition, entrepreneurs optimally scale back the size of their firms in response to risk, consistent with size being endogenously chosen. In the second stage, we examine how entrepreneurs respond to the incentives provided by the contract through equity ownership. Using hours worked as a measure of entrepreneurial effort, we find that effort responds positively to ownership shares, suggesting that at least part of entrepreneurs' actions respond to the incentives provided by the contract in a manner consistent with theory. Finally, in the third stage of the analysis, we show that entrepreneurial effort has a positive effect on firm performance, consistent with the underlying premise of the theory.

As emphasized by the model, since ownership, effort, and firm output are determined endogenously, unobservable differences across firms in production technologies and the contracting environment may make detection of these effects difficult in the data. We use instrumental-variables techniques to overcome endogeneity problems in testing these predictions. Comparison to ordinary least-squares (OLS) estimates highlights the importance of endogeneity in the data.

To date, evidence supporting agency theory's predictions has been mixed (see Murphy (1999) and Prendergast (2002) for reviews). Tests of agency theory have focused on the determinants of the optimal contract (e.g., Murphy (1986), Jensen and Murphy (1990), Garen (1994), Hall and Liebman (1998), and Prendergast (2002)) and on the relation between incentives and firm performance, a joint test of stages 2 and 3 (e.g., Demsetz and Lehn (1985), Morck, Shleifer, and Vishny (1988), and McConnell and Servaes (1990)). These studies mainly focus on large publicly traded firms. Our data on entrepreneurial effort

allow for separate tests of stages 2 and 3. In addition, use of private firm data provides a particularly attractive setting for testing agency theory for several reasons. First, entrepreneurial actions are likely critical for success early in the firm's life cycle. Second, agency costs are likely to be important, since there are weaker outside markets for corporate control to discipline manager behavior in privately held firms (e.g., Jensen and Ruback (1983)). Finally, contracts and measures of incentives are simplified, since options and long-term incentive plans are less frequently used in private firms.

The magnitude of the predicted effects found in the cross-section of firms suggests that agency theory may help explain the large average equity ownership of entrepreneurs and the high concentration of entrepreneurial wealth in private firms. This may aid our understanding of entrepreneurial activity and economic growth. For instance, Moskowitz and Vissing-Jørgensen (2002) find that about three-fourths of all private equity is owned by individuals for whom such investment constitutes at least half of their total net worth, and around 85% of private equity is held by owners who are actively involved in the management of the firm. Our findings suggest that at least part of the concentrated ownership of entrepreneurs may be driven by agency considerations. However, it is important to emphasize that tests of moral hazard focus on the incentive constraints of entrepreneurs. They do not explain the decision to become an entrepreneur initially. Hence, our model and results address how optimal contracting can help explain large entrepreneur equity stakes *conditional* on entry into entrepreneurship, but they do not address the initial motivation to become an entrepreneur. Given the poor diversification of entrepreneurs' wealth and the lack of a premium in private equity returns relative to public equity returns documented by Moskowitz and Vissing-Jørgensen (2002), the decision to become an entrepreneur remains somewhat puzzling.

The rest of the paper is organized as follows. Section I develops a model of optimal contracting applied to an entrepreneurial setting. Section II describes the data on private firms and entrepreneurs from two sources and presents summary statistics. Section III presents empirical results from the three-stage analysis of the determinants of entrepreneurial ownership share, the response to the contract via effort, and the effect of effort on firm performance. This section highlights problems of endogeneity and how we address them. Finally, Section IV concludes.

### **I. An Agency Model in an Entrepreneurial Setting**

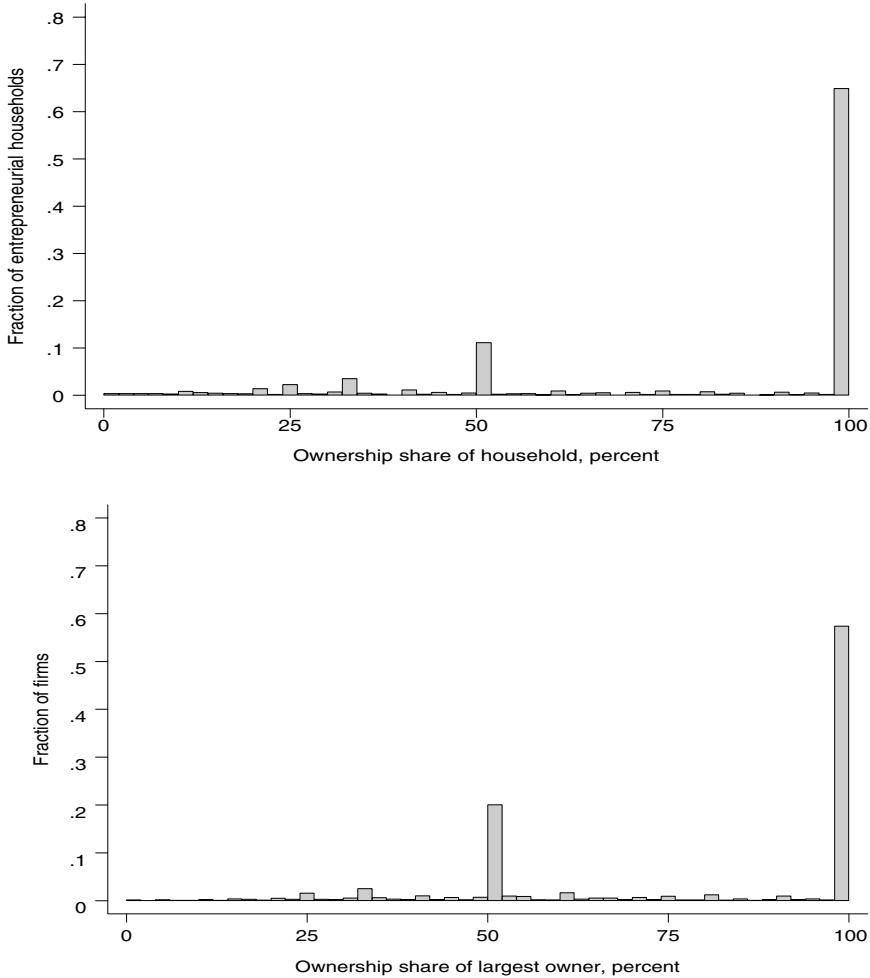
Much theoretical and empirical research focuses on the moral hazard conflict between outside shareholders (principals) and inside owners or managers (agents) of the firm. Research as early as Berle and Means (1932) recognized that when monitoring is costly and actions are partly unobservable, managers may exert less effort, consume perquisites, or invest in other nonvalue maximizing activities, such as building empires, all to the detriment of shareholder value. The agency conflict can be resolved by giving insiders total ownership of the firm, so that they bear the entire cost of such actions (Jensen and

Meckling (1976)). However, for risk-averse managers, the optimal ownership share or compensation contract will not be first best (Lazear and Rosen (1981), Harris and Raviv (1979), and Holmstrom (1979)). While there are other mechanisms that may align managerial incentives with those of shareholders such as reputational capital, competitive labor markets, and the threat of takeover or bankruptcy, the literature has viewed contracting as a more efficient mechanism. Furthermore, these other mechanisms are likely to be weak in the entrepreneurial labor market and among private firms.

We examine agency costs in an entrepreneurial setting and test the model's implications using unique data on privately held firms. We consider a risk-averse entrepreneur wishing to sell part of his equity to outside investors concerned with moral hazard. This deviates from the standard model in which outside shareholders seek to hire a manager for their firm or project, yet we show that the main implications of the standard setting hold. We add several realistic features to the model. First, capital and labor inputs are endogenously chosen by the entrepreneur simultaneously with his effort. This allows us to examine the interaction of firm size with effort and ownership. For instance, does the negative relation between risk and ownership implied by the standard agency model survive when the entrepreneur is able to scale back risky projects? Second, we employ a utility function that better captures the trade-off between consumption and leisure, allowing for wealth effects on effort. Although absolute risk aversion is typically thought to be decreasing in wealth, implying a positive relation between wealth and ownership share, more wealth also increases the desire for leisure. We examine the net effect of wealth on ownership shares. Third, issues of voting control, which are outside of the agency framework, appear to be important determinants of ownership shares in our data. Figure 1 shows that the majority of entrepreneurs own either 100 or 50% of the equity in the firm (i.e., a 50–50 split of equity between the entrepreneur and outside investors). Such clustering would not be predicted by agency costs alone. Hence, we augment the agency model to account for control issues and show that the predictions are robust to adding control conflicts.<sup>1</sup>

In addition to confirming that the main predictions of agency theory hold in an entrepreneurial setting, the model provides rough estimates of the quantitative size of the predicted effects. This is useful for judging whether a particular prediction is likely to be detected in the data. We also show that reasonable parameterizations of our model generate the large entrepreneurial ownership shares observed in the data. The model also highlights problems—generated from endogeneity issues—in interpreting empirical tests. Convincing tests of the causal effect of ownership shares on effort or effort on performance must rely on exogenous variation in these variables outside of the agency model. We discuss how control issues provide some exogenous variation in ownership shares useful for testing agency theory and also turn to instrumental variables in our empirical analysis.

<sup>1</sup> Bennesen and Wolfenzon (2000) model the optimal formation of coalitions to obtain control in an entrepreneurial setting.



**Figure 1. Distribution of principal equity ownership in privately held firms.** Using the 1989, 1992, 1995, 1998, and 2001 *Survey of Consumer Finances* and the 1993 *National Survey of Small Business Finances* and 1998 *Survey of Small Business Finances* from the Federal Reserve, the distribution of the fraction of equity owned by the entrepreneur in the SCF (top) or the principal shareholder in the (N)SSBF (bottom) in privately held firms is plotted across all firms and survey years.

*A. Basic Setup*

The basic setup of the model is as follows.

*A.1. Entrepreneur Preferences*

To allow for wealth effects on effort, the entrepreneur is given a utility function  $U(c, \mu) = \frac{1}{1-\gamma}(c^\phi(1 - \mu)^\theta)^{1-\gamma}$ , where  $\gamma$  is the coefficient of relative risk aversion,  $c$  is consumption,  $1 - \mu$  is leisure, and  $\phi$  and  $\theta$  are constants measuring

the importance of consumption and leisure. Managers have outside wealth, denoted  $W$ , which affects their disutility of effort and absolute risk aversion. For simplicity, we assume that the manager consumes a constant fraction,  $z$ , of this wealth in the current period.<sup>2</sup>

### A.2. *Production Technology*

We specify output,  $Y$ , as a Cobb–Douglas production function  $Y = AK^\alpha L^\beta \mu^\eta$ , where  $K$  is capital,  $L$  is labor, and  $\mu$  is the entrepreneur's effort. The constants  $\alpha$ ,  $\beta$ , and  $\eta$  measure the sensitivity of output to each of these inputs. The variable  $A$  is a stochastic technology shock that is uniformly distributed  $A \sim U[E(A) - \sigma, E(A) + \sigma]$ . All firm risk is idiosyncratic. The size of the firm, as measured by  $K$  and  $L$ , affects the marginal product of effort, and thus entrepreneurial effort choice and ownership share. Furthermore, since the technology shock is multiplicative, total risk increases in firm size.

### A.3. *Capital and Labor Markets*

The price of the firm's output is assumed to equal 1.<sup>3</sup> The firm can hire labor at the wage rate  $w$  and rent capital at a rate  $p$ . We could alternatively assume that the firm finances capital with debt. We assume that entrepreneurs do not have limited liability, and thus only choose plans that enable them to pay labor and capital fully for all realized values of  $A$  (to avoid zero consumption). Any debt would thus be riskless.

## B. *The Optimal Contract*

The timing of the model is as follows:

1. The entrepreneur meets with potential outside investors and sells part of the firm's equity.
2. Given his remaining ownership share, he then chooses  $K$ ,  $L$ , and  $\mu$  to maximize utility.
3. Uncertainty is realized and payoffs are received.

### B.1. *No Control Issues*

We first solve the model absent any control issues. The only contract element for entrepreneurs and outside shareholders to negotiate is  $r$ , the fraction of

<sup>2</sup> For expositional ease, we simply refer to  $zW$  as wealth. What matters in our model is how much of the entrepreneur's wealth is used for current consumption. In a one-period model, we cannot address intertemporal smoothing of consumption through variation in  $z$  as a function of entrepreneurial income.

