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Entrepreneurial Success and Failure: Confidence and Fallible Judgment

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Excess entry—or the high failure rate of market entry decisions—is often attributed to overconfidence exhibited by entrepreneurs. Assuming that these decisions depend on assessments of business opportunities, we model boundedly rational entrepreneurs and show analytically that, whereas excess entry is an inevitable consequence of imperfect judgment, it does not necessarily imply overconfidence. Indeed, judgmental fallibility can lead to excess entry even when all potential entrepreneurs are underconfident. We further demonstrate that, as a group, individuals who decide to start a new business exhibit more confidence than those who do not and that successful entrants are less confident than failures. Our results therefore question general claims that overconfidence leads to excess entry. We conclude by emphasizing the need to understand the role of judgmental fallibility in producing economic outcomes and implications for both venture capitalists and the training of entrepreneurs.

Key words: excess entry; fallible judgment; overconfidence; bounded rationality; entrepreneurship
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1. Introduction

The phenomenon of excess entry refers to the observation that "too many" entrepreneurs elect to enter certain industries and that many subsequently fail. In the United States, for example, Small Business Administration data sets suggest that, in any year, 10%–12% of all firms are new entrants (Dennis 1997). In Europe, Geroski (1995) documents that up to 100 new firms enter each of the 87 classifications of British manufacturing industries annually. Individuals as well as firms create many new enterprises. However, it has been estimated that 75% of new businesses do not survive more than five years (Bernardo and Welch 1997). Investigating the difference between closure and failure, Headd (2003) reports that approximately 50% of firms exit within their first four years, and about two-thirds of these are unsuccessful at closure (as defined by their owners). This implies an overall failure rate of 33%. The causes of this phenomenon have been attributed to both economic and psychological factors. As to the former, it has been argued that entrepreneurs essentially face lotteries with highly skewed payoffs. Thus, whereas probabilities of success are low, the accompanying payoffs are high. It is rational for entrepreneurs to accept gambles with positive expected utility even though only a minority can succeed.

Whereas the main psychological explanation has focused on the judgmental bias of overconfidence (Camerer and Lovallo 1999, Moore and Cain 2007), in this paper we consider an alternative explanation—namely, that human judgment is fallible but not necessarily biased. Specifically, potential entrepreneurs make their decisions to start a business based on assessments of success that are imperfectly correlated with outcomes. Consequently, if decision makers fail to account for the uncertainty in their predictions, fallible judgment can lead to excess entry in market entry decisions by entrepreneurs. Furthermore, we show that fallibility in judgment leads to outcomes that, ex post, can be interpreted as driven by motivational factors such as overconfidence. The significance of this interpretation is that many actual entrepreneurs who enter markets are, almost by definition, overconfident ex post. Indeed, empirical studies suggest that overconfidence is high among individuals who self-select into entrepreneurial activity. For example, Cooper et al. (1988) find that 81% of a sample of 2,994 entrepreneurs believed that their chances of success were at least 70%, and one-third believed they were certain to succeed. When asked about others, however, only 39% believed that the chances of *any* business *like theirs* succeeding were 70% or more.

To motivate our argument, imagine a situation where potential entrepreneurs are considering entering a market and each makes an assessment, x, of business opportunities. Imagine further that this assessment is imperfect in the sense that x does not perfectly match the actual realizations, y; that is, there is "noise" in the assessments. Moreover, after the decisions have been made, success and failure are determined by a specific threshold on the distribution of true realizations of opportunities, y_c. When there is no systematic bias in judgment, that is, $\mu_y = \mu_x$, potential entrepreneurs are, on average, neither overconfident nor underconfident. However, the noise in the assessment of business opportunities guarantees that some potential entrepreneurs will be too optimistic in assessing their chances of success, and their decision to enter the market will lead to excess entry. At the same time, others will underestimate their true opportunity. However, if the latter take no action (i.e., they decide not to enter), no associated outcomes can be observed. In other words, when potential entrepreneurs rely on imperfect assessments of opportunities to take action, we are guaranteed to observe excess entry but not its converse, missed opportunities.

It is important to note that this scenario also captures the essence of many other situations where individuals accept risk by betting on their skills. For example, career decisions, research project selections, and strategic industrial choices also typically involve actions taken under conditions of uncertainty that cannot be easily assessed.

In this paper, we first review previous explanations of excess entry. Next, we specify the model sketched above in greater detail. In doing so, we follow a long tradition in the individual and organizational decision-making literature by modeling decision makers as boundedly rational (Simon 1957, 1991; March 1994; Knudsen and Levinthal 2007). Specifically, we assume that our decision makers take their assessments of business opportunities at face value. As a consequence—and in accord with extensive evidence—they fail to account for the uncertainty or noise in predictive judgments (Kahneman and Tversky 1973, Tversky and Kahneman 1974, Hogarth 1987).

We show that when the assessment of business opportunities is noisy, excess entry can occur without systematic overconfidence in a population of potential market entrants. At the same time, there are also many missed opportunities. Moreover, after the individuals make their decisions, different levels of overconfidence will be observed between subpopulations that enter and do not enter the market as well as among successful and unsuccessful entrants. Whereas failures are inevitably shown to be overconfident, many of the successes are too. The causal inferences drawn from empirical studies of entrepreneurial overconfidence are thus fraught with difficulties. Rather than being a cause of excess entry, overconfidence observed ex post among entrants can result from self-sorting based on imperfect judgments. We conclude by emphasizing the need to understand the role of judgmental fallibility in producing economic outcomes as well as implications for the training of entrepreneurs.

1.1. Previous Explanations and Related Literature

Explanations of the excess entry phenomenon have been grounded in both economics and psychology. The standard economic story is that high profits attract entry, and entrants bid away these profits, eventually pushing the industry into long-run equilibrium with no excess returns and a given number of firms. Similarly, whenever profits fall below "normal" levels, exit occurs, and this depopulation of the industry raises profitability for the survivors back to equilibrium. From this perspective, failures are "hit-and-run" entrants that have only a small chance of success in the limited period when the industry exhibits extra profits.

Alternatively, starting a business can be framed as facing a gamble where the probability of winning is extremely low but the payoff for success is large. This explanation enlarges the former perspective by accounting for uncertainty, information, and risk attitudes in determining entry decisions. A further hypothesis is that entrepreneurs are more risk seeking than non-entrepreneurs. However, the empirical literature provides conflicting results. The general conclusion is that entrepreneurs do not differ in risk attitudes from the overall population (Brockhaus 1980, Masters and Meier 1988, Palich and Bagby 1995) and may even be more risk averse than non-entrepreneurs (Miner and Raju 2004).[1] Alternatively, entrepreneurs may simply accept risky business situations as given (Sarasvathy et al. 1998) or assess opportunities and threats differently from non-entrepreneurs (Norton and Moore 2002).

Psychological explanations for excess entry are based on the notion of overconfidence (Kahneman et al. 1982, Klayman et al. 1999). Specifically, individuals overestimate their chances of success and erroneously expect to succeed where others will fail. Thus, the decision to enter may be taken even if negative industry profits are expected.

More recently, Moore and Healy (2008) clarify conceptual confusion surrounding the concept of overconfidence by distinguishing three distinct meanings. First, people can be over- or underconfident in estimating a quantity or ability in an absolute sense. For example, consider the estimate that a person can run a marathon in a specified time. Here, underestimation of the time would imply overconfidence. Second, estimates can be made in a relative sense, for example, to complete a marathon within the top 10% finishers. Here, overconfidence would mean failing to be in the top 10%. The third type of overconfidence concerns estimates of future uncertainty, for example, when providing confidence intervals for forecasts of, say, sales that subsequently turn out to be too narrow (see, e.g., Alpert and Raiffa 1982). Interestingly, Wu and Knott (2006) suggest that, whereas entrepreneurs might not be overconfident in assessing market demand, they do overestimate their ability to manage ventures successfully.

