ENTREPRENEURIAL OVERCONFIDENCE, OUTSIDE EQUITY AND SUCCESSFUL EXITS

by

Craig R. Everett
Assistant Professor of Finance
Pepperdine University
Graziadio School of Business and Management
24255 Pacific Coast Highway, Malibu, CA 90263
Tel: 310-506-8543 Fax: 310-506-7323
Email: craig.everett@pepperdine.edu

Richard J. Fairchild
Lecturer in Corporate Finance
University of Bath, School of Management
Bath, BA2 7AY, United Kingdom
Tel: +44 (0) 1225 383456
Email: r.fairchild@bath.ac.uk

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ABSTRACT

We present a theoretical analysis of entrepreneurial start-ups that explores the relationship between overconfidence and successful exits (acquisition/IPO). In our model, increasing overconfidence produces two conflicting effects on the probability of a successful exit: it not only induces an entrepreneur to increase the riskiness of a venture (which lowers the likelihood of successful exit), but also drives higher entrepreneurial effort, increasing exit likelihood. Due to this conflict, a U-shaped relationship may exist between overconfidence and exits. Furthermore, our model suggests that increased outside equity mitigates the effects of overconfidence. Our empirical results[1] support the ideas suggested by the model.

INTRODUCTION

According to data published by the U.S. Small Business Administration from 2000 to 2004, there were consistent employment losses among large firms. During that same period, there were consistent employment *gains* among small businesses (defined as less than 20 employees). In 2004, small business generated 29% of total new jobs, but if job losses are netted out for that year, small businesses are actually responsible for 96% of overall employment gains (SBA, 2007).

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[1] Certain data included herein are derived from the Kauffman Firm Survey release 4.0. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the Ewing Marion Kauffman Foundation.

Startup firms account for approximately one-third of small business job growth in the U.S. Economy (SBA, 2007). As such, they are a critical engine for economic growth and potentially a rich source of returns for investors. Unfortunately, the return on investment in private startups is not higher than public equity returns, even though it carries substantially higher risk (Moskowitz and Vissing-Jorgensen, 2002). The poor average investment performance is driven primarily by the high failure rate of startup firms. Half of new companies close within four years and only 40% are still in existence after six years (Headd, 2003).

As a primary driver of employment growth, entrepreneurship is generally viewed as a net economic benefit to society. But if starting a business involves too much risk for too little return, then why do people do it? It is clear that entrepreneurs are not mainly motivated in their business efforts by philanthropic urges to help the macro economy. They start businesses because they want to succeed and be profitable, and the fact that they are statistically unlikely to achieve that goal does not appear to stop them from trying. The fact that entrepreneurs expend effort and resources in the pursuit of improbable success can be intuitively interpreted as overconfidence. This paper addresses the questions of how the level of entrepreneurial overconfidence impacts both the success and failure of startup firms, and the degree to which outside investment mitigates the negative effects of overconfidence.

There is a burgeoning body of literature that tries to get inside the seemingly irrational mind of the entrepreneur. Two facts emerge about what makes these people tick: 1) they tend to be overconfident in their abilities and 2) they tend to be overconfident in their likelihood of success (Hayward et al., 2006).

This may be bad news for outside investors, who presumably prefer that a business plan be realistic and account for risk appropriately. An overconfident entrepreneur will have difficulty being fully rational in evaluating the firm's investment opportunities. Since a typical stockholder's primary desire is to maximize financial returns, it is not beneficial if the entrepreneur has other motivations, such as the thrill of managing a new venture in a high-risk industry. Thus, it is important that the entrepreneur has his incentives aligned tightly with the outside stockholders.

It stands to reason, therefore, that overconfidence may be associated with lower success. Success in the world of externally funded startups is commonly defined as having a successful exit, meaning that the firm is acquired by another company or goes public via initial public offering (IPO). Either of these two events generally allows existing investors to liquidate their equity position in the firm – and hopefully at a profit.

Overconfidence has been deeply investigated as it relates to the behavior of investors in efficient or nearly efficient markets, such as public equity markets. In such environments, overconfidence is considered a negative factor, since it causes the investor to deviate from optimal decisions.

However, a debate exists regarding whether overconfidence is necessarily an undesirable entrepreneurial characteristic. There are compelling arguments on both sides. For example, Statman and Tyebjee (1985), Pruitt and Gitman (1987), Heaton (2002), and Malmendier and Tate (2002), argue that overconfident managers overestimate the quality of their projects in the capital budgeting process, and hence overinvest into value-destroying projects. Gervais et al. (2003) employ a real-options game theoretic framework in which managerial risk-aversion may induce a manager to delay investment sub-optimally. Overconfidence may mitigate this problem, since it induces a manager to invest early. Kahnemann and Lovallo (1993) argue that managerial optimism may lead to managers making "bold forecasts" regarding prospective projects, while at times making timid choices due to risk-aversion.

In terms of capital structure, Shefrin (1999), and Hackbarth (2002) have argued that overconfidence may induce managers to take on excessively high levels of value-destroying debt for their corporations. However, similar to our analysis, Fairchild's (2005) capital structure analysis demonstrates that overconfidence may have negative (excessive debt levels, resulting in higher financial distress costs) and positive effects (overconfidence results in higher value-creating effort levels). The overall effect of overconfidence on firm value trades-off these two factors.

In our theoretical analysis, entrepreneurial overconfidence may induce the entrepreneur to increase the volatility of the start-up, resulting in a greater probability of failure. However, it may also induce higher entrepreneurial efforts, increasing the probability of a successful exit. Trading-off these two factors, our model suggests that the relationship between overconfidence and the probability of successful exits may be roughly U-shaped, with the highest success probabilities arising from the extremes of low and high overconfidence.

Overconfidence within the operational management of a firm, however, has additional motivational effects that do not apply to passive investors in public securities markets. An overly optimistic self-view, or an unreasonably low estimate of project risk, can motivate the manager to undertake more ambitious goals and persist in the face of adversity (Benabou and Tirole, 2002). The presence of outside investors, however, may have a disciplinary effect on the entrepreneur, hopefully leading her to circumscribe her overconfident behavior and make rational decisions for the benefit of the firm and all its investors.

This paper investigates the relationship between successful exits and entrepreneurial overconfidence, while controlling for outside equity investment and firm characteristics. We posit a game theoretical model of a non-linear relationship between overconfidence (as proxied by its motivational effects on the entrepreneur) and the firm's ultimate IPO or acquisition.

To test this model, we use self-reported data from the Kaufmann Firm Survey of startup businesses. We find a negative relationship between overconfidence and exits. When testing for a curvilinear relationship, we find that our measure for overconfidence, which is derived from observed changes in the entrepreneur's level of effort, has a positive curvilinear relationship with exits. In other words, managers with either a very low or a very high level of overconfidence have a higher probability of successful exit.

The contribution of this paper is to present an empirically tested model of entrepreneurial behavior that explains a U-shaped relationship between overconfidence and exits. We also show that the presence of outside investors appears to mitigate the effects of that overconfidence.

BACKGROUND AND RELATED LITERATURE

Relevant research papers on overconfidence are found in various fields, including (but not limited to) entrepreneurship, finance, economics, psychology and strategy. The factors that we address in this paper with respect to their impact on the final disposition of a startup firm are: 1) the overconfidence of the entrepreneur/founder and its potential effects on performance, and 2) the mitigating impact of outside venture capital on the effects of overconfidence.

Cognitive Origins of Overconfidence

Overconfidence is essentially a distorted view of the world where the actor has expectations of personal performance that exceed the level that would be otherwise justified by an unbiased examination of the facts. These systematic distortions of reality are called cognitive biases. It is commonly understood that the human brain has developed these biases as shortcuts to deal with having to process too much information in too short a time (Baron, 1998).