<sup>3</sup> We do not model demand uncertainty explicitly, since it would enter the model in the same way as technological uncertainty about  $A$ . The randomness in  $A$  can thus be thought of as capturing both technological and demand-side uncertainty.

equity retained by the entrepreneur. The remaining fraction of firm equity,  $1 - r$ , is sold to outside investors who receive this fraction of firm profits,  $\pi$ , after production is realized. Since all firm risk is idiosyncratic, competitive capital markets imply that outside investors pay an amount  $k(r)$  for the share  $1 - r$  of the firm, given by

$$\begin{aligned} k(r) &= E[(1 - r)\pi] \\ &= (1 - r)(E(A)K^\alpha L^\beta \mu^\eta - wL - pK). \end{aligned} \quad (1)$$

Given  $k(r)$  and  $r$ , the entrepreneur chooses his optimal input bundle of effort  $\mu(r)$ , capital  $K(r)$ , and labor  $L(r)$ . In setting the production inputs, the entrepreneur and outside investors, who are symmetrically informed, know  $E(A)$  and  $\sigma$ , but do not yet know the realization of  $A$ . After production takes place and the technology shock  $A$  is realized, the entrepreneur consumes his payoff from the firm,

$$\begin{aligned} k(r) + r\pi &= (1 - r)(E(A)K^\alpha L^\beta \mu^\eta - wL - pK) + r(AK^\alpha L^\beta \mu^\eta - wL - pK) \\ &= E(A)K^\alpha L^\beta \mu^\eta - wL - pK + r(A - E(A))K^\alpha L^\beta \mu^\eta, \end{aligned}$$

plus a constant fraction  $z$  of his outside wealth  $W$ .<sup>4</sup>

The entrepreneur chooses production inputs to solve the following maximization problem:

$$\begin{aligned} \max_{\mu, K, L} E(U) &= \max_{\mu, K, L} E\left(\frac{1}{1 - \gamma}(c^\phi(1 - \mu)^\theta)^{1 - \gamma}\right) \\ \text{s.t. } c &= k + r(AK^\alpha L^\beta \mu^\eta - wL - pK) + zW. \end{aligned} \quad (2)$$

The first-order conditions with respect to each of the inputs  $\mu(r)$ ,  $K(r)$ , and  $L(r)$  are:

$$\frac{\partial E(U)}{\partial \mu} = E((c^\phi(1 - \mu)^\theta)^{-\gamma} [\phi c^{\phi-1}(1 - \mu)^\theta r A K^\alpha L^\beta \eta \mu^{\eta-1} - c^\phi \theta (1 - \mu)^{\theta-1}]) = 0 \quad (3)$$

$$\frac{\partial E(U)}{\partial K} = E((c^\phi(1 - \mu)^\theta)^{-\gamma} \phi c^{\phi-1} r (A \alpha K^{\alpha-1} L^\beta \mu^\eta - p)) = 0 \quad (4)$$

$$\frac{\partial E(U)}{\partial L} = E((c^\phi(1 - \mu)^\theta)^{-\gamma} \phi c^{\phi-1} r (A K^\alpha \beta L^{\beta-1} \mu^\eta - w)) = 0, \quad (5)$$

where expectations are taken with respect to  $A$ . The dependence of  $k(r)$  on the production inputs is not taken into account in deriving the first-order

<sup>4</sup> We do not have a separate fixed wage  $I$  as part of the entrepreneur's compensation contract as in the standard agency model. If the contract instead paid the entrepreneur  $k^*(r)$  for the fraction of the firm that is sold plus  $I + r\pi$  after production is realized, then competitive capital markets imply that  $k^*(r) = E[(1 - r)\pi] - I$ , and the entrepreneur ends up with the same amount  $k^*(r) + I + r\pi = k(r) + r\pi$ . Thus, our setting leads to the same payoff structure as in the standard setting.

conditions, since  $k(r)$  is set *before* the production inputs are chosen. However, at the time of contract negotiations, both the entrepreneur and equity investors recognize the effects of the contract  $r$  on the entrepreneur's subsequent choice of effort. Therefore, when solving the first-order conditions, we use equation (1) in the expression for consumption,  $c$ .

The model is solved numerically. We solve for  $r$ , and thus for  $\mu$ ,  $K$ , and  $L$ , across parameter variations in the level of risk  $\sigma$ , background wealth consumed  $zW$ , returns to scale to  $K$  and  $L$  ( $\alpha$  and  $\beta$ ), the expected value of the productivity constant  $A$ , and the coefficient of relative risk aversion  $\gamma$ , holding all other parameters fixed. Table I reports the numerical solutions across parameterizations along with expected firm profit and the standard deviation of the profit-to-equity ratio. The baseline solution sets  $\sigma = 0.50$ ,  $\gamma = 5$ ,  $zW = 500$ ,  $\alpha = \beta = 0.4$ , and  $E[A] = 3$ . Appendix A provides a brief discussion of the numerical methods employed and justification of the choice of parameters for model calibration.

As Table I shows, the model generates the large entrepreneurial ownership shares observed in the data under reasonable parameterizations. However, the model does not predict the distinct clustering of ownership shares at 50 and 100% that are predominant in the data.

### *B.2. Adding Control Issues*

To capture the clustering of ownership shares in the data, we add voting control issues to our agency model. Agency and control issues are not necessarily competing theories. Agency is concerned with providing the entrepreneur incentives when his actions are unobservable. Control rights matter for voting when there is disagreement about a course of action based on observable information. Both are likely to be important. Essentially, control dictates that no one wants to be a minority shareholder. We add control issues to our model by allowing the entrepreneur to choose only between ownership shares of 50 or 100%. Hence, the entrepreneur simply chooses between keeping all of the equity or selling half to outsiders. Entrepreneurs for which the optimal  $r$  without consideration of control issues is high choose  $r = 1$  when control issues are taken into account. Those with lower optimal  $r$  choose  $r = 0.5$ . Thus, agency determines which entrepreneurs choose ownership structures of 0.5 or 1.

We solve the model with and without control issues to show that the predictions are robust to the inclusion of voting control issues. As discussed in the next section, control issues also provide useful variation in ownership shares unrelated to agency for testing the theory's predictions.

### *C. Empirical Predictions*

Based on the numerical solutions, the model generates the following predictions.

**Table I**  
**Numerical Solutions to the Agency Model**

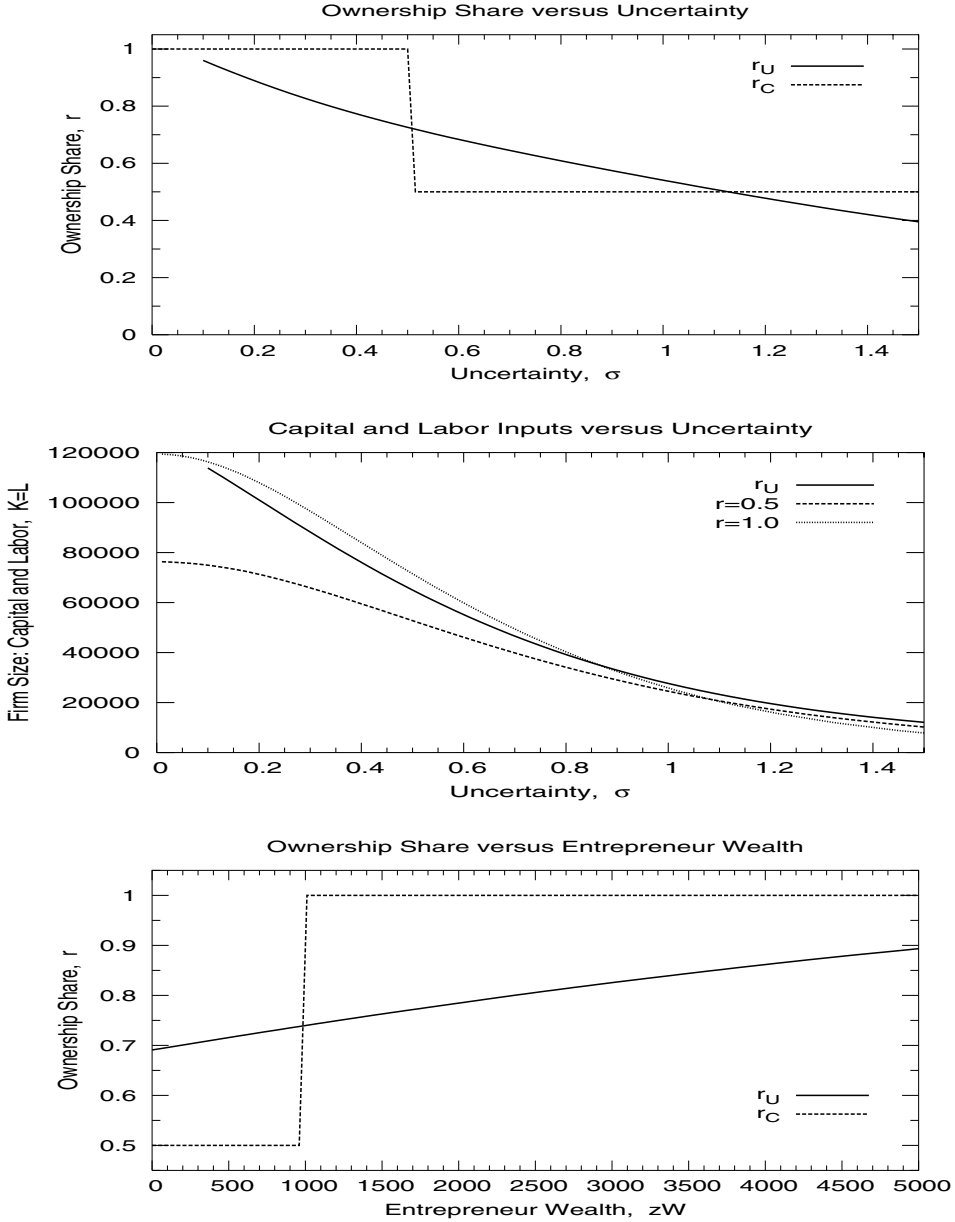
Numerical solutions to the agency model of Section I are reported for a variety of parameterizations. The solution for entrepreneur ownership share  $r$ , entrepreneur effort  $\mu$ , capital and labor inputs  $K$  and  $L$ , the implied value of expected profit  $\pi$ , and a measure of risk that is the standard deviation of the profit-to-equity ratio ( $\sigma(\pi/Eq)$ ) are reported across parameter variations in the level of risk  $\sigma$ , background wealth consumed  $zW$ , production function coefficients on labor ( $\alpha$ ) and capital ( $\beta$ ) (returns to scale to  $L, K$ ), expected value of the productivity constant  $A$ , and the coefficient of relative risk aversion  $\gamma$ , holding other parameters fixed. For computational ease (i.e., to avoid a three-dimensional grid search), the level and productivity of capital and labor are set equal to each other (i.e.,  $\alpha = \beta$  and  $K = L$ ). The baseline solution sets  $\sigma = 0.5$ ,  $\gamma = 5$ ,  $zW = 500$ ,  $\alpha = \beta = 0.4$ , and  $E[A] = 3$ . For all numerical solutions, the following parameters are held constant: the utility function parameter constants  $\phi = \theta = 0.5$ , the per unit costs of labor and capital  $w = p = 0.1$ , and the marginal product of the entrepreneur's effort  $\eta = 0.2$ . See Appendix A for a justification of the choice of parameters for model calibration.

	$\phi = \theta = 0.5, w = p = 0.1, \eta = 0.2$				
	Ownership $r$	Effort $\mu$	Size $K = L$	Expected Profit $E[\pi]$	Risk $\sigma(\pi/Eq.)$
Baseline $\sigma = 0.5, \gamma = 5, zW = 500,$ $\alpha = \beta = 0.4, E[A] = 3$	0.716	0.361	62,638	4,304	0.376
Risk					
$\sigma = 0.7$	0.640	0.307	43,444	3,470	0.472
$\sigma = 0.3$	0.817	0.416	87,656	5,128	0.255
Background wealth					
$zW = 0$	0.691	0.381	64,487	4,513	0.371
$zW = 1000$	0.740	0.343	60,749	4,101	0.381
$zW = 5000$	0.894	0.213	43,923	2,620	0.419
Returns to scale/productivity of inputs					
$\alpha = \beta = 0.41$	0.689	0.392	257,658	16,519	0.396
$\alpha = \beta = 0.39$	0.767	0.312	18,907	1,369	0.362
$\alpha = \beta = 0.38$	0.848	0.238	6,392	478	0.354
Production function constant					
$E[A] = 4.0$	0.758	0.410	335,239	21,029	0.302
$E[A] = 1.7$	0.953	0.070	863	51	0.749
$E[A] = 4.0, zW = 0$	0.753	0.414	337,683	21,247	0.302
$E[A] = 1.7, zW = 0$	0.544	0.280	1,832	171	0.534
Risk aversion					
$\gamma = 2$	0.777	0.397	78,742	4,854	0.408
$\gamma = 7$	0.694	0.345	56,025	4,053	0.362
$\gamma = 9$	0.680	0.334	51,209	3,861	0.352

### Stage 1: The Contract

PREDICTION 1: *Ownership share,  $r$ , decreases with firm risk,  $\sigma$ .*

The first plot in Figure 2 shows how the entrepreneur's equity ownership share decreases with risk for both the pure agency model and the model with control issues. This prediction is driven by the risk aversion of the entrepreneur



**Figure 2. Ownership and size versus risk and wealth.** Numerical solutions to the agency model of Section I for ownership share  $r$  (the first figure) and size inputs  $K = L$  (the second figure) are plotted against variation in the risk parameter  $\sigma$ , holding all other parameters constant:  $\gamma = 5, zW = 500, \alpha = \beta = 0.4, E[A] = 3, \phi = \theta = 0.5, w = p = 0.1,$  and  $\eta = 0.2$ . The third figure plots ownership share  $r$  against variation in the wealth parameter  $zW$ , holding the same parameters constant (except wealth) and  $\sigma = 0.5$ . Solutions to both the unconstrained model in which ownership share can take on any value ( $r_u$ ) and the constrained model with control rights in which ownership share only takes on the value 0.5 or 1 ( $r_c$ ) are plotted.

and is consistent with standard agency models. The reduction in ownership due to risk is somewhat modest, however. For risk aversion of  $\gamma = 5$ , a 40% increase in the range of  $A$  (from 1 to 1.4) only reduces ownership share from 72- to 64-percentage points (Table I). This is in part due to the endogeneity of firm size, since the entrepreneur scales back riskier projects.