Explanations of overconfidence for estimates made in both absolute and relative terms stress that because judgments typically involve error, they are liable to be regressive (Dawes and Mulford 1996, Erev et al. 1994). Moreover, because judgments of relative abilities usually imply more error than absolute judgments (one knows one's own abilities better than those of others), over- and underconfidence interact with task difficulty. In hard tasks, people tend to be overconfident for absolute judgments but underconfident in relative terms; in simple tasks, it is the reverse (Burson et al. 2006, Kruger 1999, Moore and Cain 2007, Svenson 1981). However, as Hoelzl and Rustichini (2005) demonstrate, overconfidence for relative judgments may be moderated when people are required to make incentive-compatible choices as opposed to expressing opinions. (See also Grieco and Hogarth 2009.)

Camerer and Lovallo (1999) test the overconfidence hypothesis experimentally in a game designed to mimic entry decisions. Specifically, N participants decide simultaneously to enter a market with a preannounced capacity of c participants ($N > c$) where payoffs depend on participants' ranks (i.e., of those choosing to enter, the highest-ranked participant receives the largest payoff, and the lowest-ranked participant, the smallest payoff). Ranks were established in two ways at the end of the experiment (i.e., after all choices had been made): at random and on the basis of relative performance on a test (skill). When making entry decisions, however, participants knew how ranks would be established, i.e., at random or according to relative skill. Camerer and Lovallo (1999) test for overconfidence by comparing entry rates between the random and skill conditions and find significant effects—greater entry under the skill condition.

Camerer and Lovallo (1999) conclude that their results were consistent with overconfidence in that, whereas participants had accurate expectations concerning the number of competitors, the differential entry rates between the skill and random conditions provided evidence of overconfidence in their relative skill.[2] As we argue below, however, when the decision to enter is taken on the basis of an imperfect assessment of the chances to succeed, excess entry is guaranteed independently of over- or underconfidence.

More recently, Hayward et al. (2006) propose a hubris theory of entrepreneurship that suggests that overconfidence explains why so many new ventures are created despite high observed failure rates. Among several propositions suggested is the notion that greater environmental complexity and dynamism lead to greater overconfidence among active entrepreneurs. As will be shown below, in our framework we explicitly model uncertainty in the assessment of business opportunities and reach similar conclusions for boundedly rational agents who ignore the imprecision inherent in their judgments. In particular, we find that overconfidence observed among active entrepreneurs is especially high when judgments of business opportunities are less reliable, for example, after technological or product changes.

Our contribution is to show formally that excess entry follows logically when boundedly rational individuals take actions based on noisy assessments. There is no need to postulate explanations based on overconfidence because the process we model leads to the observation of overconfidence ex post, that is, among entrepreneurs who enter markets and fail.

2. Model

To illustrate how judgmental fallibility affects entry decisions and the amount of excess entry, we present a simple model of entry behavior. We model our decision makers as boundedly rational (Simon 1957, March 1994, Knudsen and Levinthal 2007) in the sense that they take assessments of business opportunities at face value and thereby fail to account for their imperfect nature. We quantify the observed level of overconfidence among entrepreneurs who decide to enter the market and among missed opportunities. We then emphasize the differences between those who enter and succeed and those who fail on entry.

Importantly, our objectives are (1) to understand how imperfect judgment can lead to excess entry and (2) to analyze the relation between errors in entrepreneurial judgment and observed ex post levels of overconfidence among different groups, such as active entrepreneurs, successes, failures, and missed opportunities. Given these goals, it is not our purpose to present a formal model of the equilibrium or evolution of an industry (for such models, see Jovanovic 1982, Klepper 1996), and the model presented below serves us well.

2.1. Individuals

Consider an entrepreneur who is assessing a business opportunity, and let the assessment of this opportunity be represented by the variable x (where larger values of x indicate more favorable assessments). Second, assume that the entrepreneur's assessment is fallible in the sense that x does not perfectly match actual realizations of opportunities that we denote by $y \sim \mathrm{N}(\mu_y, \sigma_y)$. We model imperfect judgments as actual realizations of business opportunities plus noise, e, where noise is independent of the actual realizations. Mathematically, the individual perceives the potential of a business opportunity as

$$x = y + e, \tag{1}$$

where $e \sim \mathrm{N}(\mu_e, \sigma_e)$.

Our work is consistent with prior models of organizational decision making that have considered decision makers to be imperfect evaluators of decision alternatives (e.g., Knudsen and Levinthal 2007, Dushnitsky 2010). Moreover, modeling judgments as actual realizations plus noise is compatible with the empirical evidence on managerial judgment (e.g., Mezias and Starbuck 2003). More general evidence from psychology has further documented the imperfect nature of human judgment (for a meta-analysis, see Karelaia and Hogarth 2008). The assessment of business opportunities can be noisy for reasons that are both internal and external to the decision maker. Externally, there are uncertainties at the moment of entry concerning the industry and the business itself. Consider, for example, a lack of precise knowledge about the business environment, market demand, potential actions of competitors, and management of the project. Furthermore, possible technological or market changes can add to this external uncertainty.

By contrast, internal sources of imprecision stem from the bounded rationality of decision makers. Even when all relevant information is available, its evaluation and interpretation are subject to errors. In addition, the complexity of aggregating multiple pieces of evidence to judge the suitability of opportunities is considerable. How much weight should be given to different factors? For example, both laboratory and field evidence suggest that entrepreneurs pay disproportionate attention to their own internal characteristics and too little to those of competitors or the external market, thereby demonstrating "myopic self-focus" (Moore et al. 2007).

A further internal source of judgmental fallibility relates to how people deal with uncertainty. Specifically, as evidenced by extensive findings, individuals are less sensitive to the reliability of evidence than they should be (Kahneman and Tversky 1973, Tversky and Kahneman 1974, Hogarth 1987). For example, by matching the observation of extreme but diagnostically imperfect cues by extreme predictions, they overlook the fact that their estimates will be further from the population mean than is statistically justified. We build on this literature and model potential entrepreneurs as failing to discount noise properly in their assessment of business opportunities. We consider first the baseline situation where the assessment of business opportunities in the population of potential entrepreneurs is not biased, that is, when $\mu_e = 0$, and therefore $\mu_x = \mu_y$. Even in this situation, noise in the individual assessment ($\sigma_e > 0$) implies that the correlation between judgments and realizations is less than 1; that is,

$$\rho_{xy} = \frac{\sigma_y}{\sqrt{\sigma_y^2 + \sigma_e^2}} < 1. \quad (2)$$

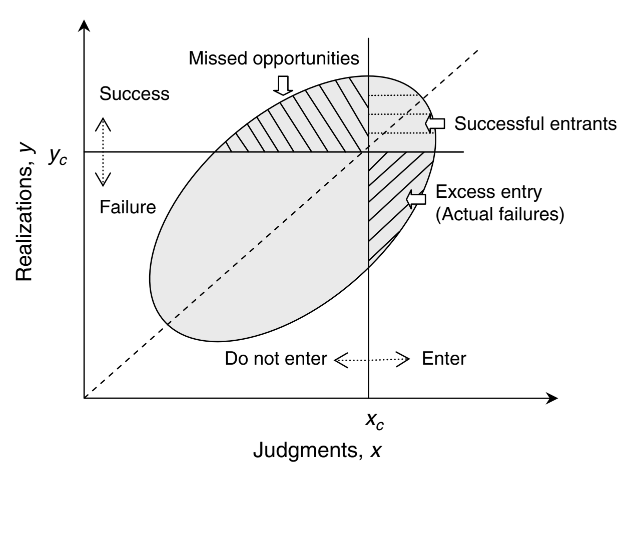
2.2. Entry Decision and Outcome

Now assume that the potential entrepreneur uses the decision rule that if $x \geq x_c$, she will accept the challenge to enter the market. In other words, she enters if her assessment x is greater than some critical value, x_c. Moreover, all potential entrepreneurs make their entry decisions simultaneously. After the decisions have been made, success and failure in the market are determined by actual realizations, y. If y is greater than a critical value y_c, the entrepreneur is successful. If $y < y_c$, she fails.