There are three main categories of overconfidence: 1) overconfidence in knowledge, 2) overconfidence in prediction, and 3) overconfidence in abilities (Hayward et al., 2006). Overconfidence in knowledge refers to the entrepreneur's view that he is more knowledgeable than is truly the case. This can either be a tendency to overestimate the correctness of an original estimate and cling to it (Bazerman, 1994), or simply excessive certainty about one's command of the relevant facts of the situation (Busenitz and Barney, 1997). Within the entrepreneurial context, overconfidence in prediction refers to the systematic underestimation of the risk involved in a new venture. Entrepreneurs are notoriously susceptible to this bias. 81% of firm founders estimate their chance of success at greater than 70% and a full third of founders estimate their chance of success at an unfathomable 100% (Cooper, Woo and Dunkleberg, 1988). An entrepreneur who is overconfident in ability may correctly estimate the risk of a venture, but believes that, unlike his peers, his unique skills (and perhaps his winning personality) will allow him to overcome the odds and succeed anyway (Hayward, Shepherd and Griffin, 2006). Overconfidence in ability is not unique to entrepreneurs, but is common in professions that are highly complex. For example, 94% of college professors feel that they have higher ability than their peers (Gilovich, 1991). In this paper, we focus on the effects of ability overconfidence.

Overconfidence in Ability

The primary driver of overconfidence in ability, skill or knowledge is attribution bias. This refers to the tendency of people to attribute successes to their own ability, while attributing their failures to outside factors. When an actor applies Bayes Rule to update his beliefs about his own ability, there will be a tendency to overweight successes and underweight failures. Over time, however, this bias diminishes as the evidence becomes overwhelming and the overconfident actor ultimately becomes aware of his true ability level (Gervais and Odean, 2001). Successful entrepreneurs have been shown to possess lower levels of attribution bias than their unsuccessful peers (Baron, 1998), confirming the intuition that there is a negative relationship between this type of overconfidence and performance.

The interrelated factors of age, experience and education have also been shown to influence overconfidence in ability. Taylor (1995) shows that both age and amount of management experience are negatively related to confidence. A higher level of education, on the other hand, appears to make people more sure of themselves than is justified (Lichtenstein and Fichoff, 1977). Likewise, the behavior of young, small firms is consistent with overconfident managers (Forbes, 2005). Gender has also been shown to be a factor, with boys being consistently more overconfident than girls in activities such as investing (Barber and Odean, 2001).

Measuring Overconfidence

A difficulty with testing the effects of overconfidence on financial decision-making is finding a good measure for this fundamentally unobservable characteristic. The most influential early attempt was provided by Malmendier and Tate (2002), who used executive stock option exercise decisions[2] as a proxy for overconfidence. Subsequently, Malmendier and Tate (2005) used an alternative measure: press releases that described individual entrepreneur characteristics as optimistic or pessimistic. Barros and da Silveira (2008) used a simple classification: entrepreneurs and non-entrepreneurs. Combined with this, they analyze other, more directly observable characteristics, such as gender, level of education, age. Oliver (2010) used the Michigan consumer sentiment index.

Hence, due to the non-observability of managerial overconfidence, researchers have either employed managerial *actions* (such as executive stock option exercise) as *indirect* proxies for overconfidence, or *direct* reports from outside observers, such as press releases.

In this paper, we take a new approach in generating our proxies for overconfidence, as follows. For our first measure, we use entrepreneurial actions (changes in level of effort) to proxy for overconfidence. This may result from increasing overconfidence as the entrepreneur becomes 'more comfortable' with his firm, or it may be due to an escalation of commitment/project entrapment (see, e.g. Statman and Caldwell, 1987). Regardless, it is intuitively obvious that an entrepreneur will only expend effort on the enterprise if she is confident that her effort will positively impact the enterprise's probability of success.

For our second proxy, we start with the decision to start a business in the face of high failure rate, as measured by mean industry failure rate within the sample. We extend this measure by incrementing or decrementing over time based on firm performance, which the entrepreneur attributes to himself when positive.

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[2] Malmendier and Tate (2002) argue that an overconfident executive would delay exercise of stock options too long, rather than rationally diversify as soon as possible.

In our empirical analysis, we consider the relationship between entrepreneurial overconfidence and the probability of successful exits. Our model develops the following hypotheses (which are supported by our empirical work): a) there exists a curvilinear relationship between overconfidence and the probability of a successful exit, and b) the negative effects of overconfidence may be mitigated by outside equity, perhaps due to monitoring or other controls. Furthermore, we argue that increased overconfidence may be proxied by higher hours worked. Our model provides a justification for this. Finally, it is interesting to note that we need to consider two aspects, the probability of success, and the expected value of the exit. Our model shows that the two are not identical.

MODEL OF ENTREPRENEURIAL OVERCONFIDENCE AND EXITS

Model Setup

We consider an entrepreneur E who runs a start-up business. The objective of the E is to take the start-up towards a successful IPO. The E has an equity stake $\alpha \in [0,1]$ in the business, with the remainder of equity $1-\alpha$ being held by outsiders. All players are risk neutral, and the risk-free rate is zero.

The E makes two choices: a) which project to invest in (a safe or a risky project), and b) how much effort to exert in developing the start-up towards IPO. The specific timeline of the game is as follows:

Date 0: The entrepreneur chooses between two projects: a risky one or a safe one. The safe project achieves Date 2 IPO for sure, which brings Date 2 income $S > 0$. The risky project has two possible Date 2 outcomes: 'success' (that is, a successful IPO) or failure. In the case of success, the risky project provides Date 2 income $R > S > 0$. In the case of failure, the risky project provides zero date 2 income. The probability of success or failure is affected by the E's Date 1 effort level, as described below.

Date 1: If the E chose the safe project, it will succeed for sure, and the E does not need to exert any effort. If the E chose the risky project, he exerts effort e in taking the venture towards an IPO. The E faces a cost-of-effort βe^2 (which, of course, demonstrates increasing marginal cost of effort).

His effort affects the probability of success for the risky project. Specifically, the probability of success is $P_R = \gamma e,$ where γ represents entrepreneurial ability.

In our model, the E may be overconfident in his ability. We model this as follows. The E's perceived ability parameter in the case of the risky project is $\hat{\gamma} \geq \gamma$. In the case that $\hat{\gamma} = \gamma$, the E is rational/well-calibrated. Increasing overconfidence is represented by increasing $\hat{\gamma}$ in excess of γ.

Date 2: The chosen project either succeeds or fails, and the E, and the outside investors, receive their payoffs.

We solve the game by backward induction. First, we take as given the E's Date 0 project choice, and solve for his optimal Date 1 effort level. Then we move back to Date 0 to solve for his equilibrium project choice. Our objective is to examine the effects of overconfidence on these decisions.

Date 1: E's effort choices

If the E chose the safe project[3] at Date 0, it succeeds for certain. Hence, he does not need to exert any effort. The value of the safe project is (trivially):

$$V_S = S. \tag{1}$$

The E's payoff is

$$\prod_E = \alpha S. \tag{2}$$

Now, consider the case where the E has chosen the risky project at date 0. The expected value of the project is

$$V_R = PR = \gamma eR. \tag{3}$$

The E is overconfident, and *perceives* the value of the project[4] to be:

$$\hat{V}_R = \hat{P}R = \hat{\gamma}eR. \tag{4}$$

He chooses his effort level to maximize his perceived payoff

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[3] We assume that the firm consists of only the one project chosen. Hence, throughout, we refer to the firm and the project interchangeably. Effectively, the value of the project is identical to the value of the firm.

[4] Throughout the text, variables identified with $\hat{X}$ refers to the E's perceived value (due to overconfidence). Variables without the 'hat' refer to the true values.

$$\hat{\prod}_E = \alpha\hat{\gamma}eR - \beta e^2. \quad (5)$$

We emphasize that this is the E's perceived payoff (represented by the 'hat'), since it incorporates the perceived ability parameter, which may be greater than the true ability parameter: $\hat{\gamma} \geq \gamma$. We obtain his optimal effort level by solving $\frac{\partial \hat{\prod}_E}{\partial e} = 0$. Next, we substitute this optimal effort level into his perceived payoff (1).

We also substitute his optimal effort level into the *true* success probability $P_R = \gamma e$, and the *true* firm value $V = P_R R = \gamma eR$.

We thus obtain our first result in the case of the risky and safe projects.