The ability to scale back risky projects is interesting in itself, because a model without agency problems and with fully diversified investors would not generate scaling back in response to idiosyncratic risk. Hence, another testable prediction from our model is

PREDICTION 2: *Firm size decreases with firm risk,  $\sigma$ .*

The second plot in Figure 2 shows how labor and capital inputs decline with firm risk, both excluding and including control issues. Given the predicted relation between risk and size, as well as the relation between ownership and size discussed below, it is important to control for size in empirical tests of Prediction 1.

PREDICTION 3: *Ownership share,  $r$ , increases with entrepreneurial outside wealth,  $W$ .*

The third plot in Figure 2 shows this clearly with and without control issues. Given constant relative risk aversion preferences, absolute risk aversion is decreasing in wealth. Therefore, wealthier entrepreneurs tolerate more risk and are willing to take a higher ownership share in order to move their effort closer to first best. If outside wealth is high enough, an entrepreneur optimally owns all firm equity and eliminates the agency conflict. Note that the model preserves a positive relation between wealth and ownership even when there is a negative wealth effect on effort.

The final prediction in stage 1 concerns the relation between ownership and firm size.

PREDICTION 4: *Ownership share,  $r$ , and firm size.*

1. *If differences in size across firms are driven by differences in the degree of returns to scale to capital and labor (e.g.,  $\alpha$  and  $\beta$ ), then ownership share decreases with firm size.*
2. *If differences in firm size are driven by differences in the value of  $E(A)$ , then the relation between ownership share and firm size is ambiguous.*

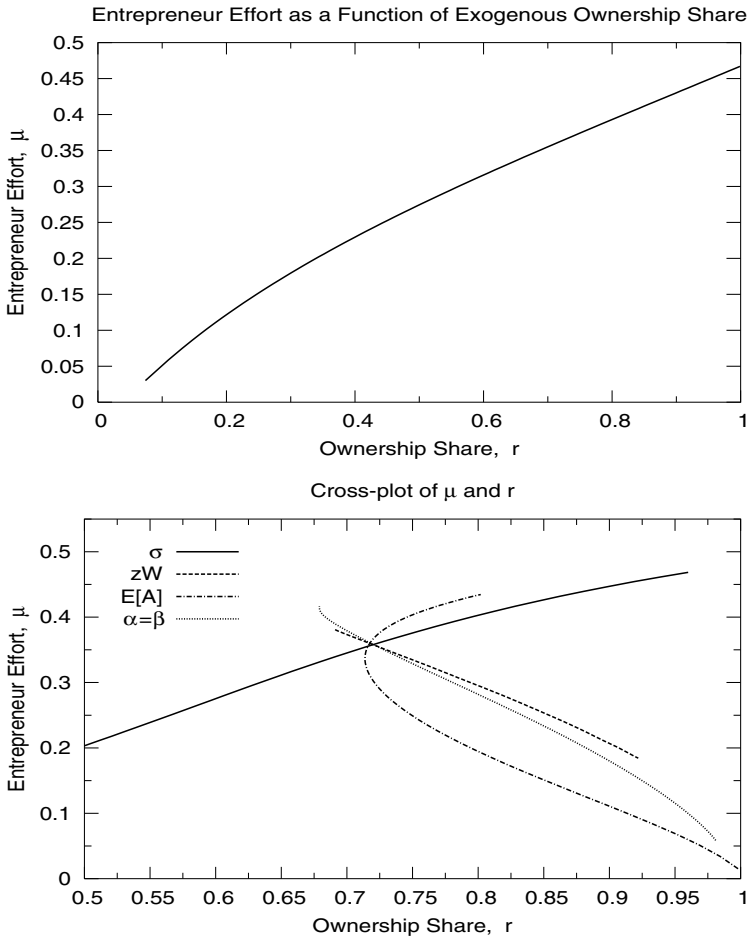
As the production technology improves, firm size increases, and there is more risk to be shared. On the other hand, there is also a wealth effect on the entrepreneur's ability to absorb risk. The net effect depends on the type of technology difference between small firms and large firms and the initial wealth of the entrepreneur. As Table I indicates,  $E[A]$  and  $r$  are negatively related when consumed wealth is high, but are positively related when consumed wealth is low. Given the ambiguous relation between firm size and ownership share, this relation is not informative about the validity of agency theory. Therefore, aside from our tests of Prediction 2, we simply include firm size as a control variable

when testing the other predictions. Note, finally, that ownership share is decreasing with risk aversion in our model even when firm size is endogenously determined.

**Stage 2: Response to the Contract**

PREDICTION 5: *Entrepreneurial effort,  $\mu$ , increases with ownership share,  $r$ , when  $r$  is varied exogenously and  $\mu$ ,  $K$ , and  $L$  solve the FOCs in equations (3), (4), and (5).*

The first plot in Figure 3 demonstrates that effort  $\mu$  is monotonically increasing in ownership share  $r$  when  $r$  is varied *exogenously*. However, the positive



**Figure 3. Effort versus exogenous and endogenous variation in ownership share.** The first figure plots effort  $\mu$  against ownership share  $r$  when  $r$  is varied *exogenously*. The second figure plots effort ( $\mu$ ) against ownership ( $r$ ) for endogenous variation in ownership due to changes in risk ( $\sigma$ ), wealth ( $zW$ ), and firm technology ( $E[A]$  and  $\alpha = \beta$ ).

relation between ownership and effort does not generally hold for endogenous variation in ownership share. The second plot in Figure 3 illustrates this by plotting the relation between effort ( $\mu$ ) and ownership ( $r$ ) for variation in ownership due to changes in risk ( $\sigma$ ), wealth ( $zW$ ), and firm technology ( $E[A]$  and  $\alpha = \beta$ ). As the figure shows, endogenous variation in  $r$  can generate a positive, negative, or ambiguous relation between effort and ownership. This will make detection of the causal positive relation in Prediction 5 difficult in the data. Hence, it will be important to find exogenous variation in ownership shares to test this prediction.

### Stage 3: Performance

PREDICTION 6: *Firm performance,  $Y$ , increases with entrepreneurial effort,  $\mu$ .*

Although this is assumed by the model, it is also empirically testable, if effort can be measured. Lacking data on effort, the relation between firm performance and ownership share,  $r$ , is typically examined, which is a joint test of Predictions 5 and 6. Our data provide a glimpse of the actions taken by the manager in the form of the number of hours worked, allowing us to test these predictions separately.

It is worth noting, however, that theoretically, entrepreneurial effort,  $\mu$ , pertains to the entire action set of the entrepreneur. That is, the contract (ownership share) is designed not only to induce more effort from the manager, but also to force him to make value-maximizing decisions. Since empirically we can only estimate one aspect of the entrepreneur's actions using the number of hours worked, ownership share may still provide some explanatory power for firm performance, potentially capturing other aspects of the entrepreneur's actions not observable in the data. Here, too, controlling for endogeneity is important for detecting an empirical link from effort or ownership to firm performance.

#### *C.1. Limitations of the Model and Their Empirical Significance*

Our model is designed to motivate and guide our empirical analysis. We discuss briefly some of the limitations of the model and their potential impact on our empirical results. First, the model is static. However, dynamic principal-agent models generally yield the same qualitative predictions (Holmstrom and Milgrom (1987)). It is difficult to say whether the magnitude of the predicted effects would be similar, but our data do not offer a time-series dimension in any case. Second, we consider only a simple linear contract consisting of ownership share. This seems reasonable for our data, since private-firm compensation contracts do not typically contain bonuses, options, or other incentive schemes. In addition, the literature finds that linear contract rules typically generate optimal contracts and effects similar to those obtained from expanding the contract set to include nonlinear compensation (see Holmstrom and Milgrom (1987), Schattler and Sung (1993), and Sung (1995)). Finally, our model focuses on ownership structure, inside versus outside equity, firm size, and effort. A key element not considered in our model or empirical work is the role of debt.

Heaton and Lucas (2002) provide a model of entrepreneurial investment in which projects are financed by the entrepreneur's personal wealth and/or outside debt. Outside equity is not considered in their model. We are not aware of any models that simultaneously analyze capital structure choice (outside debt versus equity) and choice of ownership structure in a setting with a risk-averse entrepreneur. This is an interesting topic for future theoretical and empirical work, but is beyond the scope of this paper.

#### *D. Alternative Theories for Entrepreneurial Ownership*

Although we only consider agency and control issues as determinants of entrepreneurial ownership shares, other plausible theories may contribute to observed entrepreneurial holdings. For instance, variation in financial constraints across firms/entrepreneurs may explain ownership differences (stage 1). Financial constraints also predict that ownership share increases with outside wealth. Furthermore, if entrepreneurs are risk-averse, then a model with financial constraints and no agency problems would also predict a negative relation between firm risk and ownership share. Asymmetric information may also make external finance costly, causing entrepreneurs to reduce the cost of external finance by signaling project/firm quality through their ownership share (e.g., Leland and Pyle (1977)). Signaling theory also predicts a positive relation between wealth and ownership and a negative relation between risk and ownership, since signaling works through risk aversion. Although financial constraints or signaling theory provide alternative explanations for ownership shares, both here and in the previous literature, these theories primarily address the predictions in stage 1, but do not have direct implications for the effect of ownership share on the effort of the entrepreneur (stage 2) or the effect of effort on performance (stage 3).

#### *E. Existing Evidence*

Since our model makes predictions similar to those arising from the standard principal-agent framework, the empirical literature has tested some of our predictions. Given lack of data on entrepreneur wealth and effort, the focus has been on Predictions 1, 4, and the effect of ownership share on firm performance, a joint test of Predictions 5 and 6. The literature is divided on the empirical success of these predictions. Some argue that pay-performance sensitivity is too low to align incentives (Jensen and Murphy (1990)), while others disagree (Hall and Liebman (1998)).

Regarding Prediction 1, Garen (1994) and Aggarwal and Samwick (1999) find that executive pay-performance sensitivity and stock ownership in large publicly traded companies decreases with measures of firm risk such as stock return volatility. Core and Guay (2002) argue that this relation reverses sign when controlling for firm size. Prendergast (2002) reviews the literature on the relation between risk and incentives and concludes that the evidence is weak, finding if anything, a slight positive relation. Shi (2003) argues that incentives respond to different types of risk with an opposite sign.

Regarding Prediction 4, Jensen and Murphy (1990) and others have documented a negative relation between firm size and the ownership share of managers. Hall and Liebman (1998) find a positive relation. As our model (Prediction 4) emphasizes, the relation between firm size and entrepreneur ownership share is ambiguous. Shi (2003) and Core and Guay (2002) argue that controlling for firm size is important for testing the relation to risk.

There is also an extensive literature examining the relation between ownership share and firm performance. Some find a positive relation (Ang, Cole, and Wuh Lin (2000)), others a hump-shaped relation (Morck et al. (1988) and McConnell and Servaes (1990)), and others no relation (Himmelberg, Hubbard, and Palia (1999)). The endogeneity of ownership, firm inputs, and performance makes it difficult to detect the causal relations predicted by agency theory.<sup>5</sup> We attempt to address endogeneity issues through the use of instrumental-variables techniques.

Since our data have information on entrepreneurial effort (hours worked) and wealth, we can also test Predictions 3, 5, and 6 directly in addition to the previous predictions. The links between ownership and effort (stage 2) and effort and performance (stage 3) have not been extensively studied in the literature, due to a lack of data on effort.

## II. Data and Summary Statistics

We create our sample of entrepreneurs in private firms from two main sources.

### A. Survey of Consumer Finances

The first is from the 1989, 1992, 1995, 1998, and 2001 *Survey of Consumer Finances* (SCF), sponsored by the Federal Reserve Board, which provides information on individual household portfolio composition, including investment in private firms. The surveys sample about 4,000 households per survey year, with household weights designed to allow aggregation to population levels. In addition to providing information on household assets and liabilities, the survey provides information on employment status, hours worked per week, and demographics and educational attainment, as well as attributes of private firms owned by the household. The SCF is considered quite accurate and relatively free of biases (Avery, Elliehausen, and Kennickell (1988), Kennickell and Starr-McCluer (1994), Kennickell, Starr-McCluer, and Sunden

<sup>5</sup> For example, if outside investors invest more heavily in the equity of firms with better technologies (higher  $E[A]$ ), then entrepreneur ownership is low in good firms and high in bad firms, generating a spurious negative relation between ownership share and firm performance. Bernardo, Cai, and Luo (2001) show that even a positive relation may not be causal, since capital constraints may force the firm to pay managers of higher quality projects more performance-based compensation. Thus, managers receive greater performance-based pay because they manage higher quality projects, not because higher pay-performance sensitivity increases firm value.