Figure 1 illustrates entry decisions and their outcomes. The ellipse reflects the imperfect mapping of judgments onto actual outcomes (i.e., $\sigma_e > 0$, and thus $\rho_{xy} < 1$). As shown in Figure 1, there are two possible consequences of the entrepreneur entering the market: success, if $(x \geq x_c)$ *and* $(y \geq y_c)$, and failure, if $(x \geq x_c)$ *and* $(y < y_c)$. Moreover, it is only the actions associated with entering the market that can be observed (by the entrepreneur and others). Indeed, if the entrepreneur does not enter the market, no one will have any hints as to the chances of success with assessments of x smaller than x_c. In other words, the area in Figure 1 where $(x < x_c)$ *and* $(y \geq y_c)$ can be thought of capturing "missed opportunities," that is, businesses that would have been successful had entrepreneurs decided to enter the market instead of staying out. Whereas much has been said about the entrepreneurs who enter and fail, less attention has been paid in the literature to missed opportunities (Moore et al. 2007). We thus also illustrate how these vary with the imprecision of judgment and overconfidence.

Figure 1 illustrates that, as far as the entry decision is concerned, the entrepreneur can make two kinds of error. One is entering the market when she should not, i.e., $(x \geq x_c)$ *and* $(y < y_c)$; the other is not entering when she should, i.e., $(x < x_c)$ *and* $(y \geq y_c)$. Moreover, using a threshold decision rule, there is no way to avoid the probability of making errors unless judgment is perfect (i.e., $\sigma_e = 0$ and thus $\rho_{xy} = 1$). To see this, note that were judgment perfect, the ellipse in Figure 1 would be the 45° straight dotted line, and all outcomes associated

Figure 1 Judgments and Realizations



with $x \geq x_c$ would be successful, and all outcomes associated with $x < x_c$ would be failures. Thus, given that judgment is imperfect (i.e., $\sigma_e > 0$, and thus $\rho_{xy} < 1$), prior to making an entry decision, the entrepreneur will always face the probabilities of two kinds of error. Of course, the levels of the probabilities will vary with the locations of x_c and y_c, but they will still be nonzero. In what follows, we assume for simplicity and without loss of generality that when deciding to enter the market, individuals know the critical market value y_c, and thus $x_c = y_c$.

To summarize, given that the relation between assessments of entrepreneurial opportunities and subsequent realizations is imperfect, entrepreneurs are always faced with the probability of making errors no matter what decision criterion they adopt (i.e., as made operational by the cutoff on their judgment). The ratio of the probabilities of the two kinds of error depends, of course, on the locations of the cutoffs on the judgment and of the realization of outcomes as well as the diagnosticity of judgments (i.e., ρ_{xy}). Thus, associated with a population of entry decisions, it is normal to observe successes and failures (excess entry), and to have associated missing opportunities. The question we pursue is whether and how these outcomes are related to overconfidence.

2.3. Excess Entry

The term "excess entry" implies that entrants are too numerous, and thus the "worst" among them fail. The above model captures failure after entry but without making explicit the underlying reasons. Was this really because some entrepreneurs were literally "excess entrants"? Or was it because of other reasons, say, economic conditions or poor managerial skills? In our formulation, we label all failures, i.e., $(x \geq y_c)$ *and* $(y < y_c)$, "excess entries."

However, we also consider an alternative formulation of the model—presented in the appendix—where successes and failures are jointly determined by the number of entrants, their relative abilities, and market capacity. In this alternative model, all market entrants are ranked on performance, and failures are those whose rank positions exceed market capacity (i.e., if the market has a capacity of c entrants, failures are entrants with ranks greater than c). This formulation leads to similar qualitative conclusions as those presented below.

2.4. Overconfidence

The motivation of this paper is to understand how the imperfect mapping of judgments onto actual outcomes affects excess entry and how this relates to overconfidence. The model provides a simple method of capturing overconfidence in that all we need to do is compare the entrepreneur's assessment of the business opportunity x_i and the actual realization y_i. Thus, $x_i > y_i$ implies overconfidence, and $x_i < y_i$ implies underconfidence. The magnitude of overconfidence is the difference between the judgment and its corresponding realization, i.e., $(x_i - y_i)$.

As mentioned above, we first consider the case where, on average, the population of potential entrepreneurs is neither over- nor underconfident, that is, when $\mu_e = 0$, and therefore $\mu_x = \mu_y$. The imprecision of judgment (i.e., $\sigma_e > 0$) implies that even in a population that is on average unbiased, some individuals will be overconfident and others underconfident. For this baseline situation, our interest lies in comparing the observed ex post levels of confidence among different categories of individuals—entrants, non-entrants, successes, failures, and missed opportunities. Moreover, what would the observation of overconfidence among entrants imply concerning a possible causal link between overconfidence and excess entry?

We next present scenarios with different levels of ex ante overconfidence in the population of potential entrepreneurs (i.e., $\mu_e > 0$, and thus $\mu_x > \mu_y$) or underconfidence (i.e., $\mu_e < 0$, and thus $\mu_x < \mu_y$). This allows us to illustrate the effect of ex ante overconfidence in the population on entry, as well as, similar to the baseline situation, the causal attributions that observers of ex post levels of overconfidence among entrants are likely to make. We also ask whether excess entry can occur when the population of potential entrepreneurs is, on average, underconfident.

Conceptually, the definition of overconfidence based on comparing x and y captures overconfidence in an absolute sense (see above). Alternatively, overconfidence can be defined relative to others, i.e., in terms of "overplacement." Within this setup, overplacement can be operationalized by an entrepreneur placing herself at an unreasonably high fractile of the population; that is, the entrepreneur "overplaces" herself relative to her peers when $\Pr\{y < x_i\} > \Pr\{y < y_i\}$, where x_i and y_i are specific values of x and y that characterize the individual. Note that the above inequality is equivalent to the definition of overconfidence as $x_i > y_i$.

3. Results

In this section, we use the model to explore (1) the relationship between the imprecision of judgment and market outcomes; (2) how the observed ex post levels of confidence differ among entrants, non-entrants, successes, failures, and missed opportunities; and (3) the role of ex ante over- and underconfidence in the population of potential entrepreneurs in defining market outcomes. To answer the first two questions, we consider the baseline case where at the level of population there is no overconfidence (i.e., $\mu_e = 0$), and judgments match actual realizations imperfectly (i.e., $\sigma_e > 0$). We present several scenarios that differ in the amount of noise in assessments of business opportunities (i.e., different values of σ_e). We then illustrate what happens when, in addition to the noisy assessments, an ex ante positive or negative bias is present in the population of potential entrepreneurs (i.e., $\mu_e > 0$ or $\mu_e < 0$).