Proposition 1:

a) If the E has chosen the risky project at date 0, his optimal effort level, his perception of success probability, his perception of firm value, and his perceived payoff, is as follows:

$$e_R* = \frac{\alpha\hat{\gamma}R}{2\beta},\ \hat{P}_R* = \frac{\alpha\hat{\gamma}^2 R}{2\beta},\ \hat{V}_R* = \frac{\alpha\hat{\gamma}^2 R^2}{2\beta},\ \hat{\prod}_R* = \frac{\alpha^2\hat{\gamma}^2 R^2}{4\beta}.$$

He is overconfident ($\hat{\gamma} \geq \gamma$), *and the true success probability, true firm value, and his true payoff, is as follows:*

$$P_R* = \frac{\alpha\hat{\gamma}\gamma R}{2\beta},\ V_R* = \frac{\alpha\hat{\gamma}\gamma R^2}{2\beta},\ \prod_R* = \frac{\alpha^2 R^2[2\hat{\gamma}\gamma - \hat{\gamma}^2]}{4\beta}.$$

b) If the E has chosen the safe project, his optimal effort level is zero, since the project succeeds for sure. Therefore, the success probability, firm value, and his payoff is as follows[5]*:*

$$P_S* = 1, \quad V_S* = S, \quad \prod_S * = \alpha S.$$

We note the following. In Proposition 1a), the overconfident E overestimates his ability, and hence overestimates the effect of his effort on the success probability. Hence, his effort level is increasing in overconfidence. Also, he overestimates the value of the venture, and he overestimates his payoff from the risky project.

Date 0: E's choice of project

We now move back to consider the effect of overconfidence on the E's choice of project, effort level, success probability, and venture value. In order to do so, we simply compare the results in Proposition 1.

First, we note that the E chooses the risky project if his perceived payoff from doing so exceeds his perceived payoff from the safe project: that is, iff

$$\frac{\alpha^2 \hat{\gamma}^2 R^2}{4\beta} \geq \alpha S. \tag{6}$$

In order to make the analysis interesting, we assume the following:

[5] Note that in the case of the safe project, we assume that he is well-calibrated, so that his perception of success probability, firm value, and his payoff is correct (in contrast to the risky project, where he is overconfident).

$$\frac{\alpha^2\gamma^2R^2}{4\beta} < \alpha S. \qquad (\textit{Assumption 1}).$$

That is, the E's true payoff under the safe project is higher than that under the risky project. Therefore, a well calibrated E (for whom $\hat{\gamma} = \gamma$) will choose the safe project.

We define a critical level of overconfidence $\hat{\gamma}_1$ at which the E will switch from the safe to the risky project. Thus, $\hat{\gamma}_1$ satisfies (6) as an equality. Hence,

$$\hat{\gamma}_1 = \sqrt{\frac{4\beta S}{\alpha R^2}}. \tag{7}$$

Next, we derive the critical overconfidence parameter at which the value of the risky firm rises to equal the value of the safe firm. Now, since $R > S > 0,$ there exists a critical *perceived* success probability $\hat{P}_{11}$ (and therefore critical overconfidence level $\hat{\gamma}_{11})$) at which the value of the risky project rises to equal the value of the safe project. Since $V_R = PR,$ and $V_S = S,$ this critical probability is

$$\hat{P}_{11} = \frac{S}{R} < 1. \tag{8}$$

In order to derive the critical overconfidence level, we equate (from proposition 1):

$$\frac{\alpha\hat{\gamma}\gamma R^2}{2\beta} = S. \tag{9}$$

When considering the effect of overconfidence on E's choice of project, we considered the E's *perceived* payoff. Now, when considering the effect of overconfidence on firm value, we consider *true* firm value.

The critical overconfidence level that satisfies (9) (that is, that equates the value of the risky and the value of the safe project) is

$$\hat{\gamma}_{11} = \frac{2\beta S}{\alpha\gamma R^2}. \tag{10}$$

Next, it is interesting to consider the effect of overconfidence on the probability of success for the safe project. First, we note that, at the critical overconfidence parameter $\hat{\gamma}_{11}$, where the value of the safe and risky projects are equated, the true success probability of the risky project is

$$P_R{*} = \frac{\alpha\hat{\gamma}\gamma R}{2\beta} = \frac{S}{R} < 1. \tag{11}$$

The implication of this is that overconfidence may result in a lower success probability for the risky project compared with the safe project, but the risky project may have the higher expected value. Indeed, for $\gamma > \hat{\gamma}_{11}$, the probability of success for the risky project will be lower than that for the safe project, but the expected value of the risky project will be higher (due to the higher outcome in the case of success).

Hence, empirical analysis that examines success probability only may be understating the effect of overconfidence on expected value. We need to consider both the success probability, and the outcome in the case of success (that is, we need to consider the expected outcome). The success probability may be low, but the outcome in the case of success may be high.

Finally, it is interesting to note that, for the risky project, the probability of success can never reach 1. This is because, as the overconfident E's perceived ability increases, we reach the critical level of overconfidence $\hat{\gamma}_C$ where the E's perceived success probability reaches 1; that is:

$$\hat{P}_R* = \frac{\alpha\hat{\gamma}^2 R}{2\beta} = 1 => \hat{\gamma}_C = \sqrt{\frac{2\beta}{\alpha R}}. \tag{12}$$

Since the E perceives the success probability to be 1, any further increase in perceived ability will not draw forth any further effort increases (as, in the E's perception, this would be wasted effort: he believes that the project already succeeds for sure). Hence the true success probability of the risky project is 'capped' at

$$P_R* = \frac{\alpha\hat{\gamma}\gamma R}{2\beta} = \gamma\sqrt{\frac{\alpha R}{2\beta}} = \frac{\gamma}{\hat{\gamma}_C} < 1. \tag{13}$$

To complete the analysis, we compare the critical overconfidence parameters given in (8) and (10). Equating (8) and (10), we note the following:

Lemma 1:

a) *If the E's true ability is sufficiently low:* $\gamma < \sqrt{\frac{2\beta S}{\alpha R^2}}$; *then* $\hat{\gamma}_{11} > \hat{\gamma}_1$.

b) *If the E's true ability is sufficiently high:* $\gamma \geq \sqrt{\frac{2\beta S}{\alpha R^2}}$; *then* $\hat{\gamma}_1 \geq \hat{\gamma}_{11}$.

The intuition behind this result is that the E's true ability parameter affects the comparison of the true value of the risky and safe project (given by $\hat{\gamma}_{11}$), but does not affect the E's choice of project (given by $\hat{\gamma}_1$), since he focuses on his *perceived* ability.

We draw this discussion together in our main results:

Proposition 2: *Effect of E's overconfidence on project choice, success probability, and firm value, when the E's true ability is low:*

If $\gamma < \sqrt{\frac{2\beta S}{\alpha R^2}}$; *such that* $\hat{\gamma}_{11} > \hat{\gamma}_1$, *then*

a) If $\hat{\gamma} \in [\gamma, \hat{\gamma}_1]$, *the E chooses the safe project. Success probability is 1. The value of the safe project exceeds the value of the risky project:* $V_S > V_R$.

b) If $\hat{\gamma} \in (\hat{\gamma}_1, \hat{\gamma}_{11}]$, *the E switches to the risky project. Success probability falls below 1. However, success probability increases as E's overconfidence increases in this interval. The E's choice of project is inefficient, since the value of the safe project remains higher than the value of the risky project:* $V_S > V_R$.

c) If $\hat{\gamma} > \hat{\gamma}_{11}$, *the E continues to take the risky project. Success probability continues to rise as overconfidence increases. The E's choice of project is now efficient. Overconfidence is sufficiently high, such that* $V_R > V_S$.

Furthermore,

Proposition 3: *Effect of E's overconfidence on project choice, success probability, and firm value, when the E's true ability is high:*

If $\gamma \geq \sqrt{\frac{2\beta S}{\alpha R^2}}$; *such that* $\hat{\gamma}_1 > \hat{\gamma}_{11}$, *then* *a)* *If* $\hat{\gamma} \in [\gamma, \hat{\gamma}_{11}]$, *the E chooses the safe project. Success probability is 1. The value of the safe project exceeds the value of the risky project:* $V_S > V_R$.

b) *If* $\hat{\gamma} \in (\hat{\gamma}_{11}, \hat{\gamma}_1]$, *the E continues to take the safe project. Success probability is still 1. The E's choice of project is inefficient, since the value of the risky project is now higher than the value of the safe project;* $V_R > V_S$.

c) *If* $\hat{\gamma} > \hat{\gamma}_1$, *the E switches to the risky project. Success probability falls below 1, but rises as overconfidence increases. The E's choice of project is now efficient:* $V_R > V_S$.