(1997), Kennickell, Starr-McCluer, and Surette (2000), and Aizcorbe, Kennickell, and Moore (2003)). Although hours worked are self-reported to the SCF, they are not observable to outside investors and therefore are unlikely to be biased. We define hours worked as those worked at the person's main job if the person reports working in the firm and being self-employed, or the hours worked at the person's second job if the person reports working in the firm and is not self-employed but owns a business as a secondary job. If both the head of household and spouse have positive entrepreneurial hours in the firm, we take the maximum of those hours. Results involving hours worked are robust to excluding firms where both the respondent and spouse work in the firm.

We restrict the analysis to households that report owning private equity in a firm in which they have an active management interest (about 28% of respondents, given oversampling of wealthy people in the SCF), have positive net worth, are no older than 75 years, and work positive hours in firms with positive sales and market values. To reduce the influence of outliers, we drop firms that are in the bottom two or top two percentiles in terms of real annual sales, using the consumer price index for urban consumers to deflate sales values from different years of the survey, or in terms of profit-to-equity ratios. When households are active participants in multiple companies, we examine only the firms in which they have the largest investment. We drop a small group of firms with equity shares worth \$100 million or more, since industry information is not available for these. Finally, we drop a small number of entrepreneurs who say that they acquired their equity ownership share by having joined the firm/become partner/been promoted, since our model does not capture the more complicated incentive structures associated with trying to obtain promotions/making partner. These represent a small fraction of the sample.

### *B. National Survey of Small Business Finances*

Our second source of data comes from a survey of small businesses rather than from one of households, also sponsored by the Federal Reserve Board: the 1993 *National Survey of Small Business Finances* (NSSBF) and the 1998 *Survey of Small Business Finances* (SSBF). The NSSBF (SSBF) provides detailed information on 4,637 (3,561) private, nonfinancial, nonagricultural businesses with fewer than 500 employees designed to represent the population of about five million small firms in the United States in 1993 (1998). About 90% of these firms are managed by the principal shareholder. The surveys detail the demographic and financial characteristics of the firms and their principal equity holder. For more information about these surveys, see Elliehausen and Wolken (1990), Cole and Wolken (1995), and Bitler, Robb, and Wolken (2001). Our sample criteria are the same as those used in the SCF.

The small business surveys, referred to hereafter as the (N)SSBF, provides a larger, more comprehensive sample of small business finances, performance, and ownership structure. However, information about ownership shares in the (N)SSBF is for the "principal shareholder" of the firm, who may or may not

be a manager. Although we restrict our (N)SSBF sample to firms in which the manager is an owner, there may be some cases in which the principal shareholder is not a manager. We employ both data sources for robustness. For our purposes, the key differences between the SCF and small business surveys are that the former contains hours worked by the entrepreneur and entrepreneur net worth. The NSSBF does not contain either of these variables, and the SSBF contains only limited data on the principal shareholder's net worth. We employ a two-sample instrumental-variables procedure to predict managerial hours worked in the (N)SSBF based on the principal shareholder's characteristics in order to be able to test Prediction 5 in this data set as well.

### C. Summary Statistics

Panel A of Table II reports summary statistics for our sample of entrepreneurs and privately held firms in the SCF and Panel B reports those for the small business surveys. The first row of each panel indicates that ownership is highly concentrated. Entrepreneurs are typically the principal shareholder, holding on average over 80% of the firm's equity. Even among the largest decile of private firms in the (N)SSBF (based on assets or number of employees), the principal shareholder's equity ownership share averages about 65%. Figure 1 plots the distribution of equity ownership for our samples of entrepreneurs. Around 64% of entrepreneurs in the SCF own the entire firm, with another 10% owning exactly 50% of the equity. The remaining 26% of entrepreneurs is distributed more evenly across ownership shares.<sup>6</sup> The spikes at 50 and 100% ownership shares seem consistent with control rights being important. One concern might be that those entrepreneurs at 50% or those for whom ownership equals the reciprocal of the number of owners represent a partnership with other active equity holders rather than outside equity. From the perspective of agency concerns and the entrepreneur's ownership share and actions, however, the predictions of our model should still hold. Nonetheless, for robustness, we also test our model's predictions separately on the subsample of firms for which control issues are less likely to be important and the subsample for which they are likely to be important.

On average, entrepreneurs put in about 45 hours per week, with an interquartile range of 28 hours. The mean (median) total net worth of entrepreneurs is \$1.01 million (\$316 thousand) in the SCF and \$696 thousand (\$292 thousand) in the more limited data in the 1998 SSBF.<sup>7</sup>

<sup>6</sup> Since we do not use survey weights in the subsequent analysis, the histograms are based on the unweighted data in order to best show the amount of variation in the ownership shares we use.

<sup>7</sup> Entrepreneurs tend to be among the wealthiest households, as documented by Meyer (1990), Dunn and Holtz-Eakin (2000), Quadrini (1999), Gentry and Hubbard (2004), Heaton and Lucas (2000), and Hurst and Lusardi (2004). However, there is ample variation in the wealth of entrepreneurs as well as in the fraction of net worth tied to the firm. On average, about 40% of an entrepreneur's total wealth is tied up in firm equity, according to the numbers in Gentry and Hubbard (2004) and Moskowitz and Vissing-Jørgensen (2002).

Statistics on entrepreneur age, demographics, education, and experience (defined as years of full-time employment, including self-employment, in the SCF, and years of managing or owning a business, including the current business in the (N)SSBF) as well as summary statistics on the firms themselves are also reported. Proprietors and partnerships outnumber S corporations and C corporations, but the two comprise about the same total equity value in the

**Table II**  
**Summary Statistics on Entrepreneurs and Private Firms**

Summary statistics of entrepreneurial equity ownership, effort (hours worked per week), characteristics of entrepreneurs, and attributes of the private firms are reported across two data sources: The *Survey of Consumer Finances* (SCF) in Panel A (averaged across the five survey years—1989, 1992, 1995, 1998, and 2001), and the 1993 *National Survey of Small Business Finances* (NSSBF) and 1998 *Survey of Small Business Finances* (SSBF) in Panel B. The SCF sample is restricted to households that report owning private equity in a firm in which they have an active management interest, have positive net worth, are no older than 75 years, and work positive hours in firms with positive sales and market values. When households are active participants in multiple companies, we examine only the firm in which they have the largest investment. A few firms with equity shares worth 100 million or more are dropped, since industry information is not available for these. The (N)SSBF sample is restricted to firms with positive sales, managers no older than 75 years old, and firms where the manager is an owner. Both samples remove firms in the top and bottom two percentiles of sales and profit-to-equity (profit-to-assets in the (N)SSBF). Reported are the mean, median, 25<sup>th</sup> and 75<sup>th</sup> percentiles, minimum and maximum, and standard deviation of the variables. Also reported are the percentage of firms that are proprietorships and partnerships (P&P), S and C corporations (S&C), and the percentage of entrepreneurs with some college education and with a college degree, as well as gender and ethnicity information. All statistics shown are based on the samples used in our regressions. The summary statistics are calculated using survey weights in order to be representative of the underlying population.

Panel A: Survey of Consumer Finances (SCF) 1989–2001								
	Mean	Median	25%	75%	Min	Max	Standard Deviation	
%Own	85.1%	100%	75%	100%	0.6%	100%	26.6%	
Effort (hours/week)	45.3	48	32	60	1	133	20.6	
Sales (\$,000)	\$909	\$90	\$25	\$300	\$1.4	\$114,000	\$4,702	
Profits (\$,000) <sup>a</sup>	\$170	\$39	\$14	\$110	-\$1,000	\$88,800	\$866	
Equity (\$,000)	\$643	\$90	\$30	\$300	\$0.3	\$100,000	\$2,610	
No. of employees <sup>b</sup>	10.4	3	1	6	1	3,200	47.6	
Net worth (\$,000)	\$1,014	\$316	\$124	\$778	\$1.1	\$370,000	\$3,193	
Firm age	11.4	8	4	16	0	63	10.2	
Entrepreneur age	45.9	44	38	53	20	75	11.5	
Experience	21.2	21	12	30	0	61	13.1	
	P&P	S&C	Some College	College Grad	Male	African American	Hispanic	Asian
% Sample	73.1%	26.9%	23.9%	39.7%	79.9%	3.0%	3.3%	4.1%

(continued)

Table II—Continued

Panel B: Survey of Small Businesses (NSSBF) 1993, (SSBF) 1998								
	Mean	Median	25%	75%	Min	Max	Standard Deviation	
%Own	83.4%	100%	51%	100%	1%	100%	24.8%	
Assets (\$,000)	\$342	\$65	\$20	\$223	\$0.02	\$100,000	\$1,301	
Sales (\$,000)	\$731	\$168	\$60	\$500	\$4	\$32,000	\$2,174	
Profits (\$,000)	\$90	\$22	\$2.4	\$65	-\$37,800	\$31,900	\$545	
Book equity (\$,000)	\$145	\$23	\$2.9	\$99	-\$41,000	\$87,000	\$968	
No. of employees <sup>b</sup>	8.1	3	2	7	1	475	19.0	
Net worth (\$,000) <sup>c</sup>	\$696	\$292	\$127	\$674	\$0.7	\$116,000	\$2,596	
Firm age	13.4	11	6	18	0	216	10.9	
Entrepreneur age	49.0	49	41	56	19	75	10.5	
Experience	18.1	16	10	25	0	56	10.4	
	P&P	S&C	Some College	College Grad	Male	African American	Hispanic	Asian
% Sample	55.2%	44.8%	25.1%	46.4%	78.6%	3.3%	5.1%	3.9%

<sup>a</sup>Profits in the SCF include salaries reported by the entrepreneur. Such information is not available in the 1998 SSBF so for consistency profits in the (N)SSBF do not include officers' compensation.

<sup>b</sup>Including the entrepreneur.

<sup>c</sup>Only available in the 1998 SSBF.

SCF data where market value estimates are given (see Moskowitz and Vissing-Jørgensen (2002)). Prior studies that employ the small business data (e.g., Ang et al. (2000) and Nagar, Petroni, and Wolfenzon (2002)) focus exclusively on C corporations, which are less than 25% of the sample. The justification given in these studies for excluding S corporations, proprietorships, and partnerships is complications in comparing operating expenses across organizational form due to varying tax motives and other considerations. Since the predictions for stages 1 and 2 do not focus on expenses and since we focus on estimating the production function directly in stage 3, we study the more comprehensive sample of all private businesses. Use of SCF data in testing agency theory is unique.

### III. A Three-Stage Analysis: Ownership, Effort, and Performance

Our empirical tests are organized in three stages: (1) What determines entrepreneurial ownership shares? (2) How does ownership affect effort? (3) How do ownership and effort affect firm performance?

#### A. Stage 1: The Contract—What Determines Entrepreneurial Ownership?

We begin by analyzing the contract itself. Table III reports regression results of entrepreneur equity ownership shares on measures of firm risk (Prediction 1) and entrepreneur wealth (Prediction 3). Since our model predicts an effect on ownership share both for firms facing control issues and those that are not, we

**Table III**  
**What Determines Entrepreneur Equity Ownership Shares? (Stage 1)**

Regressions of entrepreneur equity ownership shares on firm risk, size, and entrepreneur wealth measures are reported. Panel A reports results for the 1989, 1992, 1995, 1998, and 2001 *Survey of Consumer Finances* (SCF). Firm risk is measured as the absolute value of the residual of the profit-to-equity ratio regressed on year dummies, log of number of employees, log of total equity value, firm age and age squared, industry dummies, education, gender, and race dummies, years of experience, dummies for how the firm was acquired (founded or given/inherited), and the variable used to instrument for risk. In the SCF, we also include an additional experience dummy for having previously been self-employed for 3 years or more in a different business. This risk measure is also instrumented with a dummy for whether the entrepreneur used personal assets as collateral for the business. Also included as regressors are the log of entrepreneurial net worth or the log of entrepreneurial net worth outside of/unrelated to the company, the log of firm market equity, log of number of employees, firm age and age squared, age and age squared of the entrepreneur, years of experience, and the additional experience dummy in the SCF), and dummies for founders, having inherited/been given the firm, gender, education, ethnicity, industry, and year. Panel B reports results for the 1993 *National Survey of Small Business Finances* (NSSBF) and 1998 *Survey of Small Business Finances* (SSBF). Regressions are identical to those in Panel A (SCF data) except total asset value replaces equity value, the risk measure is the absolute value of the residual from a profit-to-assets ratio regression, and risk is instrumented by dummy variables indicating whether the firm has exports or whether the firm primarily sells its products in the same area as the firm's main office (the omitted dummy is for those firms without exports and that sell mainly regionally or nationally in the United States) and the number and number squared of R&D employees (available only in the 1993 NSSBF). Tests of overidentifying restrictions are reported at the bottom of each panel for the instrumental-variables regressions. Regressions are repeated in both panels for the noncontrol sample (defined as firms with ownership not equal to 1/5, 1/4, 1/3, 1/2, or 1). All regressions are run using robust standard errors that account for heteroskedasticity and cross-correlated errors (*t*-statistics in parentheses). Panel C reports results from the first stage of the instrumental-variables regressions, along with  $R^2$ 's and *p*-values of the *F*-statistics for the joint significance of the instruments. Only coefficient estimates on the instruments are reported for brevity.