To illustrate these issues, we simulated populations of 100 individuals drawing estimates of noise, e, and actual realizations, y, from uncorrelated normal distributions with fixed parameters. For each population, we then calculated the proportion of entrants, successes and failures among entrants, missed opportunities among non-entrants, and the proportion of overconfidence in all these categories. The results presented below correspond to the average of 5,000 populations of individuals.

3.1. Noisy Assessment and Market Outcomes

Table 1 illustrates the effect of changes in the amount of noise in assessments of business opportunities, σ_e, when the population of potential entrepreneurs is well calibrated, i.e., when $\mu_e = 0$. We consider σ_e ranging from 0 to 10 (corresponding to ρ_{xy} from 1 to 0.1). In addition, we present the results for three levels of the success cutoff y_c (three panels in Table 1): 1.65 (corresponding to the upper 5% of the population), 1.28 (upper 10%), and 0.52 (upper 30%). Of course, these values are arbitrary but were chosen to depict market conditions varying from "demanding" to "relatively easy." Figure 2 presents the same results graphically.

We emphasize several results. First, when judgment matches exactly the realizations of business opportunities (i.e., $\sigma_e = 0$), there is perfect sorting with neither excess entry nor missed opportunities.

Second, as the noise in assessments increases, more individuals make extreme predictions of future performance and enter the market. As a consequence, the proportion of failures among entrants almost doubles when σ_e increases from 0.5 to 10. Here, however, excess entry cannot be attributed to overconfidence because, on average, potential entrepreneurs are well calibrated (i.e., $\mu_e = 0$). Rather, it is judgmental fallibility (i.e., $\sigma_e > 0$) that generates excess entry. The imperfect assessment of business opportunities ensures excess entry even when reliability is quite high, i.e., when ρ_{xy} is as high as 0.9 ($\sigma_e = 0.5$).

Third, the proportion of missed opportunities among individuals who decide not to enter the market also increases when the error in assessments grows larger. This increase is especially pronounced with the lower success cutoff (i.e., when $y_c = 0.52$). An important implication is that reducing missed opportunities by improving assessments ofbusiness opportunities especially benefits society in markets that can accommodate a relatively high number of entrepreneurs.

3.2. Observed Ex Post Overconfidence

If, on average, there is no overconfidence in the population of potential entrepreneurs (i.e., $\mu_e = 0$, and therefore $\mu_x = \mu_y$), can an external observer still conclude that excess entry is due to overconfidence? To investigate this question further, we assessed the observed ex post levels of overconfidence by calculating (1) the proportion of individuals for whom assessments are superior to realizations, $x_i > y_i$, and (2) the magnitude of over- or underconfidence, $(x_i - y_i)$. To illuminate how observed ex post levels of confidence differ between those who do and do not enter the market, and between successful and unsuccessful entrants, we quantify the two measures of overconfidence separately for each of the following categories: entrants, non-entrants, successful entrants, excess entrants (i.e., failures), and missed opportunities.

Table 2 illustrates how the level of observed ex post overconfidence in the different categories evolves with the level of noise in assessments of business opportunities, σ_e. The scenarios presented here are the same as in Table 1; that is, σ_e ranges from 0 to 10 within each of the three success cutoff levels. Figure 3 presents graphically the results for the case of $y_c = 1.28$ (i.e., upper 10% of population). As in Table 1, the population of potential entrepreneurs is, on average, well calibrated; i.e., $\mu_e = 0$.

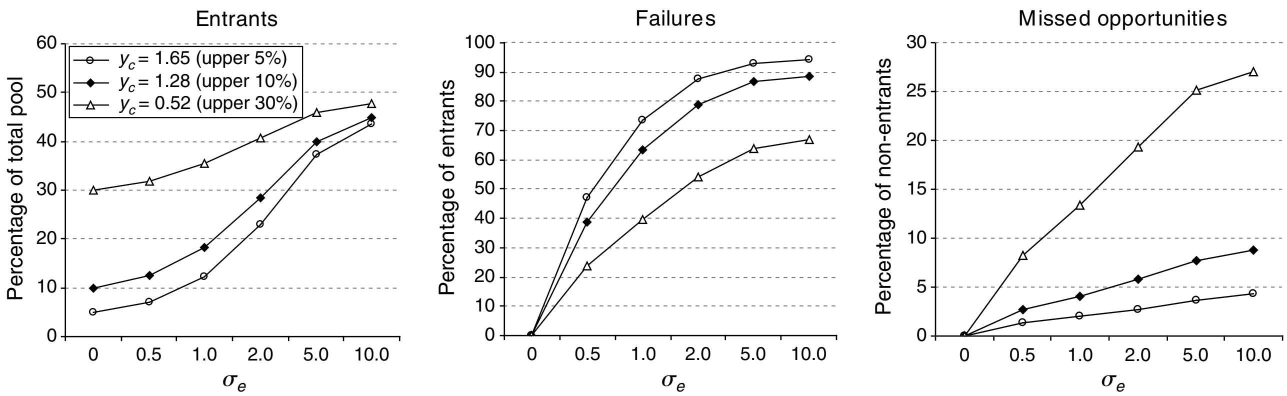
The proportions of overconfidence in different categories reveal several trends. First, these proportions are much greater for entrepreneurs who enter the market than those who do not. In particular, across all situations

Table 1 Entry and Market Outcomes

$y_c =$	1.65 (upper 5%)						1.28 (upper 10%)						0.52 (upper 30%)					
$\sigma_e =$	0	0.5	1.0	2.0	5.0	10.0	0	0.5	1.0	2.0	5.0	10.0	0	0.5	1.0	2.0	5.0	10.0
1 ρ_{xy}	1.0	0.9	0.7	0.4	0.2	0.1	1.0	0.9	0.7	0.4	0.2	0.1	1.0	0.9	0.7	0.4	0.2	0.1
2 Entrants (% of total pool)	5	7	12	23	37	44	10	13	18	28	40	45	30	32	35	41	46	48
3 Failures (% of entrants)	0	47	73	88	93	94	0	39	63	79	87	89	0	24	40	54	64	67
4 Missed opportunities (% of non-entrants)	0	1	2	3	4	4	0	3	4	6	8	9	0	8	13	19	25	27

Note. y is the realized outcome, N(0, 1); y_c is the market success cutoff; e is the assessment error, N(0, σ_e); $x = y + e$ is the personal assessment of the opportunity by the entrepreneur; and ρ_{xy} is the correlation between the assessed and the realized outcomes.

Figure 2 Entry and Market Outcomes



Note. y is the realized outcome, N(0, 1); y_c is the market success cutoff; and e is the assessment error, N(0, σ_e).

presented in Table 2, more than 50% of entrants overestimate their skill, whereas less than 50% of non-entrants do so; that is, more confident individuals self-select into the market. Second, overestimation is greater among failures (excess entrants) than among successful entrants. In fact, all failures are overconfident in the scenarios presented in Table 2.

At one level it may appear that excess entry is due to overconfidence in that a greater proportion of entrepreneurs who fail are overconfident compared to those who succeed. However, it is important to recognize that this observation is entirely consistent with a model in which population assessments of entrepreneurial opportunities are not systematically biased (i.e., overconfident), but are simply imperfect (i.e., $\sigma_e > 0$). Actions based on noisy assessments produce the result that, ex post, is easy to attribute to observed overconfidence.

As to the magnitude of over- or underconfidence, this increases when judgments become noisier. Comparing the average difference between assessed and realized outcomes across different categories again reveals self-selection. In particular, entrants, on average, show overconfidence in their assessments—as indicated by positive values of $(x_i - y_i)$, whereas non-entrants underestimate the opportunities (i.e., $(x_i - y_i) < 0$). As for excess entrants (failures), they overestimate their skills more than successful entrants. Interestingly, missed opportunities are, on average, underconfident under all conditions that we consider.