The only difference between Propositions 2 and 3 is in the interim interval given in Proposition 2b) and 3b).

Propositions 2 and 3 emphasize the importance of considering both the success probability and the outcome in the case of success. The risky project may have lower success probability, but may have higher expected value due to the higher outcome in the case of success.

Numerical Example

In order to clarify the analysis, we now consider a numerical example, with the following parameters:

$$S = 50,\ R = 100,\ \alpha = 0.5,\ \gamma = 5,\ \beta = 5{,}000.$$

Note that we have chosen true ability parameter $\gamma = 5$. We noted in lemma 1 (and Proposition 2 and 3) that there exists a critical value for the true ability, such that if true ability is low, then Proposition 2 applies, and if it is high, then Proposition 3 applies. Given our parameter values in this example, the critical true value is

$$\sqrt{\frac{2\beta S}{\alpha R^2}} = 10.$$

Therefore, we focus on low true ability parameter, such that proposition 2 holds. Substituting the parameter values into proposition 1, we note that the true success probability is given by

$$P_R * = \frac{\alpha \hat{\gamma} \gamma R}{2\beta} = 0.05\hat{\gamma}.$$

Therefore, the true value of the risky project is

$$V_R * = \frac{\alpha \hat{\gamma} \gamma R^2}{2\beta} = 2.5\hat{\gamma}.$$

E's perceived payoff is

$$\hat{\Pi}_R * = \frac{\alpha^2 \hat{\gamma}^2 R^2}{4\beta} = 0.125\hat{\gamma}^2.$$

The critical overconfidence parameter at which E switches from the safe to the risky project is

$$\hat{\gamma}_1 = \sqrt{\frac{4\beta S}{\alpha R^2}} = 14.14.$$

The critical overconfidence parameter at which the value of the risky project becomes larger than the value of the safe project is

$$\hat{\gamma}_{11} = \frac{2\beta S}{\alpha \gamma R^2.} = 20.$$

Therefore, $\hat{\gamma}_{11} > \hat{\gamma}_1$, such that Proposition 2 applies. We may thus present the following diagram.

Insert Figure 1 here

The E's choice of project is represented by the thick line. Up to the critical value $\hat{\gamma}_1 = 14.14$ he chooses the safe project. After this critical value, he switches to the risky project. Until $\hat{\gamma}_{11} = 20$ this is inefficient, as the safe project continues to provide the higher value. However, after $\hat{\gamma}_{11} = 20$ overconfidence is sufficiently high that the risky project provides higher value (due to E's higher effort level). In summary, the analysis contributes to the debate surrounding managerial overconfidence. We have demonstrated that overconfidence can be value-reducing (it causes entrepreneurs to take too much risk: in the model, switching from the safe to the risky project). However, it can be value-increasing, as overconfident entrepreneurs work harder.

The next chart considers the success probability. It supports our empirical analysis of a U-shaped relationship between overconfidence and success probability. In our model, this U-shape arises because overconfidence causes the E to switch from safe to risky projects, but, as his overconfidence becomes sufficiently large, this drives higher effort. Combining the two charts, we observe that we need to consider the effect of overconfidence both on the success probability and the expected value. Although the probability of success is lower in the risky case than the safe case, the risky project has higher expected value once the level of overconfidence becomes sufficiently large (above $\gamma'' = 20$).

Insert Figure 2 here

Outside equity and monitoring

Thus far, we have assumed that the start-up entrepreneur is free to choose his project (safe or risky) unhindered by outside influence. Now, we introduce the idea that outsider equity-holders may be able to monitor the entrepreneur and affect his choice of project.

Since the entrepreneur holds an equity stake $\alpha \in [0,1]$ in the business, outside equity-holders hold the balancing equity-stake $1-\alpha$. We model their monitoring effort as a binary decision as follows. They can monitor the entrepreneur at cost $M > 0$. Monitoring is perfect, in that it enables them to prevent the entrepreneur form taking the risky project. On the other hand, they may choose not to monitor, in which case the entrepreneur is free to make his project choice without hindrance.

We continue to focus on the case where the entrepreneur has low true ability (proposition 2). Firstly, we note that, in the case where the entrepreneur has low overconfidence in his ability (Proposition 2a: $\hat{\gamma} \in [\gamma, \hat{\gamma}_1],$), he takes the safe project. As this is the value-maximizing choice, outside equity-holders will not wish to monitor him.

In the case where the entrepreneur has high overconfidence in his ability (Proposition 2c: $\hat{\gamma} > \hat{\gamma}_{11},$), he switches to the risky project. However, his overconfidence is sufficiently high that he works hard enough for the value of the risky project to exceed the value of the safe project. Again, the outside equity-holders will not wish to monitor him, as their expected wealth is maximized by his choice.

The outside equity-holders' monitoring decision is relevant in the case where the entrepreneur has medium overconfidence (Proposition 2b: $\hat{\gamma} \in (\hat{\gamma}_1, \hat{\gamma}_{11}],$). In this case, the entrepreneur chooses the risky project, but the safe project has the higher value. In this interval, if the outside equity holders do not monitor, their expected payoff is

$$\prod_O = (1-\alpha)V = (1-\alpha)\frac{\alpha\hat{\gamma}\gamma R^2}{2\beta}.$$

If they monitor, their expected payoff is

$$\prod_O = (1-\alpha)S - M.$$

Therefore, they monitor iff:

$$(1-\alpha)(\frac{\alpha\hat{\gamma}\gamma R^2}{2\beta}-S)\geq M.$$

That is, they monitor if their monitoring costs are sufficiently low, and if their equity stake is sufficiently high.

Note that, as outside equity decreases/inside equity increases, both $\hat{\gamma}_1$ and $\hat{\gamma}_{11}$ decrease. Nevertheless, in that interval, we may state the following result:

Proposition 4: *Given that the entrepreneur wishes to invest in the risky project, and given that this choice is value-reducing, outside equity-holders will monitor if their outside equity is sufficiently high, given the monitoring costs. Monitoring forces the entrepreneur to choose the safe project, increases the probability of success, and increases the expected firm value.*

If outside equity ownership is below a critical level, the outsiders do not monitor the entrepreneur, and he takes the risky project, which reduces the probability of success, and reduces expected venture value.

Hence, our model supports the idea that there may be a positive relationship between outside equity and success of the start-up, due to increased incentives for outsiders to monitor.

It is interesting to note that, in agency/moral hazard models of capital structure, such as Jensen and Meckling (1976), an increase in inside equity/decrease in outside equity is desirable to align managerial incentives with outside equity-holders. In our current model, we achieve the opposite result. Why is this?

The answer comes from considering the behavioral aspects of the model. The entrepreneur believes that he is making the optimal choice of project, but in fact is overconfident. Now, increasing his equity stake may actually worsen the problem. Therefore, outside equity-holders are needed to monitor him.[6]

Furthermore, it is interesting to note that we have assumed that outside investors are fully rational, and are thus able to objectively monitor the manager. However, there is a body of evidence that outsiders, such as venture capitalists, may be equally overconfident in the success of the venture. It would be interesting to include this in the model. However, we leave this for future research.

DATA

The primary data source for this paper is the public version of the Kauffman Firm Survey (KFS). The KFS is a longitudinal panel study of new businesses founded in 2004 and then tracked over the following four years. 4928 firms were sampled from the Dun & Bradstreet database. The survey data collected includes: nature of formation activities, strategy, employment patterns, employee benefits, sources of capital and other financial arrangements, and characteristics of the founders. The associated variables are described in Table 1.

This paper concerns only those firms with a potential for outside investment, so it is necessary to exclude sole proprietorships and partnerships, which leaves a total of 3,038 firms.