Regression	Dependent Variable = Ownership Share of Entrepreneur									
	Panel A: SCF (1989-2001)					Panel B: (N)SSBF (1993-1998)				
	OLS	OLS	IV <sup>(1)</sup>	OLS	IV <sup>(1)</sup>	1998 OLS	1998 OLS	IV <sup>(2)</sup>	1993 IV <sup>(3)</sup>	Noncontrol 1998 OLS
Risk, $\sigma$	-0.044 (-3.40)	-0.050 (-3.99)	-1.205 (-1.97)	-0.121 (-4.20)	-1.675 (-1.42)	-0.019 (-3.22)	-0.021 (-3.55)	-0.201 (-1.41)	-0.191 (-1.24)	-0.038 (-1.72)
log(Wealth)		0.068 (13.74)	0.102 (9.56)	0.103 (9.85)	0.144 (3.39)		0.033 (5.87)			0.051 (4.22)
log(Nonfirm Wealth)	0.021 (6.09)					0.008 (2.11)				
log(Size) <sup>a</sup>	-0.051 (-13.28)	-0.083 (-17.67)	-0.213 (-3.07)	-0.091 (-8.84)	-0.228 (-2.15)	-0.031 (-7.38)	-0.043 (-9.00)	-0.078 (-1.85)	-0.069 (-1.69)	-0.068 (-4.85)

log(Employees)	-0.031 (-7.20)	-0.031 (-7.62)	0.013 (0.53)	-0.012 (-1.57)	0.013 (0.51)	-0.059 (-11.15)	-0.059 (-11.37)	-0.022 (-0.85)	-0.026 (-1.10)	0.003 (0.19)
$R^2$	0.261	0.301		0.338		0.266	0.277			0.154
No. of observations	3,273	3,300	3,300	633	633	2,070	2,070	6,061	3,371	403
Over ID test ( <i>p</i> -values)								0.330 (0.566)	0.804 (0.370)	

Panel C: 1st Stage Instrumented Regressions for Risk,  $\sigma$

IV Regression	Collateral	Exports	Local	R&D	(R&D) <sup>2</sup>	$R^2$	<i>p</i> -values
(1) Risk, $\sigma$	-0.029 (-2.25)					0.256	0.024
(2) Risk, $\sigma$		0.126 (2.07)	-0.028 (-1.23)			0.248	0.034
(3) Risk, $\sigma$				0.019 (2.67)	-0.0002 (-2.44)	0.236	0.027

<sup>a</sup>Firm size is market value of equity for the SCF and total assets for the (N)SSBF.

employ the full sample of firms initially. However, because control issues are a large determinant of ownership share in some firms, for robustness, we also restrict the sample to firms for which control issues are not likely to be present or are weaker. These are firms in which either there is little disagreement among owners and therefore no voting contests or nothing is easily observable or verifiable and therefore cannot be voted upon. In the latter case, agency concerns affecting ownership shares may be more evident. We identify non-control firms in the data as those for which the entrepreneur does not have an ownership share of 1, 1/2, 1/3, 1/4 or 1/5, since such shares likely correspond to ownership structures with  $N$  owners holding equal shares, indicating that control is important. The share of firms with ownership shares of 1/6, 1/7, etc., is insignificant in our sample.

Panel A contains results from the SCF and Panel B from the (N)SSBF.<sup>8</sup> Entrepreneur age and age squared, firm age and age squared, entrepreneur experience, along with dummies for year, industry, entrepreneur education, gender, race/ethnicity, and for how the firm was acquired (founded or given/inherited) are included, since they may affect the production technology (or affect ownership share directly), but are omitted from the table for brevity. In the SCF we also include an additional experience dummy for having previously been self-employed for 3 years or more in a different business.<sup>9</sup>

### *A.1. Risk and Ownership*

To construct a measure of firm risk, we run a cross-sectional regression of firm profit-to-equity ratios on a constant, log of number of employees (including the entrepreneur), log of total firm equity, firm age and age squared, entrepreneur experience (and the additional experience dummy in the SCF), along with dummies for year, industry, entrepreneur education, gender, race/ethnicity, and for how the firm was acquired (founder or given/inherited). The regression also includes the variable used to instrument for risk (described below). The absolute

<sup>8</sup> All estimates are unweighted. In the SCF, we average the data across imputations before performing any calculations. Results are robust to using all five imputations and adjusting standard errors for the multiple imputation. Results using the (N)SSBF are also robust to using weights to adjust for nonresponse and adjusting for complex sampling using Taylor series linearization techniques. Information on the sampling frame for the SCF is not released publicly to reduce disclosure risk, making it infeasible to verify the robustness of the SCF results to adjusting for the complex sample.

<sup>9</sup> The 1989 public-use version of the SCF records 26 categories for the type of business the entrepreneur works. However, after 1989, the public-use version of the SCF records only seven broad categories for the line of business. These are roughly (1) farming; (2) contracting, construction, mining, oil and gas; (3) manufacturing, arts and crafts; (4) restaurants, direct sales, gas stations, food/liquor stores, other retail/wholesale; (5) auto repair, real estate, insurance, entertainment, various business services, banking and financing; (6) professional practices, beauty shops, trucking, repairs, personal services, management and consulting services, communications, writing services, transportation, educational services; and (7) other. In the (N)SSBF, industry categories are defined based on 2-digit SIC codes that are collapsed into eight broad industry dummies. Education dummies are for having some college education and for having a college degree. Race/ethnicity dummies are for Asian, Hispanic, and African American.

value of the residual from this regression is used as a proxy for firm risk, denoted  $\sigma$ . We drop observations where this risk measure is in the top 2%.

Column 1 of Table III reports OLS coefficient estimates with robust standard errors that account for heteroskedasticity and cross-correlated errors. Consistent with Prediction 1, there is a negative and significant relation between risk and ownership, although the economic effect is small. Moving from the 10<sup>th</sup> percentile of  $\sigma$  (0.06) to the 90<sup>th</sup> percentile of  $\sigma$  (0.89) reduces the ownership share by only 4-percentage points.

Since our risk measure is the absolute value of the residual from a cross-sectional regression, one might worry that this is picking up something other than risk. For example, the residual may simply pick up differences in firm technologies. If differences in technologies are correlated with different ownership structures in an asymmetric way, then the negative effect of our risk measure on ownership share could be driven by large positive residuals or by large negative residuals only. As a robustness check, we allow the coefficient on the risk measure to differ for positive and negative residuals. We find, in unreported results, that large positive and large negative residuals both decrease ownership share about equally, supporting our interpretation of the absolute value of the residual as being a reasonable measure of risk.

Column 6 of Table III repeats the same regression using the 1998 SSBF data. The regressors are the same, except that total assets is used as a measure of firm size instead of total equity, and profits-to-assets is used for constructing the risk measure, since the (N)SSBF only has book equity measures, which are negative for a substantial fraction of firms. Furthermore, the regression used to construct the risk measure now includes the (N)SSBF instruments for risk described below. A negative and statistically significant effect of risk on ownership share is again observed.

Column 3 supplements the SCF analysis with instrumented measures of firm risk designed to reduce the errors-in-variables problem caused by measurement error in our risk variable. The instrument for risk is a dummy variable for whether the entrepreneur is using personal assets as collateral for the business. Two-stage least squares (2SLS) estimates, where firm risk  $\sigma$  is predicted in a first-stage regression using the instrument, and the predicted  $\sigma$  is then used as a regressor in the second-stage ownership regression, are reported. Panel C reports the coefficient estimates and  $t$ -statistics for the first-stage regression on the instruments, where coefficient estimates on the other regressors are omitted for brevity, along with the  $R^2$  and the  $p$ -value of the  $F$ -statistic for significance of the instruments. The instrument is successful in capturing cross-sectional variation in  $\sigma$ . The collateral dummy is negatively associated with risk, probably because entrepreneurs in risky firms are not willing to post personal assets as collateral. In the instrumental-variables regression, the effect of risk on ownership share in the second stage is magnified substantially. Standard errors account for estimation error from the first stage.

Columns 8 and 9 of Table III in Panel B demonstrate that the economic effect of risk on ownership share in the (N)SSBF also increases when instrumental variables are employed, though statistical significance declines. In the small

business survey data, two sets of instruments for risk are used. The first set of instruments includes two dummy variables indicating whether the firm has exports or whether the firm primarily sells its products in the same area as the firm's main office. The omitted dummy is for those firms without exports and that sell mainly regionally or nationally in the United States. The second set of instruments is the number and number squared of R&D employees, available only in the 1993 NSSBF (about 24% of firms had at least one R&D employee). Firms with more R&D employees probably face more uncertain cash flows and higher volatility, as suggested by theory (Huang and Xu (1999)) and by empirical evidence from publicly traded firms (Chan, Lakonishok, and Sougiannis (2001)). Both sets of instruments are significant in the first stage and we fail to reject the test of overidentifying restrictions in the second stage for both sets of instruments.

As highlighted by the endogeneity of firm size in our model, it is important to control for size in our regressions. When we exclude measures of  $L$  and  $K$  as regressors, the significance of  $\sigma$  on ownership drops substantially, and in several cases causes the coefficient on risk to switch sign. This occurs under both OLS and instrumental-variables regressions. Failing to account for size, which can be another mechanism by which entrepreneurs control their risk exposure, can make it difficult to detect a relation between risk and ownership in the data.

Lacking good instruments for size, we do not instrument for  $K$  and  $L$  in the regressions. If the instruments we employ for risk are uncorrelated with firm size, then the instrumental-variables estimates for risk are still consistent (Wooldridge (2002)). While correlation of our instruments with firm size is not zero, the correlation between the collateral dummy and log equity (log employees) in the SCF is, conditional on the control variables included in the regression, only 0.09 (0.07). In the 1993 and 1998 (N)SSBF, the correlation (conditional on the controls) between the export dummy and log assets (log employees) is 0.06 (0.04), while the local dummy has a correlation of  $-0.15$  ( $-0.17$ ) with log assets (log employees), and the number of R&D employees has a correlation of 0.11 (0.17) with log assets (log employees). Thus, while it is possible that the nonzero correlations of the instruments with size could bias the instrumental-variables regression coefficient on risk, it is comforting that all three instrumental-variables estimations lead to substantial economic effects of risk and with roughly similar coefficients across two different sets of instruments in the (N)SSBF. Furthermore, we argue below that the issue of correlation between size and instruments is unlikely to have a substantial effect on the results in stages 2 and 3.<sup>10</sup>

<sup>10</sup> In addition, since many of the 100% manager-owned firms are proprietorships or partnerships that face unlimited liability, the effect of risk on ownership share could be understated, because organizational form changes with risk as well. As risk increases, firms tend to move from unlimited liability forms to corporations with limited liability. This, therefore, provides another mechanism to reduce the entrepreneur's risk, and could mute the effect on ownership share. However, we ran the regressions in columns 1 and 3 for S&C corporations only (which have limited liability) and found the effect on ownership share from risk to be similar in magnitude.

### A.2. Wealth and Ownership

Columns 1 and 6 of Table III show that the coefficient on entrepreneurial nonfirm wealth is positive and significant both in the SCF and in the 1998 SSBF for which lower quality wealth data is available (households are asked for very detailed wealth categories in the SCF, but are only asked for their home equity and the total net worth of other nonfirm assets in the SSBF). Moving from the 10<sup>th</sup> percentile in the distribution of nonfirm wealth, around \$79,000, to the 90<sup>th</sup> percentile, around \$16 million, increases ownership share by around 11-percentage points.

For robustness, we also employ the entrepreneur's total wealth, including the value of the entrepreneur's firm equity. Entrepreneurs who sell more of their business subsequently own more nonfirm wealth. This induces a mechanical negative relation between observed nonfirm wealth as opposed to true nonfirm wealth and ownership share. Consistent with this, columns 2 and 7 show that the effect of total entrepreneur wealth on ownership share is about three to four times stronger in both data sets. As a further robustness check for the SSBF, not included in the table, we restrict the sample to firms where the number of owners who report working in the firm equals one to be sure the principal shareholder is a manager, and obtain similar results.

### A.3. Noncontrol Firms

We repeat the previous regressions on the smaller sample of noncontrol firms. Agency considerations may have a greater impact on ownership share here, since control issues seem to play little role in ownership determination for these firms. As the last two columns of Panel A and the last column of Panel B indicate, the effect of risk and wealth on ownership share is economically larger in the noncontrol sample, though the much smaller sample size leads to lower statistical significance.<sup>11</sup>

### A.4. Scaling Back Firm Size in Response to Risk

Because size is an endogenous input variable, the entrepreneur may scale back risky projects in response to idiosyncratic risk (Prediction 2). Table IV reports results from regressions of firm size variables: capital ( $K$ ) and labor ( $L$ ) inputs, on our measures of firm risk and all previous control variables, excluding size. Both OLS and instrumental-variables regressions indicate a negative and significant effect of risk on firm size across both data sets. The magnitude of the effect is amplified when instrumenting risk, with coefficients varying between

<sup>11</sup> We also ran the same regressions for the sample of firms facing control issues (the complement sample). Due to the distinct nature of the dependent variable having values of 1/5, 1/4, 1/3, 1/2, or 1, we employed an ordered probit model in addition to OLS. For both the SCF and the (N)SSBF, we found a significant negative relation between ownership and risk and a significant positive relation between ownership and outside wealth.