These results suggest that, in surveys measuring confidence of active entrepreneurs, the presence of overconfidence is almost guaranteed as long as individuals act on noisy assessments, even when there is no bias in the population of potential entrepreneurs. In addition, observed ex post overconfidence will be especially high in conditions of high uncertainty, e.g., after a technological or product change. Nevertheless, it is not necessarily overconfidence that drives excess entry.

3.3. Ex Ante Over- and Underconfidence in the Population

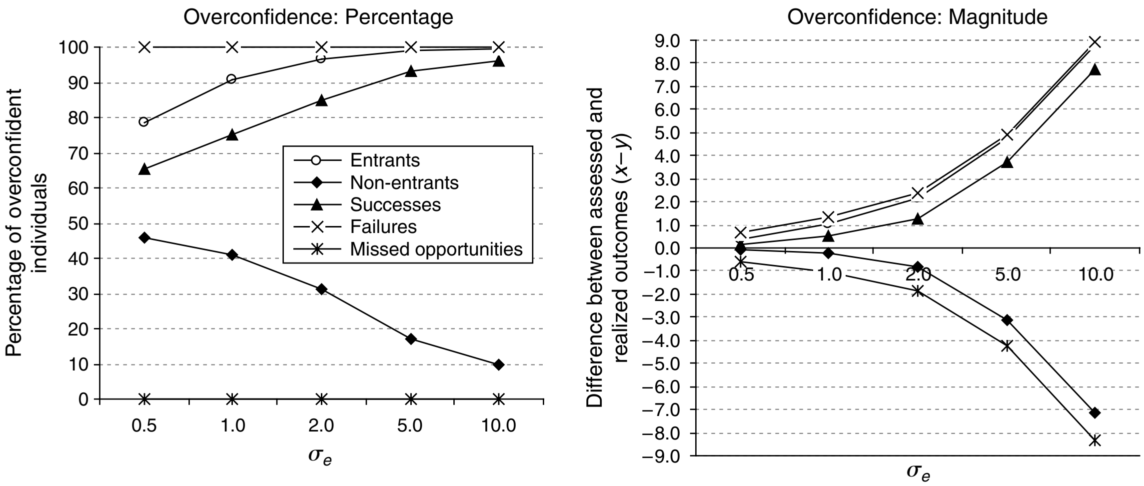
In this section, we explore the role of ex ante over- and underconfidence in the population of potential

Table 2 Observed Ex Post Overconfidence in Different Groups

$y_c =$	1.65 (upper 5%)						1.28 (upper 10%)						0.52 (upper 30%)					
$\sigma_e =$	0	0.5	1.0	2.0	5.0	10.0	0	0.5	1.0	2.0	5.0	10.0	0	0.5	1.0	2.0	5.0	10.0
1 Proportion of overconfidence (%) among																		
1.1 Entrants	0	82	94	98	100	100	0	79	91	97	99	100	0	70	82	91	97	98
1.2 Non-entrants	0	47	44	35	20	12	0	46	41	31	17	10	0	40	32	22	10	6
1.3 Successes	0	67	76	86	94	97	0	65	75	85	93	96	0	61	70	81	91	95
1.4 Failures	—	100	100	100	100	100	—	100	100	100	100	100	—	100	100	100	100	100
1.5 Missed opportunities	—	0	0	0	0	0	—	0	0	0	0	0	—	0	0	0	0	0
2 Average difference between assessed and realized outcomes among																		
2.1 Entrants	0.0	0.4	1.2	2.4	5.0	9.0	0.0	0.4	1.0	2.1	4.7	8.8	0.0	0.2	0.7	1.7	4.3	8.3
2.2 Non-entrants	0.0	0.0	−0.2	−0.7	−3.0	−6.9	0.0	−0.1	−0.2	−0.8	−3.2	−7.1	0.0	−0.1	−0.4	−1.2	−3.6	−7.6
2.3 Successes	0.0	0.2	0.5	1.3	3.7	7.7	0.0	0.2	0.5	1.3	3.7	7.7	0.0	0.1	0.4	1.2	3.6	7.6
2.4 Failures	—	0.7	1.4	2.5	5.1	9.1	—	0.7	1.3	2.4	4.9	8.9	—	0.6	1.2	2.1	4.6	8.6
2.5 Missed opportunities	—	−0.6	−1.0	−1.8	−4.2	−8.2	—	−0.6	−1.0	−1.9	−4.3	−8.3	—	−0.6	−1.1	−1.9	−4.4	−8.4

Notes. y is the realized outcome, N(0, 1); y_c is the market success cutoff; e is the assessment error, N(0, σ_e); and $x = y + e$ is the personal assessment of the opportunity by the entrepreneur. Overconfidence at the individual level occurs where $x_i > y_i$. Positive values in lines 2.1–2.5 indicate overconfidence; negative values indicate underconfidence.

Figure 3 Observed Ex Post Overconfidence in Different Groups



Note. y is the realized outcome, N(0, 1); y_c, the market success cutoff, is 1.28 (upper 10%) in this example; and e is the assessment error, N(0, σ_e).

entrepreneurs. In our model, entry is an action based on noisy assessments that generates excess entry even if there is no overconfidence in the population of potential entrepreneurs (i.e., $\mu_e = 0$). What happens when individuals are, on average, overconfident (i.e., when $\mu_e > 0$ and thus $\mu_x > \mu_y$) and when they are underconfident (i.e., when $\mu_e < 0$ and thus $\mu_x < \mu_y$)?

Table 3 illustrates the effect of systematic miscalibration in the population of potential entrepreneurs. For the same three levels of success cutoff y_c (i.e., upper 5%, 10%, and 30% of the population), we vary μ_e from −1.0 (underconfident) to 1.0 (overconfident). The mid case in each panel corresponds to the case of no systematic bias (i.e., $\mu_e = 0$) and is provided as a point of comparison. In the results presented in Table 3, the standard deviation of error, σ_e, has been fixed at 2.0, implying $\rho_{xy} = 0.4$.

We comment on several outcomes. First, as the mean level of confidence increases, more entrepreneurs enter the market. Second, when entry is based on noisy assessments, excess entry is observed even in underconfident populations. In fact, the percentage of failures among entrants is quite stable within all scenarios presented in Table 3.

Third, the proportion of missed opportunities drops as the population, on average, becomes more overconfident. One intuitive implication of this result might be to advise potential entrepreneurs to boost their confidence to reduce missed opportunities and thereby increase social welfare. However, this would not be wise. As Table 3 shows, greater overconfidence implies not only fewer missed opportunities but also more failures. Reducing the error in assessment of business opportunities, however, can decrease *both* missed opportunities and failures.