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[6] This argument is similar to that made by Shefrin (1999), who argues that, if bad managerial decisions are simply caused by self-interested moral hazard, this can be corrected through managerial incentive schemes (such as increasing the manager's equity stake). However, if bad managerial decisions come from behavioral biases (the manager believes that he is doing the right thing for shareholders, but in reality is mistaken), then this is much more difficult to correct through incentive schemes. Now education (or monitoring) may be more effective.

Since we measure the effects of cognitive bias on firm success and failure, it is necessary to drop from the sample all firms who failed or had a successful exit in the first two follow-up years of the survey. Those are the years in which the cognitive bias measures are being generated, thus those outcomes could not be related to the measures being studied. Thus, the final sample size is 2,042 firms.

Insert Table 1 Here

Table 2 contains summary statistics. Of all 2,042 firms, 28.5% of them fail in 2007 and 2008, while only 2.4% achieve a successful exit. Firms possessing patents have a successful exit four times more frequently. Whether the founder is male or female does not appear to make a significant difference in the raw results.

Nearly half of the firms with a successful exit had outside capital at startup, whereas only 29% of the failed firms had outside capital. The mean percentage of outside equity ownership was 19.4% for successful exit firms, but only 14.5% for failed firms.

Insert Table 2 Here

EMPIRICAL METHODOLOGY AND PREDICTIONS

There are three possible mutually exclusive states for the firm at the end of the study: failure (worst case), survival, and exit (best case). The central model is a logistical analysis as shown in equation (14)

$$DISP_i = \alpha + \beta_1 OC_i^2 + \beta_2 OC_i + \theta FC_i + \gamma CEOC_i + \varepsilon_i \quad (14)$$

where DISP represents either EXIT or FAIL, depending on which outcome is being tested. OC represents entrepreneurial overconfidence from attribution bias. FC represents the control variables for firm characteristics, such as risk-style, size, leverage and the presence of patents. CEOC represents a vector of traits of the entrepreneur herself. Both the firm and entrepreneur characteristics have been shown to be significant predictors of performance in other research.

We empirically test two original proxies for overconfidence. The first is the observed overconfidence of the entrepreneur based on changes in personal level of effort as compared to the other key employees. The second is a measure constructed by adding the effects of (supposedly) overconfidence enhancing events to an estimate of initial overconfidence. We will discuss these two overconfidence proxies one at a time, starting with the measure based on level of effort.

In constructing a measure for overconfidence, Grinblatt and Keloharju (2009) take their raw overconfidence proxy and regress it against demographic variables that had been shown to be associated with overconfidence. They use the resulting residuals as an overconfidence measure in subsequent analyses. We do not take this approach, since we find that because our overconfidence measures are short-term, they are unreliably associated (if at all) with demographic characteristics, consistent with Ben-David, Graham and Harvey (2006). We therefore use our constructed overconfidence measures in their raw form. Correlations between our measures of overconfidence and all explanatory variables, including demographics, are shown in Table 3.

Insert Table 3 Here

The entrepreneur founder is assumed to start at year zero already possessing some level of overconfidence. Since most firms will fail, it is reasonable to assume that anyone who starts a firm must be overconfident – at least to some degree (Camerer and Lovallo, 1999). The proxy we choose for initial overconfidence is the mean sample failure rate for the industry[7] in which the entrepreneur is starting the firm. These failure rates fall between zero and one.

According to our theoretical model, the initial overconfidence measure is updated based on E's observed motivation level. An entrepreneur with attribution bias believes that she has the power to generate the desired firm outcome through her own efforts. For each of the first three years we calculate the HOURSSLICE, which is the percentage of hours that entrepreneur works as compared to the total hours for the top five owners. We then calculate the percentage change in hours slice (which can be positive or negative) and add it to the starting overconfidence figure. Since many of these firms have only one owner working in the firm, these firms have a constant HOURSSLICE of 100%, and hence no change from year to year. To capture the absolute

[7] In this paper, industries are always defined by their respective 2-digit SIC code.

change in E's hours, we also calculate the percentage change in entrepreneur hours for each of the first three years and add it to the measure as follows:

$$OC(effort)_i = \sum_{t=1}^{3}[\frac{(HOURSSLICE_{i,t} - HOURSSLICE_{i,t-1})}{HOURSSLICE_{i,t-1}} + \frac{(HOURS_{i,t} - \ HOURS_{i,t-1})}{HOURS_{i,t-1}} \ ]$$

The second measure that we construct is based on the idea that the entrepreneur starts with an exogenously determined level of overconfidence, and then this overconfidence is updated based on interim firm outcomes. Our proxy for initial overconfidence is the mean failure rate of firms in the sample that are within the entrepreneur's industry. The idea is that it takes a higher level of confidence to start a firm in a risky industry than it does to start a firm in a safe industry. Then, in each of the next three years, if profit is higher than the previous year, overconfidence is incremented by a constant (0.382, which is the overall business failure rate in the sample). That number was chosen because it is the same order of magnitude as the initial overconfidence measure, so neither should overwhelm the other. The empirical results are robust to other choices for that constant. In years when profit is lower than the previous year, the overconfidence measure is decremented by half the amount of that constant. This is based on the idea that entrepreneurs with attribution bias put a heavier weight on events that reinforce their bias.

$$OC(attrib)_i = FR_{IND} + \sum_{t=1}^{3}[(1_{profit_t > profit_{t-1}} * FR_{mean}) - (1_{profit_t < profit_{t-1}} * \frac{FR_{mean}}{2})]$$

Since attribution bias reflects an inability to correctly interpret root causes of success and failure, it follows that this bias should be associated with suboptimal decision-making, and thus a lower number of exits and higher number of failures. Hence the following hypothesis:

H1: Overconfidence is negatively associated with successful exits.

In the extant literature, overconfidence has traditionally been modeled in a linear fashion. Since this paper admits the possibility of a nonlinear overconfidence function, all regressions will also include a squared overconfidence term to capture any potential non-linear effects. Based on our model, the expectation is that the relationship between overconfidence and exit is U-shaped.

H2: Overconfidence has less negative effects at extreme levels, resulting is a positive curvilinear relationship with successful exits.

The above hypotheses assume that the entrepreneur is unchecked and therefore subject to the full impact of his overconfidence and risk-taking style. If there is outside investment, however, the investors may not allow the manager to have completely free reign, but will engage in monitoring activities in order to protect their investment. Venture capitalists would not invest unless their expected return is positive and they are appropriately compensated for the expected risk. Thus, somehow the rationality of the external investors must, in the aggregate, overcome the irrationality of the entrepreneurs themselves. These effects should manifest themselves as reduction in either the magnitude or the significance of the coefficients of the measures for overconfidence.

H3: Outside capital mitigates the effects of CEO overconfidence and is therefore associated with increased successful exits.

Hypothesis 3 is tested using one-way analysis of variance (ANOVA) tests of the differences in the firm disposition population mean. The dependent variable is *EXIT* and the groups are defined by the indicator variable *Ext. Capital (end)*, which has a value of 1 if the firm has outside investors in year 2. The test is repeated with the independent variable *Ext. Control (end)*, which has a value of 1 if the firm is more than fifty percent owned by outside investors at the end of year 2.

RESULTS

The empirical results of the logit analyses of the effects of overconfidence on successful exit are summarized in Table 4. In columns 1-4, the dependent variable is *EXIT*. In columns 5-8, the dependent variable is *FAIL*. Control variables include leverage, size, the presence of outside equity, and whether or not the firm has patents. In all models, the coefficient is negative and both economically and statistically significant. These results support Hypothesis 1, which posits that overconfidence is negatively related to firm performance.

Insert Table 4 Here

Table 4 also provides evidence for Hypothesis 2. Our measure of effort-based overconfidence has a strongly positive curvilinear association with both successful exits and failures. This is consistent with our game theoretical model that suggests that overconfidence causes the entrepreneur to switch from safe to risky projects, but as overconfidence becomes sufficiently large, it also results in higher effort levels. The results are robust to the inclusion of all the available controls and are significant at the 1% level in every model. This evidence of a curvilinear relationship between overconfidence and firm outcomes appears to be unique to this paper.