**Table IV**  
**How Does Risk Affect Firm Size?**

Regressions of firm size on risk measures are reported. Panel A reports results for the 1989, 1992, 1995, 1998, and 2001 *Survey of Consumer Finances* (SCF) and Panel B reports results for the 1993 *National Survey of Small Business Finances* (NSSBF) and 1998 *Survey of Small Business Finances* (SSBF). Labor inputs are measured by the log of the number of employees. Capital inputs are measured by the log of the market value of equity in the SCF and by the log of the total asset value in the (N)SSBF. Firm risk is measured as in Table III, excluding the size measures in the regressions used to determine risk, and is instrumented using the same instrumental variables as in Table III. Regressions include all of the control regressors in Table III, excluding size measures. Tests of overidentifying restrictions are reported at the bottom of each panel for the instrumental-variables regressions. All regressions are run using robust standard errors that account for heteroskedasticity and cross-correlated errors (*t*-statistics in parentheses). Panel C reports results from the first stage of the instrumental-variables regressions, along with  $R^2$ 's and *p*-values of the *F*-statistics for the joint significance of the instruments. Only coefficient estimates on the instruments are reported for brevity.

Dependent Variables Regression	Panel A: SCF (1989–2001)				Panel B: (N)SSBF (1993–1998)			
	Labor, <i>L</i>		Capital, <i>K</i>		Labor, <i>L</i>		Capital, <i>K</i>	
	OLS	IV <sup>(1)</sup>	OLS	IV <sup>(1)</sup>	IV <sup>(2)</sup>	IV <sup>(3)</sup>	IV <sup>(2)</sup>	IV <sup>(3)</sup>
Risk, $\sigma$	-0.180 (-3.08)	-4.516 (-5.16)	-0.654 (-8.19)	-7.025 (-5.95)	-3.367 (-5.25)	-9.915 (-2.52)	-4.039 (-5.56)	-9.174 (-2.39)
Entrepreneur's age (Age) <sup>2</sup>	0.0185 (0.98)	-0.0069 (-0.21)	0.0533 (2.03)	0.0160 (0.34)	0.0633 (1.65)	0.4404 (2.21)	0.0815 (1.91)	0.3909 (2.07)
$R^2$	0.225		0.306					
No. of observations	3,300	3,300	3,300	3,300	6,061	3,371	6,061	3,371
Over ID test ( <i>p</i> -values)					1.913 (0.167)	0.452 (0.502)	4.495 (0.034)	0.550 (0.459)
Panel C: 1st-Stage Instrumented Regressions for Risk, $\sigma$								
IV Regression	Collateral	Exports	Local	R&D	(R&D) <sup>2</sup>	$R^2$	<i>p</i> -values	
(1) Risk, $\sigma$	-0.1012 (-6.73)					0.170	0.000	
(2) Risk, $\sigma$		0.0635 (0.92)	0.1411 (5.54)			0.087	0.000	
(3) Risk, $\sigma$				-0.0142 (-1.82)	0.0001 (0.99)	0.077	0.119	

-3 and -10 for labor and between -4 and -9 for capital. These are large effects since the 10<sup>th</sup> to 90<sup>th</sup> percentile range is around 5 for  $\log(L)$  and around 6 for  $\log(K)$ .<sup>12</sup>

<sup>12</sup> One may worry that data for small companies have more measurement error, resulting in larger positive or negative measured values of profit/equity or profit/assets for small firms that may erroneously classify them as high risk. However, since the scaling back in response to risk is stronger in the instrumental-variables estimations, which are less affected by measurement error, this does not seem to be driving the results.

### *B. Stage 2: Response to the Contract—How Does Ownership Affect Effort?*

We provide direct evidence of entrepreneur actions in response to incentives using the number of hours worked as a measure of entrepreneur effort. Prediction 5 states that effort increases with exogenous variation in ownership share. As highlighted by our model, endogeneity problems may make it difficult to detect a causal relation in the data. We employ the previous firm production and entrepreneur control variables to account for observable differences across firms. To account for unobservable firm and entrepreneur heterogeneity, however, we need variation in ownership outside of the agency model.

#### *B.1. OLS Estimates*

As emphasized by the model, the positive causal relation between effort and ownership should hold whether or not control issues affect ownership structure. Hence, we test stage 2 (Prediction 5) on the full sample of data. However, because control issues affect ownership, they provide useful variation in ownership shares for testing this agency prediction. For example, under agency theory alone, suppose two identical firms have optimal ownership shares of 69%. Now, suppose voting rights or control issues are important in firm A but not in B, and that this difference in voting rights is not related to the firms' production technologies. In this case, the entrepreneur in firm A may scale down his ownership to 50%, while the entrepreneur in firm B remains at 69%. Because of this, entrepreneur B works harder than A. Thus, the variation in ownership share caused by control is useful for testing the effect of incentives on effort, since in this example, the two firms/entrepreneurs are otherwise identical, yet have different ownership stakes. Since a large fraction of the cross-sectional variation in ownership shares may be generated by control according to Figure 1, an OLS regression, controlling for firm production and entrepreneur characteristics, may still be informative about the causal effect of ownership share on effort. The first column of Table V in Panel A shows that effort is positively related to ownership shares. Moving from 50 to 100% ownership increases effort by about 3.3 hours per week, according to OLS estimates.

#### *B.2. Instrumental Variables*

A more direct approach to finding exogenous variation in ownership is to employ instrumental variables. Finding instruments for ownership share that are otherwise unrelated to effort, and because we do not instrument for  $K$  and  $L$ , are uncorrelated with firm size, is difficult. This, for instance, rules out firm risk or entrepreneurial wealth as potential instruments.<sup>13</sup>

<sup>13</sup> Firm risk and nonfirm wealth are not valid instruments for ownership share, since nonfirm wealth has an independent effect on effort and firm risk is correlated with  $K$  and  $L$ , which have direct effects on effort, because they affect the marginal product of effort. In general, instrumenting for one variable but not another is valid only if the instruments are not correlated with the other variable.

**Table V**  
**How Do Ownership, Size, and Wealth Affect Effort? (Stage 2)**

Regressions of entrepreneurial hours worked per week on the entrepreneur's equity ownership, wealth, and firm size are reported. Data are taken from the 1989, 1992, 1995, 1998, and 2001 *Survey of Consumer Finances*. Focusing only on the firm in which the household has its largest actively managed ownership investment, hours worked are those in the person's main job if the person reports working in the firm and being self-employed, or in the person's second job if the person reports working in the firm and not being self-employed but owns a business as a secondary job. If both the head of household and spouse have positive entrepreneurial hours in the firm, the maximum is taken. Ownership is also instrumented using dummy variables for how the entrepreneur acquired the firm (a founder dummy and a dummy for having inherited/been given the firm) and the entrepreneur's initial investment in the firm. Three sets of instrumental-variables regressions are used: employing all three instruments (IV<sup>(1)</sup>), just the two firm acquisition dummies (IV<sup>(2)</sup>), and just the initial investment variable (IV<sup>(3)</sup>). The instrumental-variables regressions are run via two-stage least squares. Tests of overidentifying restrictions are reported at the bottom of Panel A. Additional control regressors include the entrepreneur's age, age squared, year dummies, firm age, firm age squared, experience controls, and dummies for gender, education, ethnicity, and industry. An instrumental-variables regression is also reported for the subsample of firms that include only entrepreneurs involved in a single firm and whose spouse does not work in the firm. Panel B reports results from the first stage of the instrumental-variables regressions, along with  $R^2$ s and  $p$ -values of the  $F$ -statistics for the joint significance of the instruments. Only coefficient estimates on the instruments are reported for brevity.

Panel A: Dependent Variable = Entrepreneurial Effort (hours worked)					
Regression	OLS	IV <sup>(1)</sup>	IV <sup>(2)</sup>	IV <sup>(3)</sup>	1 Firm, No Spouse IV <sup>(1)</sup>
Own	6.550 (5.84)	14.763 (2.89)	15.939 (2.09)	13.266 (1.87)	18.504 (2.38)
log(Wealth)	-1.465 (-4.57)	-2.017 (-4.38)	-2.096 (-3.51)	-1.916 (3.36)	-1.959 (-2.80)
log(Equity)	2.194 (7.25)	2.835 (5.77)	2.927 (4.43)	2.718 (4.34)	3.115 (4.32)
log(Employees)	0.652 (2.40)	0.963 (2.88)	1.007 (2.51)	0.906 (2.39)	1.598 (2.73)
$R^2$	0.229				
No. of observations	3,368	3,368	3,368	3,368	1,614
Over ID test ( $p$ -values)		0.232 (0.891)	0.189 (0.664)		0.202 (0.904)

Panel B: 1st-Stage Instrumented Regressions for Ownership					
IV Regression	Founded	Inherited	Initial Investment	$R^2$	$p$ -values
Own	0.0738 (6.65)	-0.0675 (-3.02)	0.0158 (9.32)	0.320	0.000

We employ a dummy variable for having inherited/been given the firm and a dummy for having founded the firm as instruments. The omitted category consists of those who purchased the firm. Entrepreneurs who have been given or have inherited their ownership share may have ownership shares that reflect

things other than agency concerns (e.g., family relations). Founders' ownership shares may be different from those of nonfounders, because founders have a stronger preference for control. While it is possible that family relations or a preference for control could affect the disutility of providing effort and thus have a direct effect on hours worked, our tests of overidentifying restrictions below do not suggest such direct effects, conditional on one of the instruments being valid, thus providing support for the instruments. We also employ the initial investment of the entrepreneur as an instrument for ownership share. The size of the initial investment indicates the original financial strength of the entrepreneur, capturing the entrepreneur's outside wealth at the time when the firm was started or acquired, which will affect initial ownership share. Because this investment took place at the time when the firm was founded/acquired, it is not affected by current technology shocks. Note, too, that we control for the market value of the firm in all the hours regressions. This by itself may pick up technology differences to a large extent. In addition, since only current wealth determines current effort, and we control for current wealth in the regression, initial investment should not have an effect on effort except through ownership. Tests of overidentifying restrictions confirm this.

The second through fifth columns of Panel A in Table V report the results from instrumental-variables regressions of effort on ownership share. Column 2 uses all three instruments, column 3 uses just the firm acquisition dummies, and column 4 uses just initial investment to instrument ownership share. The three sets of instruments yield very similar results. The effect of ownership on effort more than doubles in magnitude from OLS estimates and is highly statistically significant in all three specifications. Using only the founder dummy or the inherited dummy to instrument for ownership provides similar results as well (not reported).<sup>14</sup>

Panel B reports results from the first stage of the instrumental-variables estimations. The significance of the coefficients on initial investment and inherited/given and founder dummies and the  $F$ -statistic for their joint significance indicates that these instruments capture substantial variation in ownership shares. Tests of overidentifying restrictions further support the use of these instruments, consistent with the finding that results using each set of instruments are quite similar.

For robustness, the fifth column of Table V presents results for the subsample of entrepreneurs with active management equity shares in only one firm, and excludes all households in which the spouse also works in the firm. The results are economically larger for this subsample of firms. This rules out the concern that our full sample results could be driven by misreporting of hours in households with active management equity shares in multiple firms who may spend the majority of their hours working in other firms. It also rules out the

<sup>14</sup> Of the three instruments, two have a positive correlation with size, while one (the founder dummy) is negatively correlated with size. The fact that all three instruments lead to similar instrumental-variables coefficients on ownership share suggests that our lack of instrumenting for firm size is not causing a substantial bias in the results.

concern that effort is mismeasured if spouses share some of the workload or if there is labor–leisure substitution within a household. We also repeated the column 2 regression for entrepreneurs who work at least 20 hours per week and truncating (possibly inflated) hours responses above 100 to 100 hours per week. The estimated coefficient (not reported) on ownership in this truncated hours sample is 8.32 with a  $t$ -statistic of 1.96. In addition, we also repeated regressions employing the initial investment instrument on the subsample of firms at least 5 years of age to ensure that initial entrepreneurial investment does not mechanically equal the entrepreneur's current dollar equity ownership. The results are slightly stronger on this subsample, with a coefficient estimate on ownership share of 15.67 with a  $t$ -statistic of 2.65. Finally, since ownership should affect effort regardless of whether control issues are important, we ran the regressions separately for the control and noncontrol samples and found similarly sized effects.

In general, the positive correlation between ownership and effort may be indicative of many other managerial actions that also increase firm value, but that we cannot observe in the data. The effect on hours worked may thus indicate a larger overall effect of equity ownership shares on the incentives of the entrepreneur, which could imply a larger effect of effort on firm performance than the above estimates may indicate. This suggests that both effort and ownership may be useful in explaining firm performance, if hours worked only captures one aspect of entrepreneurial actions.

### *C. Stage 3: Performance—Do Ownership and Effort Affect Firm Performance?*

One of the critical premises of agency theory is Prediction 6, that the inducement of managerial effort through incentives has a direct impact on firm value. If managerial effort is important, then hours worked, and if hours worked are not a sufficient statistic for effort or other managerial actions, ownership share should be positively related to firm performance.