Finally, the proportion of observed ex post levels of overconfidence among entrants is systematically higher

Table 3 Observed Ex Post Overconfidence in Different Groups

$y_c =$	1.65 (upper 5%)					1.28 (upper 10%)					0.52 (upper 30%)				
$\mu_e =$	−1.0	−0.5	0.0	0.5	1.0	−1.0	−0.5	0.0	0.5	1.0	−1.0	−0.5	0.0	0.5	1.0
1 Entrants (% of total pool)	12	17	23	30	39	15	21	28	36	45	25	32	41	50	58
2 Failures (% of entrants)	84	86	88	89	90	74	77	79	81	83	48	51	54	57	60
3 Missed opportunities (% of non-entrants)	3	3	3	2	2	7	6	6	5	4	23	21	19	17	15
4 Proportion of overconfidence (%) among															
4.1 All population	31	40	50	60	69	31	40	50	60	69	31	40	50	60	69
4.2 Entrants	97	98	98	99	99	94	96	97	98	98	85	89	91	93	95
4.3 Non-entrants	22	28	35	43	50	19	25	32	38	45	13	17	22	27	33
4.4 Successes	80	83	86	89	92	77	81	85	88	90	72	77	81	85	88
4.5 Failures	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
4.6 Missed opportunities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes. y is the realized outcome, N(0, 1); y_c is the market success cutoff. In this example, assessment error e is N(μ_e, 2.0), implying $\rho_{xy} = 0.4$. Positive values of μ_e correspond to overconfident populations of individuals; negative values of μ_e indicate underconfident populations. The personal assessment of the opportunity by the entrepreneur is $x = y + e$. Overconfidence at the individual level occurs where $x_i > y_i$.

than it is among non-entrants, and failures are more overconfident than successes, regardless of whether individuals come from, on average, overconfident, underconfident, or well-calibrated populations. Thus, even when the population of individuals is on average underconfident, it might appear as if overconfidence drives excess entry.

Overall, we conclude that excess entry can be observed even in the presence of systematic underconfidence in the population of potential entrepreneurs. Enhancing entrepreneurial overconfidence decreases missed opportunities but at the cost of increased failures.

3.4. Summary

In short, our model suggests that, with or without systematic ex ante overconfidence in the population of potential entrepreneurs, excess entry simply follows from people acting on assessments of opportunities that are imperfectly related to realizations. Moreover, the amount of observable excess entry is a complex function of the imprecision of judgment (σ_e), the success cutoff (y_c), and systematic overconfidence in the underlying population (μ_e). Thus, from any empirical study, it is difficult to prove or disprove that overconfidence drives the excess entry phenomenon. As the above simulations show, excess entry can be observed even when all entrants are, on average, underconfident.

Our model implies that failures exhibit greater confidence than successful entrants. In terms of empirical evidence, Koellinger et al. (2007) do indeed report a negative relation between self-reported measures of entrepreneurial skills and survival chances. In the case of Wu and Knott's (2006, p. 1321) study of banking, evidence of overconfidence is heavily dependent on observing failures. However, as we have shown, the confidence–survival relationship can be observed whether or not the population of entrepreneurs is, on average, overconfident.

Finally, our results suggest that overconfidence among active entrepreneurs will be especially great when the reliability of subjective assessments is low, e.g., after technological or product changes. At the very least, the model provides directions for empirical researchers to investigate what drives excess entry, and when.

4. Discussion

This paper introduces a model of entrepreneurial entry where individuals base their decisions on noisy assessments of business opportunities. The imperfect match between assessments and actual realizations can be due to many issues, such as a lack of critical information when entry decisions are made, technological or market changes, and the complexity of assessing and aggregating multiple factors in judgment as well as difficulty in accounting for the reliability of evidence (e.g., Kahneman and Tversky 1973, Hogarth 1987). Our model thus illustrates the decision-making process of boundedly rational individuals (Simon 1957, March 1994, Knudsen and Levinthal 2007) who take noisy evidence at face value and do not discount extreme—and only partially diagnostic—cues for noise.

Our main argument is that it is not necessarily overconfidence that generates the "excess" of new ventures that subsequently fail. Instead, differential self-confidence between active entrepreneurs and everyone else is a result, rather than cause, of a noisy self-selection process. Errors in the assessment of business opportunities in the population of potential entrepreneurs result in both excess entry and missed opportunities. When judgment is fallible, excess entry can occur even when the population of potential entrepreneurs is, on average, underconfident.

4.1. The Role of Judgmental Fallibility

Assuming irreducible uncertainty in the assessment of entrepreneurial opportunities, what would happen if individuals (1) were aware of the magnitude of the uncertainty and (2) appropriately discounted evidence? Within the context of our model, such "super-evaluators" would assess the uncertainty of their assessments (σ_e) before actually entering the market or not and bring them closer to the mean of the distribution of realizations y; that is, they would base entry decisions not on their assessments x_i but on the expectations of outcomes given their subjective assessments $\mathrm{E}[y \mid x_i]$, which are functions of x_i and the parameters of the distributions of both y and e. This process would lead to no excess entry. Moreover, with high σ_e there would be no entrants because all assessments x_i would be regressed to the population mean, μ_y; that is, no potential entrepreneurs would have beliefs of success strong enough to justify entry. However, realistically, decision makers are unlikely to conform to such high standards of super-evaluators.

Previous models of industry equilibrium studied uncertainty in firm ability and showed that, even in equilibrium, there is constant entry and exit (e.g., Jovanovic 1982). When entry is based on the expectation of uncertain abilities, some errors among entrants are inevitable. Our model generates similar predictions, but in contrast to the industrial organization tradition, we focus on the psychological underpinnings of entry. In particular, we address the question how errors in the self-selection process generate outcomes that, ex post, can be interpreted as if overconfidence were driving entry.

Our results are the consequence of two pervasive phenomena. One is the presence of irreducible error in judgment, and the other is the fact that people take actions based on fallible judgment. At the individual level, it has been shown that these two factors can induce people to have unwarranted confidence in their judgments

(Einhorn and Hogarth 1978; Denrell 2003, 2005). This is not to say, of course, that fallible judgment is the only explanation (see also Benoît and Dubra 2011). However, we argue that research investigating other factors contributing to excess entry needs to demonstrate clearly that they have impacts over and beyond what would be expected from an analysis based only on fallible judgment. In other words, alternative explanations should be judged relative to the baseline of fallible judgment in the same way that regression effects should be used to assess the impact of specific interventions, rewards, and punishments (Tversky and Kahneman 1974).

4.2. Sorting and Observed Ex Post Overconfidence

We have shown that imperfect judgment produces self-selection in that entrepreneurs who take risks by acting on beliefs about business opportunities are, on average, more confident than those who take no action; that is, after the process of sorting into entrants and non-entrants is over, entrants appear to be more overconfident than non-entrants. Thus, it might appear as if excess entry is caused by overconfidence. Kalnins (2007) develops a general argument regarding the effect of self-selection on causal attribution using an example of firms' abilities to select new ventures appropriately. Specifically, he argues that self-selection can cause the appearance of an illusory but systematic causal relation where none exists. In this paper, we showed that self-selection of potential entrepreneurs can create the illusory appearance of a causal effect of overconfidence on excess entry.

Our results also suggest that overconfidence among active entrepreneurs is especially high when subjective assessments of business opportunities are less reliable, e.g., after technological or product changes. The latter result suggests that further empirical studies should compare overconfidence among active entrepreneurs under different market conditions and investigate whether, under certain conditions, overconfidence can be functional, for example, by encouraging persistence in the face of change.

Greater overconfidence of active entrepreneurs compared with non-entrepreneurs has been showed empirically. For example, Koellinger et al. (2007) conclude that confidence in one's own skills to start a business is higher among established entrepreneurs than non-entrepreneurs. Similarly, Busenitz and Barney (1997) examine differences in the decision-making processes used by entrepreneurs and managers in large organizations and found that active entrepreneurs, compared with managers, tend to overestimate more the probability of being right. We argue, however, that high overconfidence exhibited by entrants after self-selection based on imperfect judgment does not imply that entry is driven by overconfidence. Our model predicts that when judgment is fallible, individuals who self-select into entrepreneurial activities necessarily tend to be overconfident, as measured ex post.