The third testable hypothesis is that the monitoring effects of outside investors improve the probability of successful exit by reducing the negative effects of overconfidence or by improving the positive effects (i.e. motivation). In columns 1-4 of Table 4, the coefficient on the initial outside capital variable *Ext. Capital (beg)* is positive and significant, which is consistent with this hypothesis. Outside control is also positive, but is only significant for the level of effort overconfidence measure, and only at period two.. The comparisons of population means reported in Table 5 are also supportive of Hypothesis 3. Specifically, both the presence of outside capital at startup and outside control at year two significantly increase the mean of *EXIT*. This is confirmatory evidence that outside investors improve the chances that the firm will have a successful exit.

The presence of outside investors should mitigate the ill effects of entrepreneur overconfidence and therefore have a negative relationship with firm failure. The evidence does not support this hypothesis, but this may be due to the short time horizon of the study. The results reported for *FAIL* in Table 4 are ambiguous. The coefficients for the outside capital variables are positive, but only outside control at year 2 is significant, and again, only for the overconfidence measure based on changes in the entrepreneur's level of effort. Looking at the mean comparisons in Panel B of Table 5, the presence of outside investment – either initially or at year 2 - does not affect the failure rate. Outside control, however, either at startup or at year two, have a very significant and *positive* impact on the mean failure rate. This result begs the question of why firms should seek outside investment if it just increases the probability of failure. The intuition is fairly straightforward about what might be happening. Outside control of the firm leads to dispassionate and rational decisions when faced with the real option of either abandoning the venture or extending it. The entrepreneur is emotionally tied to the project, so he will be biased toward extending the life of the firm even when it is not warranted. A venture capitalist is more likely to realistically interpret bad signals and make the tough decision to liquidate the firm earlier in the process in order to redirect investment funds to more promising opportunities. Hence, outside control is associated with higher numbers of exits, due to expertise in taking new ventures there, and is also associated with higher failures, due to the ability to coldly liquidate a firm that is not meeting its predetermined benchmarks.

Insert Table 5 Here

CONCLUSIONS

Startup firms account for approximately one-third of small business job growth and thus are a critical engine for economic growth. Their efficacy as an investment is less assured, since they carry such a high risk of failure. Half of new companies close within four years.

Unless they are irrational, entrepreneurs must either overestimate their personal ability to succeed in the face of very long odds, or alternatively, don't believe that the odds are really that long. These two distortions of reality can be explained by cognitive biases documented in psychology literature. The one that we address in this paper is attribution bias.

Attribution bias refers to the tendency to attribute good outcomes to our superior ability, while attributing bad outcomes to bad luck or other external forces. The result is overconfidence in personal ability. Overconfidence can lead to suboptimal management behaviors, such as overinvestment. On the other hand, confidence is also positively related to motivation levels, which could mitigate some of the ill effects of overconfidence. In the short-term, overconfidence appears to reduce the probability that the firm will fail, which is likely due to the entrepreneur refusing to quit even when quitting is the most rational decision. Ultimately, however, a failing firm must fail, so a longer horizon study should reveal a curvilinear relationship between overconfidence and firm failure over time, where overconfidence reduces failure in the short-run yet increases failure in the long-run. This is a topic for further study.

Outside equity mitigates the ill decision-making effects of overconfidence while enhancing the motivation of the founder/entrepreneur. These relationships are tested using data from more than two thousand startup firms supplied by the Kauffman Firm Survey. Outside control of the firm appears to shorten the life of the firm by encouraging both successful exits and prompt failures.

We find evidence of a positive curvilinear relationship between overconfidence and successful exits. The insight that may be drawn from this result is that new ventures may be best managed by people that are either perfectly rational about their own abilities or else managed by someone highly overconfident. Our empirical results indicate that success may be more limited for managers that are between the two extremes.

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Table 1
Description of Variables

Variable	Description
EXIT	Equals 1 if firm is acquired, merges or goes public
FAIL	Equals 1 if firm fails
Ext. Capital (beg)	Equals 1 if the firm had outside capital (debt or equity) at startup
Ext. Capital (end)	Equals 1 if the firm had outside capital at second follow-up year
Ext. Control (beg)	Equals 1 if outside equity exceeded 50% at startup
Ext. Control (end)	Equals 1 if outside equity exceeded 50% at second follow-up year
OC (attrib)	Overconfidence proxied by attribution bias measure
OC (effort)	Overconfidence proxied by escalation of hours worked by entrepreneur
Size	The proxy for firm size is average number of employees for first three years
Patents	Equals 1 if the firm had a least one patent at startup
Leverage	Total Debt divided by Total Assets at startup
CC	Personal credit card debt of entrepreneur at startup
Age	Age of entrepreneur at startup 1=18-24, 2=25-34, etc.
Male	Equals 1 if male, 0 if female.
Ind Exp.	Entrepreneur years of industry experience
Prev. Startups	Entrepreneur total number of previous startups
Prev. Startups(ind)	Entrepreneur total number of previous startups in same industry
Education	Highest level of education completed by entrepreneur
Afr. Amer.	Equals 1 if African American
Latino	Equals 1 if Latino
Urban	Equals 1 if business is in urban area

Table 2
Summary Statistics

PANEL A: Firm count / Percentage of total			
	Successful Exit	Survival	Failure
Total Firms	49 / 2.4%	1411 / 69.1%	582 / 28.5%
Patents	5 / 10.2%	71 / 5.0%	28 / 4.8%
Male CEO	41 / 83.7%	1102 / 78.3%	458 / 78.7%
Female CEO	8 / 16.3%	305 / 21.7%	124 / 21.3%
African American	1 / 2.0%	82 / 5.9%	55 / 9.5%
Latino	4 / 8.2%	58 / 4.1%	34 / 5.9%
Ext. Capital (beg)	22 / 44.9%	402 / 28.5%	169 / 29.0%
Ext. Capital (end)	12 / 24.5%	310 / 21.9%	143 / 24.6%
Ext. Control (beg)	13 / 26.5%	282 / 20.0%	140 / 24.1%
Ext. Control (end)	11 / 22.5%	173 / 12.3%	101 / 17.4%
Entrepreneur's Investment	35 / 71.4%	1511 / 81.6%	473 / 81.3%

PANEL B: Mean Variable Values			
	Successful Exit	Survival	Failure
Leverage	0.558	0.495	0.500
Size (average)	4.748	3.079	3.135
Outside Equity	0.194	0.125	0.145
Age of CEO	3.408 (≈44)	3.656 (≈47)	3.550 (≈46)
Industry Experience	12.735	14.464	12.876
Prev. Startups	1.020	1.011	1.103
Prev. Startups (same Ind)	0.265	0.215	0.215
Education	7.082	6.820	6.601

This table contains summary statistics for the 4928 firms included in the Kaufmann Firm Survey (KFS). Since the analyses conducted in this paper are concerned with outside equity investment, sole proprietorships (1635), general partnerships (170), limited partnerships (74), and other (11) are excluded, leaving a total of 3038 firms in the initial dataset. Further, since this paper is concerned with firms that fail or exit in 2007 or 2008 as a result of overconfidence demonstrated in 2004-2006, observations for firms that failed or exited in 2005 (563) or 2006 (433) are also excluded, leaving a total of 2042 observations.