Prior studies examine the relation between ownership and performance, a joint test of Predictions 5 and 6, by regressing ratios of profitability or efficiency on ownership shares or pay–performance sensitivity (Morck et al. (1988), McConnell and Servaes (1990), and Ang et al. (2000)). We take a more direct approach by estimating the firm's production function to assess the marginal product of effort and incentives. This is also more closely linked to our model, which helps identify the controls needed in the regression and what variables constitute valid instruments for effort and ownership share.

We estimate the Cobb–Douglas production function from Section I.A in logs,

$$\log(Y_t) = \alpha \log(K_t) + \beta \log(L_t) + \eta \log(\mu_t) + \log(A_t), \quad (6)$$

using the log of sales (and, for robustness, firm profits) as a measure of output. Labor inputs are measured by the log of the number of employees and capital by the log of total value of equity (SCF) or assets ((N)SSBF). Entrepreneur weekly hours worked are used as a measure of effort,  $\mu$ . If we allow the

ownership share,  $r$ , to have a multiplicative effect in the production function, assuming hours worked is not a sufficient statistic for  $\mu$ , then we add a term  $\delta r_t$  to equation (6).

Since ownership and effort are endogenously determined, detection of a relation to performance may be difficult. To address endogeneity, we first try to “saturate” the regression with as many firm and entrepreneur attributes as are available. For example, using market equity as our measure of capital in the SCF may help to alleviate potential endogeneity problems, since market equity may be a good proxy for the unobserved technology parameter,  $A$ . Of course the coefficient on  $\log(K)$  then does not have a structural interpretation, but that coefficient is not a main focus of the analysis. We cannot use a firm fixed-effects approach since we do not have panel data.

Second, we employ instrumental-variables techniques. Theory provides some guidance on the choice of instruments for hours. Variables that affect the disutility of effort, and the derivatives of this function, and that are not related to  $K$  and  $L$ , serve as valid instruments for hours in the performance regressions, since these variables are unlikely to have a direct effect on the production function.<sup>15</sup> The variables we employ as instruments for effort are the entrepreneur’s age and age squared. It is important when using age as an instrument for hours worked to control for the entrepreneur’s experience, since experience probably affects firm performance. We control for experience in the SCF using years of full-time employment and a dummy for having previously been self-employed for 3 years or more in a different business. Furthermore, Table IV shows that the entrepreneur’s age, controlling for experience, only bears a weak relation to firm size.

If hours worked is not a sufficient statistic for effort, then ownership may also capture firm performance. We therefore include ownership share and instrument it with the two dummies for how the entrepreneur acquired the firm (founded or inherited/was given the firm).<sup>16</sup> Panel C of Table VI indicates that the instruments are successful in capturing cross-sectional variation in effort and ownership in the SCF and that the tests of overidentifying restrictions support use of both of these sets of instruments. However, in the (N)SSBF, the instruments for ownership share are weak in the first stage. Hence, we focus on instrumenting for effort only in that sample. All regressions include a host of controls for entrepreneur attributes, namely experience, dummies for education, race/ethnicity, and gender, and firm characteristics, including firm age and age squared, as well as industry and year dummies.

<sup>15</sup> Heterogeneity in the disutility of providing effort does raise one possible concern. For instance, if entrepreneurs with a low disutility of providing effort choose to work in or start firms where the marginal product of labor is high, then we may find that the additional hours worked increase firm performance, even if higher productivity per hour worked is the cause of this increase. What can be said in the face of such endogenous matching is that either extra hours do lead to better outcomes or that entrepreneurs allocate their hours in ways suggesting that they think extra hours lead to better outcomes.

<sup>16</sup> The entrepreneur’s initial investment does not seem to be a valid instrument for ownership share in the performance regressions. When including this variable in addition to the other two instruments we reject the test of overidentifying restrictions.

**Table VI**  
**Do Ownership and Effort Affect Firm Performance? (Stage 3)**

Regressions of firm output (log of sales in Panel A and log of profits, including entrepreneurial salaries for the SCF (not available in the (N)SSBF), in Panel B) on entrepreneur ownership shares and effort are reported. The first two columns of each panel employ data from the 1989, 1992, 1995, 1998, and 2001 *Survey of Consumer Finances* and the last column of each panel employs data from the 1993 *National Survey of Small Business Finances* and 1998 *Survey of Small Business Finances*. Effort is the weekly hours worked by each entrepreneur as defined in Table V. Regressions are estimated using OLS with robust standard errors that account for residual heteroskedasticity and cross-correlations (*t*-statistics in parentheses). Regressions are also estimated via instrumental-variables estimation (two-stage least squares), where ownership and effort are instrumented by dummy variables for how the firm was acquired (a founder dummy and a dummy for having inherited/been given the firm), and the entrepreneur's age and age squared, respectively. Since entrepreneurial effort is not reported in the (N)SSBF, effort is estimated based on the coefficients from an hours regression in the SCF applied to the (N)SSBF values of those regressors. Estimations including this hours measure are referred to as two-sample instrumental-variables (2SIV) estimations and are described in Appendix B. Tests of overidentifying restrictions are reported at the bottom of each panel. All regressions include dummies for industry, year, firm age, firm age squared entrepreneur gender, education, and ethnicity, as well as experience and size controls. Panel C reports results from the first stage of the instrumental-variables regressions, along with  $R^2$ s and  $p$ -values of the  $F$ -statistics for the joint significance of the instruments. Only coefficient estimates on the instruments are reported for brevity.

Dependent Variables	Panel A: log(Sales)			Panel B: log(Profits)		
Data Source	SCF	SCF	(N)SSBF	SCF	SCF	(N)SSBF
Regression	OLS	IV	2SIV	OLS	IV	2SIV
log(Effort)	0.2278 (5.86)	0.4023 (3.40)	0.5549 (4.39)	-0.0387 (-1.06)	0.5531 (3.87)	0.6023 (2.93)
Own	-0.0167 (-0.21)	0.8905 (1.98)		-0.0858 (-0.99)	1.7160 (2.88)	
log(Equity)	0.5064 (32.53)	0.5351 (22.78)	0.4141 (39.54)	0.4726 (28.13)	0.5227 (17.64)	0.4212 (24.75)
log(Employees)	0.5256 (26.92)	0.5576 (21.38)	0.6109 (45.20)	0.2492 (11.69)	0.3104 (10.10)	0.2395 (11.02)
$R^2$	0.792			0.612		
<i>No. of observations</i>	3,368			3,247		
Over ID test	0.098			4.706		
( $p$ -values)	(0.952)			(0.030)		
Panel C: 1st-Stage Instrumented Regressions for Ownership and Effort						
IV Regressions	Founded	Inherited	Age	(Age) <sup>2</sup>	$R^2$	$p$ -values
log(Effort)			0.0439 (3.69)	-0.0005 (-4.57)	0.163	0.000
Own	0.0712 (6.65)	-0.0913 (-4.45)	0.0120 (3.53)	-0.0001 (-3.47)	0.255	0.000

Panel A in Table VI reports regression results for log sales and Panel B reports results for log profits across the SCF and (N)SSBF samples. Since some entrepreneurs report taking a salary and some do not, we add reported salaries back to profits in the SCF. We do not add back entrepreneur salaries in the

(N)SSBF since such information is not available for 1998. Results in the SCF and the 1993 NSSBF are robust to employing profits net of salaries as well. The first column of each panel reports OLS estimates with robust standard errors that account for heteroskedasticity and cross-correlated error terms. The effect of entrepreneurial hours on sales is positive and statistically significant, and the effect of ownership shares is negative and insignificant. For profits, OLS estimates are negative and insignificant for both hours and ownership. The coefficients on hours and ownership share are marginally larger when leaving out the other variable. Interpreting these coefficients is difficult due to endogeneity problems. Hence, we turn to the instrumental-variables regressions.

The second column of each panel reports the effect of instrumented effort and ownership share on log sales and profits in the SCF data. Both instrumented effort and ownership share have significant positive effects on both sales and profits, consistent with Prediction 6. This highlights the importance of controlling for endogeneity. Most compelling is the switch in sign and significance in the profit regressions from OLS to instrumental variables.

The third column of each panel reports results for the (N)SSBF. The (N)SSBF does not record hours worked by the entrepreneur. However, it does contain the variables with which we instrument hours worked in the SCF. We therefore run two-sample instrumental-variables regressions, in which we use the coefficients on the instruments for hours in the SCF to project predicted hours in the small business data using the instruments available in that data. Details of the two-sample instrumental-variables procedure are provided in Appendix B. Consistent with Prediction 6, instrumented hours worked has a large, positive, and significant impact on sales and profits.

The results for effort in Table VI are robust for subsamples of the data that include only those entrepreneurs with active management equity shares in a single firm and those who do not have a spouse who also works in the firm. In addition, the effect of hours is strong in the profit regressions across the noncontrol and control samples using instrumental variables. For sales, results are weaker for the noncontrol sample.

### *C.1. Multiple Dimensions of Effort*

Finally, it is important to emphasize that hours worked are only one dimension of entrepreneurial effort. For example, working longer hours may correlate with buying more productive assets or with hiring more productive employees. Suppose  $Y = AK^{\alpha+\delta_1\mu}L^{\beta+\delta_2\mu}\mu^\eta$ . To test whether there is any interaction between measured effort and the marginal productivity of labor and capital, we test whether  $\delta_1$  and  $\delta_2$  are significantly different from zero. Using our proxies for  $K$ ,  $L$ , and  $\mu$ , we run the following regression in logs using the SCF data,

$$\log(Y) = \log(A) + (\alpha + \delta_1\mu)\log(K) + (\beta + \delta_2\mu)\log(L) + \eta \log(\mu), \quad (7)$$

where  $Y$  is sales. Our estimates of  $\delta_1$  and  $\delta_2$  are  $-0.045$  ( $t$ -statistic =  $-2.74$ ) and  $-0.040$  ( $t$ -statistic =  $-1.71$ ), respectively, and the coefficient on log hours,  $\eta$ , increases when the interaction terms are included. This indicates that

working longer hours does not seem to be associated with more productive assets or employees. One interpretation might be that entrepreneurs have to work harder when they cannot find productive employees or capital, although the lack of instruments for  $K$  and  $L$  imply that strong conclusions cannot be drawn.

Another issue regards the productivity of a unit of effort. Entrepreneurs with better incentives should not only work longer hours but also work harder during those hours. If total effort is  $\mu e$  where  $e$  measures intensity of effort, then our estimate of  $\eta$  will tend to pick up both the effect of longer hours and increased productivity per hour and should be interpreted as such.

#### IV. Conclusion

Employing a structural model augmented to fit the entrepreneurial labor market and using two samples of private firms, we test the implications of agency theory in three stages: (1) What determines the entrepreneur's compensation contract (equity share)? (2) How does the entrepreneur respond to the incentives provided by the contract? (3) How is firm performance related to the response of the entrepreneur?

Overall, we find fairly strong evidence supporting agency theory's predictions across two data sets, using several sets of instrumental variables, and across a variety of specifications and subsamples. We present direct evidence of the effect of entrepreneur wealth on the contract, of the response of entrepreneur actions, measured by hours worked, to the contract, and of the impact of those actions on firm output.

Given the support for agency theory across all three stages of the analysis, it is likely that agency considerations do play a key role in explaining why entrepreneurs on average hold large ownership shares. However, while agency costs may help explain why managers maintain large equity shares in the firm, they cannot explain the decision to become an entrepreneur. Given the seemingly unattractive private equity risk-return trade-off documented by Moskowitz and Vissing-Jørgensen (2002) caused by the large equity ownership shares and the resulting large amounts of idiosyncratic risk taken on, the decision to become an entrepreneur remains somewhat puzzling.

#### Appendix A: Numerical Solution and Choice of Parameters for Model Calibration

The model is solved numerically. First, for a grid of possible values of  $r$  we solve for the values of  $\mu$ ,  $K$ , and  $L$  that satisfy the three first-order conditions. This generates functions (vectors)  $\mu(r)$ ,  $K(r)$ , and  $L(r)$  that characterize the dependence of the production inputs on the entrepreneur's equity ownership share. Given these functions, and the implied function for  $k(r)$ , the entrepreneur's utility is calculated for each value of  $r$  and the optimal  $r$  chosen. For computational ease, we set  $\alpha = \beta$  and  $w = p$  such that the optimal values of  $K$  and  $L$  are equal. We parameterize the model by setting the utility function parameters  $\phi = \theta = 0.5$ , the costs of labor and capital  $w = p = 0.1$ , and the production function coefficient on the entrepreneur's effort  $\eta = 0.2$ .

We assume that the production function exhibits constant returns to scale in  $K, L$ , and  $\mu$ . This is consistent with the assumption made in most of the literature on real business cycles and growth and implies that output could be doubled if all inputs were doubled. Note that firm size is well defined in our model even under constant returns to scale, since the entrepreneur's utility cost of providing effort is increasing in effort.

We have little guidance on how to pick the relative size of  $\eta$  and  $\alpha$  ( $=\beta$ ) but pick a value for  $\eta$  that, along with our calibration of the utility function, is consistent with optimal values of  $\mu$  of around one third. This roughly matches the fraction of time that entrepreneurs work, which is 48 hours for the median entrepreneur in our sample.