Indeed, other empirical studies have failed to demonstrate a connection between overoptimism and entry decisions by potential entrepreneurs (Lowe and Ziedonis 2006). Moreover, empirical studies often measure entrepreneurial self-confidence and not *overconfidence*, and so to conclude that *overconfidence* is driving entry is imprecise, to say the least. As we have shown, those who decide to start a new business always exhibit greater confidence than non-entrants, as observed ex post. The main argument of this paper is that excess entry is not necessarily caused by overconfidence or a systematic bias. Instead, it can result simply from imperfect judgment involving random errors.

An important issue centers on the costs and benefits of overconfidence at the individual level. Bonnefon et al. (2006) provide an intriguing result that suggests a positive relationship between success as an entrepreneur and being appropriately calibrated. In a group of entrepreneurs attending a management course, the more successful entrepreneurs exhibited less overconfidence in an experimental task. Biais and Weber (2009) have further demonstrated a relationship between the amount of hindsight bias (the "I knew it all along" effect) and performance by investment bankers. The better-performing bankers exhibit less bias. Thus, overall, the literature suggests that success is linked to calibrated judgment.

Our analytical results show that noisy sorting guarantees that successful entrepreneurs are less overconfident than failures. This is consistent with empirical evidence. Duchesneau and Gartner (1990), for example, conduct a field study of an emerging industry with high uncertainty and found that lead entrepreneurs in unsuccessful companies relied less on outside professional and advisors and believed that they had more control of their success in business than successful entrepreneurs. Finally, there is evidence of greater overconfidence among failures than among successes in the banking industry (Wu and Knott 2006). On the other hand, none of these results means that overconfidence drives excess entry. In fact, our model suggests that excess entry can occur even when all potential entrepreneurs are, on average, underconfident. The presence of noise in assessments of business opportunities is sufficient to guarantee excess entry (and missed opportunities).

4.3. Excess Entry: Definition and Alternative Causes

An important implication of our model relates to the conditions under which there will be no excess entry in a new market. Consider a setup similar to Camerer and Lovallo (1999), where market capacity is limited (only c of N participants can succeed). Here, there is no excess entry if (a) there is no error in judgment (i.e., $\sigma_e = 0$)

such that potential entrants know for sure whether or not they should enter, or (b) when judgment is imperfect (i.e., $\sigma_e > 0$), the number of entrants who fail to enter but who should have is matched exactly by the number who enter but who should not have—in other words, when individual errors cancel each other out. However, one would only expect to see the latter occur when potential entrants perceive that the economic consequences of the two types of error are equal. It is not clear that this will generally be the case, and thus the only way to diminish excess entry is to reduce the error in assessment of business opportunities.

Our work questions whether the psychological explanation of overconfidence accounts for excess entry. It is tempting to think, therefore, that the economic theory of risk taking is sufficient to explain the phenomenon and to conclude at this point. However, we do not believe this would be wise. First, it would be problematic to disconfirm the economic theory by empirical data because observations of excess entry could be easily rationalized after the fact (Benoît and Dubra 2011). Second, the economic explanation provides little or no insight into how potential entrepreneurs appraise the risks they face nor how they judge whether these risks are acceptable. And third, it provides no clues as to how entrepreneurs might better assess risks.

This paper suggests that judgmental fallibility generates excess entry. One argument is that imprecision in the assessment of business opportunities is inevitable because at the moment entrepreneurs decide to enter the market, much relevant information is unavailable. On the other hand, failures would be reduced if entrepreneurs took account of the uncertainty inherent in their evaluations of business opportunities. Therefore, an important empirical question centers on how potential entrepreneurs evaluate this uncertainty. Do they ignore the role serendipity plays in determining outcomes and thereby fall prey to the “illusion of control” (Langer 1975)?

Survey data of an MBA population suggest that the intention to create a new venture is related to the perception of the venture’s riskiness and that this is lower for individuals who are more prone to the illusion of control (Simon et al. 2000). In this study, the illusion of control was measured by the degree of underestimation of the role of uncontrollable events in determining the venture’s outcome. In contrast, overconfidence—measured as knowledge of the limits of one’s own knowledge—was not predictive of intentions to create a new venture. Keh et al. (2002) report similar results regarding the illusion of control using a sample of owners of small and medium-sized enterprises in Singapore.

A further step in understanding the role played by the illusion of control in generating market outcomes would be to compare differences in how successes and failures approach uncertainty. Are failures more prone to ignore the role of serendipity? Although the evidence from other populations (e.g., financial traders) suggests a reverse link between susceptibility to the illusion of control and performance (Fenton-O’Creevy et al. 2003), we advocate more studies of the illusion of control among potential, actual, and serial entrepreneurs. Ultimately, the goal should be to train potential entrepreneurs to reduce errors in the evaluation of business opportunities.

4.4. Limitations of Our Approach

The model of entry developed in this paper is a simplification of reality and, as such, is subject to several limitations that suggest directions for further research. First, we modeled one-shot decisions to enter the market. It would also be interesting to investigate recurrent decisions made by serial entrepreneurs. Arguably, experience should enable serial entrepreneurs to better assess the degree of uncertainty in their judgments. However, evidence on the effects of expertise on both the calibration and the accuracy of judgments is mixed (see, e.g., Shanteau and Stewart 1992), and so it remains an open question as to how and whether the specific nature of entrepreneurial experience leads to better judgments. It could be the case, for example, that success in one venture leads to overconfidence when undertaking others. More generally, the effects of different types of expertise on entrepreneurial decisions need elucidation.

Second, we assume that all potential entrepreneurs make entry decisions simultaneously. In reality, the outcomes of pioneer entrepreneurs might be visible to other potential entrants who then assess their chances of success by observing these outcomes. Such sequential processes should imply lower uncertainty for later entrants—and thus more chances for better sorting. However, they might also imply lower chances of success because of the failure to recognize the business opportunity early enough (Lieberman and Montgomery 1988). The numbers of failures in such situations will depend on how well potential entrepreneurs learn from the experience of others and, in particular, whether they adjust expectations for not being first movers.

Third, in our simple model of entrepreneurship as a market entry decision, we assume that the capacity of the market is given and fixed. Although this assumption facilitates the exposition, we are aware that, in many cases, capacity is not known in advance. Sarasvathy and Dew (2005, p. 533) propose that as opposed to being “given,” markets are instead “a transformation of extant realities into new possibilities” and thus can evolve through such internal drivers as demand, supply, and institutions. A more complex and thus complete model of entrepreneurial entry would allow market capacity to grow as a function of skill level or performance of first entrants.

4.5. Managerial Implications

It is sometimes said that, whereas overconfidence is dysfunctional for individual entrepreneurs, it is functional for society in that many individual failures are necessary to achieve success at the societal level. We disagree. Overconfidence can have two different effects. It reduces both missed opportunities and the success rate of entrepreneurs who decide to enter the market. Judgmental fallibility plays an important role in why entrepreneurs enter businesses that fail. However, it also plays a role in why people fail to enter businesses they should have entered. Reducing the unreliability of the assessment of business opportunities diminishes both missed opportunities and failures. Society would be better off as a whole if entrepreneurs were able to estimate their abilities better in both absolute and relative terms. However, this is not the same as saying excess entry is due to overconfidence.

One implication of our work is to emphasize the importance of training entrepreneurs to reduce the error in their assessments of business opportunities. Although we have no precise "formula for success," we speculate that the basis of such training should follow principles relevant to the acquisition of expertise. These involve, principally, total immersion in the domain of activity and learning to improve performance through continued practice with appropriate feedback (see, e.g., Ericsson and Charness 1994). However, this is not something that can be achieved in a short period of time. In the case of potential entrepreneurs, we believe it would involve—in addition to acquiring basic business skills—detailed studies of the specific industry of interest and many experiential exercises involving accurate feedback that can increase the entrepreneur's awareness of her chances to succeed (taking into consideration other potential entrants) as well as indicating paths to improvement. The organization of such educational experiences is an important challenge for society.