Table 3
Pearson Correlation Coefficients

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1. EXIT	1.000																				
2. FAIL	**0.234**	1.000																			
	0.000																				
3. Ind. Fail Rate	-0.024	**0.064**	1.000																		
	0.286	*0.005*																			
4. OC (Effort)	**-0.088**	**-0.493**	-0.022	1.000																	
	0.000	*0.000*	*0.326*																		
5. OC^2 (Effort)	**0.122**	**0.333**	0.009	0.044	1.000																
	0.000	*0.000*	*0.681*	*0.053*																	
6. OC (Attrib)	**-0.073**	**-0.197**	**0.081**	**0.138**	**-0.090**	1.000															
	0.001	*0.000*	*0.000*	*0.000*	*0.000*																
7. OC^2 (Attrib)	**-0.054**	**-0.171**	**0.073**	**0.135**	**-0.084**	**0.934**	1.000														
	0.018	*0.000*	*0.001*	*0.000*	*0.000*	*0.000*															
8. Pers. Funds	0.019	**0.090**	**0.049**	-0.014	0.007	**-0.127**	**-0.109**	1.000													
	0.405	*0.000*	*0.032*	*0.551*	*0.762*	*0.000*	*0.000*														
9. Ext. Funds	**0.059**	0.028	-0.005	-0.026	-0.038	**-0.106**	**-0.083**	0.005	1.000												
	0.010	*0.224*	*0.827*	*0.264*	*0.094*	*0.000*	*0.000*	*0.835*													
10. Age	-0.031	-0.045	**-0.047**	-0.003	-0.006	-0.024	-0.015	0.039	**0.007**	1.000											
	0.182	*0.051*	*0.039*	*0.890*	*0.808*	*0.297*	*0.522*	*0.085*	*0.758*												
11. Educ	0.027	-0.037	**-0.087**	-0.027	-0.016	-0.040	-0.039	-0.020	**0.008**	**0.117**	1.000										
	0.235	*0.104*	*0.000*	*0.236*	*0.497*	*0.082*	*0.088*	*0.393*	*0.722*	*0.000*											
12. Male	0.014	-0.001	**-0.065**	-0.001	-0.024	0.003	0.015	0.020	**0.056**	-0.008	0.029	1.000									
	0.551	*0.954*	*0.005*	*0.983*	*0.288*	*0.902*	*0.505*	*0.374*	*0.015*	*0.712*	*0.205*										
13. Ind. Exp.	-0.030	**-0.070**	**-0.074**	0.025	**-0.074**	0.038	0.038	**-0.047**	0.029	**0.415**	0.044	**0.198**	1.000								
	0.187	*0.002*	*0.001*	*0.281*	*0.001*	*0.096*	*0.092*	*0.041*	*0.201*	*0.000*	*0.054*	*0.000*									
14. Startups	0.004	0.030	0.011	-0.008	0.005	**-0.094**	**-0.072**	**0.066**	**0.095**	**0.179**	**0.049**	**0.110**	**0.122**	1.000							
	0.852	*0.187*	*0.640*	*0.731*	*0.827*	*0.000*	*0.002*	*0.004*	*0.000*	*0.000*	*0.032*	*0.000*	*0.000*								
15. Ind. Startups	0.019	0.003	-0.040	0.005	-0.027	**-0.056**	**-0.052**	**0.064**	**0.065**	**0.089**	0.040	**0.116**	**0.255**	**0.426**	1.000						
	0.403	*0.880*	*0.078*	*0.813*	*0.235*	*0.014*	*0.023*	*0.005*	*0.005*	*0.000*	*0.080*	*0.000*	*0.000*	*0.000*							
16. Afr. Amer.	-0.028	**0.061**	0.013	-0.004	0.010	-0.012	-0.016	**0.067**	-0.023	**-0.070**	0.013	**-0.054**	-0.038	-0.016	-0.003	1.000					
	0.213	*0.007*	*0.568*	*0.855*	*0.653*	*0.599*	*0.488*	*0.003*	*0.308*	*0.002*	*0.560*	*0.018*	*0.100*	*0.471*	*0.913*						
17. Latino	0.016	0.033	0.016	-0.019	0.030	-0.004	-0.003	0.024	0.002	**-0.062**	-0.007	-0.001	-0.008	-0.042	-0.018	-0.040	1.000				
	0.498	*0.147*	*0.475*	*0.417*	*0.188*	*0.855*	*0.894*	*0.296*	*0.941*	*0.007*	*0.762*	*0.961*	*0.718*	*0.066*	*0.426*	*0.081*					
18. White	0.022	-0.038	0.013	0.017	**-0.047**	0.004	0.005	**-0.067**	0.032	**0.152**	-0.038	0.036	**0.087**	0.038	0.032	**-0.652**	**-0.130**	1.000			
	0.344	*0.093*	*0.558*	*0.454*	*0.038*	*0.864*	*0.825*	*0.003*	*0.156*	*0.000*	*0.095*	*0.114*	*0.000*	*0.092*	*0.157*	*0.000*	*0.000*				
19. Nat. Amer.	0.000	0.001	-0.029	0.008	0.038	-0.015	0.016	-0.030	**-0.053**	0.004	-0.037	0.009	-0.009	0.023	-0.027	0.030	0.035	**-0.189**	1.000		
	0.986	*0.953*	*0.206*	*0.724*	*0.100*	*0.517*	*0.495*	*0.192*	*0.021*	*0.867*	*0.109*	*0.709*	*0.702*	*0.306*	*0.245*	*0.192*	*0.121*	*0.000*			
20. Asian	0.001	-0.026	**-0.063**	-0.007	0.012	0.003	-0.003	-0.004	-0.003	**-0.118**	**0.087**	-0.025	**-0.081**	**-0.046**	-0.026	**-0.058**	-0.035	**-0.507**	-0.032	1.000	
	0.980	*0.260*	*0.006*	*0.763*	*0.607*	*0.906*	*0.902*	*0.879*	*0.899*	*0.000*	*0.000*	*0.272*	*0.000*	*0.045*	*0.262*	*0.011*	*0.129*	*0.000*	*0.161*		
21. Nat. Hawaiian	-0.009	0.016	0.011	-0.001	-0.003	0.006	-0.004	0.038	-0.004	-0.026	0.024	-0.011	0.000	-0.026	-0.011	-0.016	-0.013	**-0.102**	-0.009	0.029	1
	0.682	*0.479*	*0.637*	*0.972*	*0.887*	*0.780*	*0.864*	*0.099*	*0.874*	*0.252*	*0.286*	*0.642*	*0.996*	*0.253*	*0.638*	*0.472*	*0.562*	*0.000*	*0.692*	*0.199*	

This table contains the Pearson correlation coefficients for the major variables of this study. P-values are listed in italics below each coefficient. Bold indicates significance at 5% level or better.

Table 4
Effects of Overconfidence on Firm Outcomes

	EXIT				FAIL			
	1	2	3	4	5	6	7	8
OC (effort)	-0.341***	-0.342***			-1.185***	-1.097***		
	(-3.068)	*(-3.678)*			*(-14.188)*	*(-30.886)*		
OC^2 (effort)	0.152***	0.156***			0.319***	0.294***		
	(4.829)	*(5.065)*			*(17.187)*	*(17.679)*		
OC (attrib)			-1.885***	-1.806**			-1.244***	-1.290***
			(-4.000)	*(-2.140)*			*(-4.062)*	*(-3.659)*
OC^2 (attrib)			0.701	0.656			0.135	0.122
			(1.001)	*(0.943)*			*(0.562)*	*(0.456)*
Size	0.025	0.013	0.036**	0.031	-0.013	-0.014	0.003	0.001
	(1.208)	*(0.438)*	*(2.037)*	*(1.210)*	*(-0.815)*	*(-1.021)*	*(0.227)*	*(0.137)*
Leverage (initial)	-0.109	-0.181	0.019	-0.035	-0.040	-0.062	0.068	0.052
	(-0.389)	*(-0.524)*	*(0.096)*	*(-0.110)*	*(-0.411)*	*(-0.520)*	*(1.121)*	*(0.558)*
Patents	0.690	0.738	0.469	0.643	-0.122	-0.076	-0.241	-0.087
	(1.394)	*(1.332)*	*(1.103)*	*(1.195)*	*(-0.627)*	*(-0.274)*	*(-1.380)*	*(-0.372)*
Ext. Capital (beg)	0.804***	0.835**	0.712***	0.753**	-0.106	-0.060	0.032	0.062
	(2.589)	*(2.110)*	*(2.631)*	*(2.060)*	*(-0.635)*	*(-0.378)*	*(0.316)*	*(0.484)*
Ext. Capital (end)	-0.086	0.011	-0.147	-0.109	0.104	0.074	0.044	0.059
	(-0.260)	*(0.029)*	*(-0.506)*	*(-0.305)*	*(0.853)*	*(0.494)*	*(0.557)*	*(0.486)*
Ext. Control (beg)	-0.191	-0.221	-0.309	-0.351	0.316*	0.282*	0.055	0.059
	(-0.522)	*(-0.522)*	*(-0.933)*	*(-0.884)*	*(1.899)*	*(1.672)*	*(0.377)*	*(0.436)*
Ext. Control (end)	0.701***	0.682*	0.357	0.373	0.453**	0.386**	0.242	0.243*
	(2.661)	*(1.714)*	*(1.507)*	*(0.958)*	*(2.543)*	*(2.115)*	*(1.535)*	*(1.667)*
Intercept	-4.754***		-3.386***		-1.682***		-0.222**	
	(-17.213)		*(-14.963)*		*(-19.025)*		*(-2.487)*	
Fixed Effects	No	Yes	No	Yes	No	Yes	No	Yes
Marginal Effects	Yes	No	Yes	No	Yes	No	Yes	No
Obs	1953	1604	2042	1827	1953	1940	2042	2028
Pseudo R^2	0.100	0.112	0.046	0.048	0.321	0.333	0.033	0.037