For the utility function, we assume a constant relative risk aversion coefficient of 5, which is typical in calibrations of life cycle consumption and portfolio choice. The large equity premium for publicly traded equity in historical U.S. data could suggest higher values. However, the seeming lack of a premium for private equity over public equity, despite the poor diversification of entrepreneurs, is all the more puzzling the larger entrepreneurial risk aversion is (see Moskowitz and Vissing-Jørgensen (2002)). We chose the exponents on consumption and leisure such that they (along with the value of  $\eta$ ) ensure work effort around the empirically observed fraction of time in the baseline calibration. This is the standard approach followed in calibrations of real business cycle models that involve consumption and leisure.

The standard deviation of the annual stock return for a publicly traded U.S. firm is around 50% according to Campbell et al. (2001). Accurate estimates of the standard deviation of a typical privately held firm's stock return are not available, although it is clear that idiosyncratic risk is also very high for private firms (see Moskowitz and Vissing-Jørgensen (2002)). In our one-period model, the equity return is simply profits divided by the initial value of firm equity. We pick the value of  $\sigma$  for the baseline case to ensure that a standard deviation of this return is a bit lower than the standard deviation of the annual stock return for a publicly traded U.S. firm.

Finally, our model allows for outside wealth, since this affects an entrepreneur's absolute risk aversion and thus his optimal equity ownership share. We are mostly interested in confirming the intuition that entrepreneurs with more nonfirm-related wealth should have higher ownership shares in their firm, even within a model where the utility function allows for wealth effects on effort. In the baseline case, we set consumption from nonfirm wealth  $zW$  equal to about 10% of total firm profits, but consider values up to around the size of firm profits in the comparative static analysis.<sup>17</sup>

<sup>17</sup> Empirically, there is a very wide distribution of nonfirm wealth among entrepreneurs in new firms. In the SCF, the 10<sup>th</sup> percentile of nonfirm wealth is about \$10,000 and the 90<sup>th</sup> percentile is around \$600,000 for entrepreneurs with firms younger than 5 years. For comparison, median (mean) firm profits, including salaries taken by the entrepreneur, in the SCF are \$39,000 (\$170,000). At a 5% interest rate, \$600,000 corresponds to a 30-year annuity of about \$39,000, suggesting that entrepreneurs who start with a lot of nonfirm wealth can plausibly rely on this for a substantial part of their consumption.

## **Appendix B: Two-Sample Instrumental-Variables Estimation**

Our two-sample instrumental-variable estimates follow Angrist and Krueger (1995), and correct the standard errors in the second stage for the first-stage estimation. We use the owner's age and age squared as instrumental variables for hours worked. Regressions pool the 1992 and 1998 SCF to estimate the first stage and pool the 1993 and 1998 small business data to estimate the second stage.

In order to satisfy the conditions for the estimator to be consistent, the two samples should be drawn from the same population. Since the small business data cover only small businesses and nonfarm, nonfinancial, private, for-profit firms, we exclude firms not eligible for the small business survey from the sample of SCF firms for estimation of the first stage.

The SCF data contain only a very broad measure of industry. The seven industry categories available consistently in the 1998 and 1992 SCF (based on underlying 3-digit Census industry codes) were matched to the 1987 2-digit SIC code data released with the (N)SSBF. Industry categories seven (government) and one (fishing, forestry, and agriculture) were dropped. Firms with more than 499 employees are also dropped. Since Hispanic ethnicity and race are two separate questions in the (N)SSBF (e.g., a firm can have owners who are either Hispanic or are not Hispanic and any race), while Hispanic ethnicity and each racial category are mutually exclusive in the SCF, we recoded small business firms that were Asian and Hispanic or Black and Hispanic in the (N)SSBF to be only Hispanic. Furthermore, we restricted the first stage to the 1992 and 1998 SCF to better match the population from which the sample of firms in the 1998 and 1993 (N)SSBF were drawn. Because the measure of market value of equity in the SCF is not available in the (N)SSBF, and since the measure of book equity in the (N)SSBF is negative for about one-fourth of the firms, we use assets as a measure of size in the second-stage regressions. Our measure of experience for these regressions differs slightly from that in the other regressions. Because the (N)SSBF does not ask about full-time experience but merely asks about years of experience in business, we construct an alternative dummy for having had at least 3 years of experience full-time in a business in the SCF and at least 3 years of experience in a business in the (N)SSBF. The relevant first stage for these regressions is shown in row one of Panel C of Table VI.

Finally, there are some issues worth noting in matching these two samples. The SCF firms could be any firm that the respondent is actively involved in managing, while the small business firms have information for the largest owner who may not be the manager. There are also a small number of industries that could be sampled for the SCF, but that were ineligible for the (N)SSBF. These industries are in a broad SCF industry category mainly full of firms eligible for the (N)SSBF and thus should not cause substantial problems. Finally, race and ethnicity in the small business data are not for any specific owner unless the firm only has one owner; rather, the small business data asks if the race (ethnicity) of more than 50% of the share holders is Black, Asian, or other non-White (Hispanic). Again, since most firms have very few owners, we expect this not to affect the determination of race or ethnicity of the owners of most small business firms.

## REFERENCES

- Aggarwal, Rajesh K., and Andrew A. Samwick, 1999, The other side of the trade-off: The impact of risk on executive compensation, *Journal of Political Economy* 107, 65–105.
- Aizcorbe, Ana M., Arthur B. Kennickell, and Kevin B. Moore, 2003, Recent changes in U.S. family finances: Evidence from the 1998 and 2001 Survey of Consumer Finances, *Federal Reserve Bulletin* 80, 1–31.
- Ang, James S., Rebel A. Cole, and James Wuh Lin, 2000, Agency costs and ownership structure, *Journal of Finance* 55, 81–106.
- Angrist, Joshua D., and Alan B. Krueger, 1995, Split-sample instrumental variables estimates of the returns to schooling, *Journal of Business and Economic Statistics* 13, 225–235.
- Avery, Robert B., Gregory E. Elliehausen, and Arthur B. Kennickell, 1988, Measuring wealth with survey data: An evaluation of the 1983 Survey of Consumer Finances, *Review of Income and Wealth* 34, 339–369.
- Bennedsen, Morten, and Daniel Wolfenzon, 2000, The balance of power in closely held corporations, *Journal of Financial Economics* 58, 113–139.
- Berle, Adolf A., and Gardiner C. Means, 1932, *The Modern Corporation and Private Property*, (Harcourt, Brace, & World Inc., New York).
- Bernardo, Antonio E., Hongbin Cai, and Jiang Luo, 2001, Capital budgeting and compensation with asymmetric information and moral hazard, *Journal of Financial Economics* 61, 311–344.
- Bitler, Marianne P., Alicia M. Robb, and John D. Wolken, 2001, Financial services used by small businesses: Evidence from the 1998 Survey of Small Business Finances, *Federal Reserve Bulletin* 87, 183–205.
- Campbell, John, Martin Lettau, Burton G. Malkiel, and Yexiao Xu, 2001, Have individual stocks become more volatile? An empirical explanation of idiosyncratic risk, *Journal of Finance* 56, 1–43.
- Chan, Louis, Josef Lakonishok, and Theodore Sougiannis, 2001, The stock market valuation of research and development expenditures, *Journal of Finance* 56, 2431–2456.
- Cole, Rebel A., and John D. Wolken, 1995, Financial services used by small businesses: Evidence from the 1993 National Survey of Small Business Finances, *Federal Reserve Bulletin* 81, 630–667.
- Core, John, and Wayne Guay, 2002, The other side of the tradeoff: The impact of risk on executive compensation—A comment, mimeo, Wharton School.
- Demsetz, Harold, and Kenneth Lehn, 1985, The structure of corporate ownership: Causes and consequences, *Journal of Political Economy* 93, 1155–1177.
- Dunn, Thomas, and Douglas Holtz-Eakin, 2000, Financial capital, human capital, and the transition to self-employment: Evidence from intergenerational links, *Journal of Labor Economics* 18, 282–305.
- Elliehausen, Gregory E., and John D. Wolken, 1990, Banking markets and the use of financial services by small and medium-sized businesses, *Federal Reserve Bulletin* 76, 801–817.
- Garen, John E., 1994, Executive compensation and principal-agent theory, *Journal of Political Economy* 102, 1175–1199.
- Gentry, William, and R. Glenn Hubbard, 2004, Entrepreneurship and household saving, *Advances in Economic Analysis and Policy*, 4, 1, Article 8.
- Hall, Brian J., and Jeffrey B. Liebman, 1998, Are CEOs really paid like bureaucrats? *Quarterly Journal of Economics* 113, 653–691.
- Harris, Milton, and Artur Raviv, 1979, Optimal incentive contracts with imperfect information, *Journal of Economic Theory* 20, 231–259.
- Heaton, John, and Deborah Lucas, 2000, Portfolio choice and asset prices: The importance of entrepreneurial risk, *Journal of Finance* 55, 1163–1198.
- Heaton, John, and Deborah Lucas, 2002, Capital structure, hurdle rates, and portfolio choice—Interactions in an entrepreneurial firm, Working paper, Northwestern University.
- Himmelberg, Charles P., R. Glenn Hubbard, and Darius Palia, 1999, Understanding the determinants of managerial ownership and the link between ownership and performance, *Journal of Financial Economics* 53, 353–384.

- Holmstrom, Bengt, 1979, Moral hazard and observability, *Bell Journal of Economics* 10, 74–91.
- Holmstrom, Bengt, and Paul Milgrom, 1987, Aggregation and linearity in the provision of intertemporal incentives, *Econometrica* 55, 303–328.
- Huang, Haizhou, and Cheng-Gang Xu, 1999, Institutions, innovations, and growth, *American Economic Review Papers and Proceedings* 89, 438–444.
- Hurst, Erik, and Annamaria Lusardi, 2004, Liquidity constraints, wealth accumulation, and entrepreneurship, *Journal of Political Economy* 112, 319–347.
- Jensen, Michael, and William Meckling, 1976, Theory of the firm: Managerial behavior, agency costs and ownership structure, *Journal of Financial Economics* 3, 305–360.
- Jensen, Michael, and Kevin J. Murphy, 1990, Performance pay and top-management incentives, *Journal of Political Economy* 98, 225–264.
- Jensen, Michael, and Richard S. Ruback, 1983, The market for corporate control: The scientific evidence, *Journal of Financial Economics* 11, 5–50.
- Kennickell, Arthur B., and Martha Starr-McCluer, 1994, Changes in family finances from 1989 to 1992: Evidence from the Survey of Consumer Finances, *Federal Reserve Bulletin* 80, 861–862.
- Kennickell, Arthur B., Martha Starr-McCluer, and Annika E. Sunden, 1997, Family finances in the U.S.: Recent evidence from the Survey of Consumer Finances, *Federal Reserve Bulletin* 83, 1–24.
- Kennickell, Arthur B., Martha Starr-McCluer, and Brian J. Surette, 2000, Recent changes in U.S. family finances: Results from the 1998 Survey of Consumer Finances, *Federal Reserve Bulletin* 86, 1–29.
- Lazear, Edward, and Sherwin Rosen, 1981, Rank-order tournaments as optimum labor contracts, *Journal of Political Economy* 89, 841–864.
- Leland, Hayne E., and David H. Pyle, 1977, Informational asymmetries, financial structure, and financial intermediation, *Journal of Finance* 32, 371–387.
- McConnell, John J., and Henri Servaes, 1990, Additional evidence on equity ownership and corporate value, *Journal of Financial Economics* 27, 595–612.
- Meyer, Bruce, 1990, Why are there so few black entrepreneurs? Working paper no. 3537, National Bureau of Economics Research.
- Morck, Randall, Andrei Shleifer, and Robert W. Vishny, 1988, Management ownership and market valuation: An empirical analysis, *Journal of Financial Economics* 20, 293–315.
- Moskowitz, Tobias J., and Annette Vissing-Jørgensen, 2002, The returns to entrepreneurial investment: A private equity premium puzzle? *American Economic Review* 92, 745–778.
- Murphy, Kevin J., 1986, Incentives, learning, and compensation: A theoretical and empirical investigation of managerial labor contracts, *RAND Journal of Economics* 27, 59–76.
- Murphy, Kevin J., 1999, Executive compensation, in O. Ashenfelter and D. Card, eds.: *Handbook of Labor Economics* (North Holland, Amsterdam).
- Nagar, Venky, Kathy Petroni, and Daniel Wolfenzon, 2002, Ownership structure and firm performance in closely held corporations, Working paper, NYU.
- Prendergast, Canice, 2002, The tenuous trade-off between risk and incentives, *Journal of Political Economy* 110, 1071–1102.
- Quadrini, Vincenzo, 1999, The importance of entrepreneurship for wealth concentration and mobility, *Review of Income and Wealth* 45, 1–19.
- Schattler, Heinz, and Jaeyoung Sung, 1993, The first-order approach to the continuous-time principal-agent problem with exponential utility, *Journal of Economic Theory* 61, 331–371.
- Shi, Lan, 2003, Responsible risk and incentives: Evidence from executive compensation, Working paper, University of Chicago, GSB.
- Sung, Jaeyoung, 1995, Linearity with project selection and controllable diffusion rate in continuous-time principal-agent problems, *RAND Journal of Economics* 26, 720–743.
- Wooldridge, Jeffrey M., 2002. *Econometric Analysis of Cross Section and Panel Data* (MIT Press, Cambridge, MA).