This table contains the results of logit analyses with the EXIT or FAIL indicator as the dependent variable. EXIT is defined as an acquisition or IPO. FAIL is defined as any state of being out of business not (except for a successful exit). Overconfidence is proxied by cumulative changes in entrepreneurial level of effort or by disparate attribution of positive and negative performance. Columns 2, 4, 6 and 8 report industry fixed effects. Columns 1, 3, 5, and 7 report marginal effects. z-scores are in parentheses. ***, **, * denote significance levels of 1%, 5%, and 10%, respectively.

Table 5
Effect of Outside Investment on Successful Exits and Firm Failures

PANEL A: Successful Firm Exits				
	Mean	Std. Dev	Freq	F
Ext. Capital (beg)				
No	.01863354	.13527365	1449	6.14 **
Yes	.03709949	.18916518	593	
Ext. Control (beg)				
No	.02240199	.14803303	1607	0.82
Yes	.02988506	.17046625	435	
Ext. Capital (end)				
No	.02346227	.15141443	1577	0.08
Yes	.02580645	.15872826	465	
Ext. Control (end)				
No	.02162777	.14550623	1757	3.02 *
Yes	.03859649	.1929701	285	

PANEL B: Firm Failures				
	Mean	Std. Dev	Freq	F
Ext. Capital (beg)				
No	.30365769	.45999536	1449	0.67
Yes	.32209106	.46767215	593	
Ext. Control (beg)				
No	.29744866	.4572779	1607	4.73 **
Yes	.35172414	.4780582	435	
Ext. Capital (end)				
No	.30183893	.45920138	1577	1.67
Yes	.33333333	.47191223	465	
Ext. Control (end)				
No	.29538987	.4563477	1757	10.99 ***
Yes	.39298246	.48927211	285	

This table contains the results of series of one-way ANOVA analyses to do population mean comparisons of EXIT and FAIL with and without outside investment. Four measure of outside investment are utilized: the presence of outside capital at startup (OUTCAP_0), outside control at startup as measured by outside equity being greater than 50% (OUT_CTRL_0), the presence of outside capital at year 2 (OUTCAP_2), and outside control at year 2 (OUT_CTRL_2). ***, **, * denote significance levels of 1%.

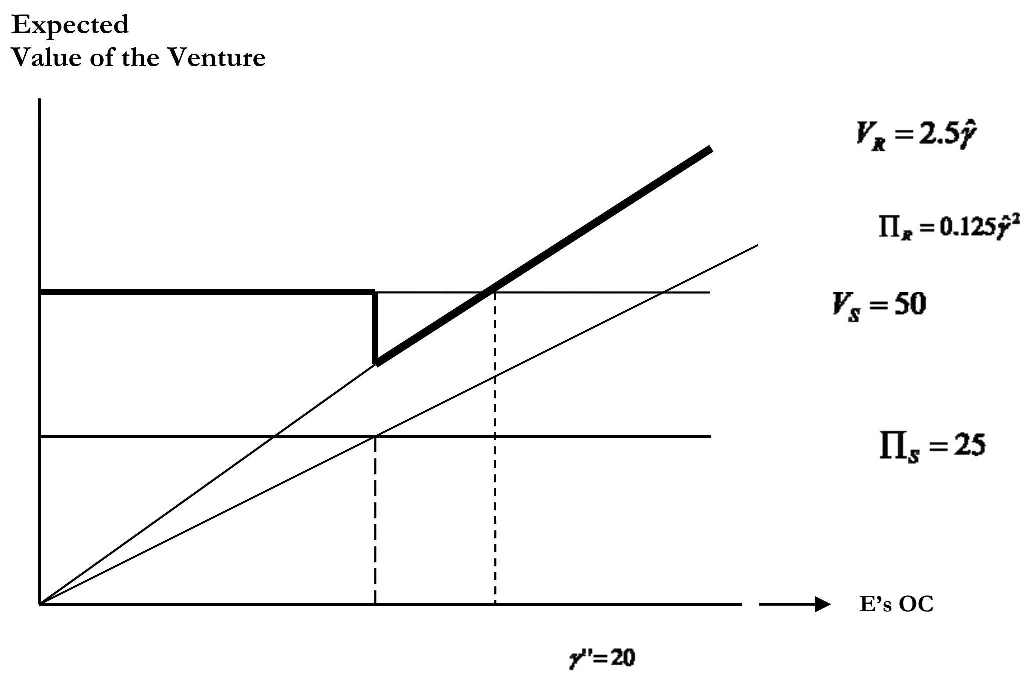

Figure 1
The Effect of entrepreneurial overconfidence on the expected value of the venture.
Increasing overconfidence beyond a critical level causes the entrepreneur to switch from the safe to the risky project. However, it has the positive effect of driving higher effort levels.

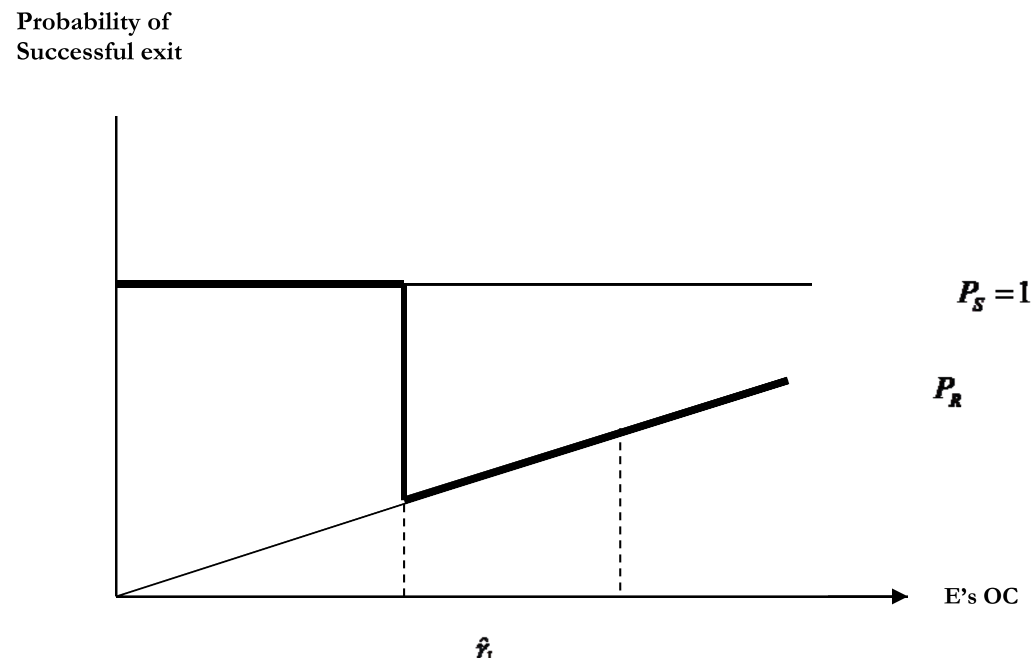

Figure 2
The Effect of entrepreneurial overconfidence on the probability of a successful exit.
Increasing overconfidence beyond a critical level causes the entrepreneur to switch from the safe to the risky project. However, it has the positive effect of driving higher effort levels.