Finally, we conclude with implications of our work for venture capitalists. As is well known, venture capitalists rely on their own beliefs about the characteristics of a potentially successful business when assessing new entrepreneurial proposals. The most important block of selection criteria appears to be the management team, one component of which is the entrepreneur's self-confidence (Riquelme and Watson 2002). Indeed, one study documented the entrepreneur's "desire for success" as the most important selection criterion (Khan 1987). And yet in this study, the entrepreneur's competence in the field of endeavor was not a significant predictor of venture capitalists' judgments. More generally, we suspect that being ambitious and willing to succeed is important for success, but that the desire for success alone is rarely sufficient. In fact, in Khan's (1987) study, the desire for success was negatively related to the actual outcomes of the ventures. And as shown above, high confidence is not a good predictor of success.[3] We suggest, therefore, that venture capitalists will make better decisions if they do not equate confidence with skill and experience. Moreover, to improve awareness of the factors determining their decisions, we recommend that venture capitalists consciously decompose their assessments of entrepreneurs by judging the entrepreneurs' desire for success separately from their skills and competence (Armstrong et al. 1975). Crafting experiments such as sampling, from time to time, less confident entrepreneurs can further improve venture capitalists' judgments. Indeed, the value of experimentation as a tool to improve business practice is not sufficiently recognized (Davenport 2009, Pfeffer and Sutton 2006). However uncomfortable such experimentation might be at the moment of the decision, it may lead to revising erroneous models of project selection as well as discovering unexpected talents.

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Appendix. An Alternative Definition of Market Success

We present a variation of our model where successes and failures are jointly determined by the number of entrants, their relative abilities, and market capacity. We then illustrate the main results using this alternative formulation, which leads to similar qualitative conclusions as those presented above, thereby suggesting that the conclusions are robust.

Definition of Success

The model presented in this paper assumes that the success cutoff point y_c is exogenously defined. Alternatively, the success cutoff can be endogenously defined by the number of entrants, their ability distribution, and market capacity. Two cases should be considered. First, when the number of entrants does not exceed a given market capacity c, all entrants are successful; that is, no minimum level of "performance" is needed to succeed. Note that in this paper, we model simultaneous decisions made by all potential entrepreneurs and so assume that there is no possibility that other individuals observe "underentry" and fill the gap in the next period. Second, if the number of entrants exceeds c, only the best c will be successful such that the rest will fail and represent "excess entry." In both cases, the performance level of the least successful entrant defines the success cutoff point.

In this alternative formulation, we define missed opportunities as non-entrants with values of y superior to that of the least successful entrant; that is, missed opportunities would have replaced this least successful entrant and been successful had they entered the market.

Table A.1 Entry, Market Outcomes, and Ex Post Overconfidence Under the Alternative Model Formulation

$c =$	5%						10%						30%					
$\sigma_e =$	0	0.5	1.0	2.0	5.0	10.0	0	0.5	1.0	2.0	5.0	10.0	0	0.5	1.0	2.0	5.0	10.0
1 ρ_{xy}	1.0	0.9	0.7	0.4	0.2	0.1	1.0	0.9	0.7	0.4	0.2	0.1	1.0	0.9	0.7	0.4	0.2	0.1
2 Success cutoff y_c	1.7	1.5	1.4	1.4	1.3	1.3	1.3	1.1	0.9	0.9	0.9	0.9	0.5	0.3	0.0	−0.2	−0.2	−0.2
3 Entrants (% of population)	5	7	12	23	38	44	10	13	18	28	40	45	30	32	36	41	46	48
4 Failures (% of entrants)	11	31	59	78	87	89	7	22	45	65	75	78	4	8	16	26	35	38
5 Missed opportunities (% of non-entrants)	1	4	6	6	8	9	1	7	11	13	16	18	2	17	33	46	54	57
6 Proportion of overconfidence (%) among																		
6.1 Entrants	0	83	94	98	100	100	0	79	91	97	99	100	0	70	82	91	97	98
6.2 Non-entrants	0	47	44	35	20	12	0	46	41	31	17	9	0	40	32	22	10	5
6.3 Successes	0	76	86	92	97	98	0	74	84	91	96	98	0	68	79	88	95	97
6.4 Failures	0	99	100	100	100	100	0	100	100	100	100	100	0	100	100	100	100	100
6.5 Missed opportunities	0	20	13	6	2	1	0	18	12	6	2	1	0	16	13	8	3	2

Notes. c is the market capacity; y is the realized outcome, N(0, 1); y_c is the market success cutoff; e is the assessment error, N$(0, \sigma_e)$; $x = y + e$ is the personal assessment of the opportunity by the entrepreneur; and ρ_{xy} is the correlation between the assessed and the realized outcomes. Overconfidence at the individual level occurs where $x_i > y_i$.

Entry Decision

The individual enters the market if she believes that she is within the best c/N proportion of the population, where N is the population size. That is, she enters if

$$\Pr\{y \leq x_i\} = \Phi(\mu_y, \sigma_y)|_{x_i} \geq 1 - \frac{c}{N}, \tag{3}$$

where $\Pr\{y \leq x_i\}$ is her assessed fractile based on the noisy assessment x_i, and $\Phi(\mu_y, \sigma_y)|_{x_i}$ is the cumulative distribution function of $y \sim \mathrm{N}(\mu_y, \sigma_y)$ evaluated at x_i.

Simulations

We simulated populations of 100 individuals drawing estimates of noise e and actual realizations y from uncorrelated normal distributions with fixed parameters. For each population, we calculated the proportion of entrants, successes and failures among entrants, missed opportunities among non-entrants, and the proportion of overconfidence. The results correspond to the average of 5,000 populations of individuals.

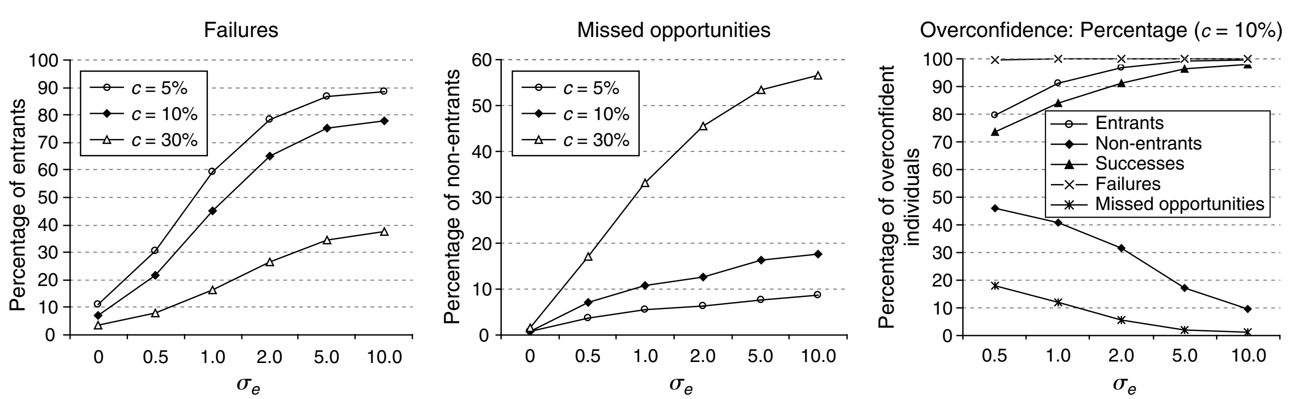
Results

Table A.1 illustrates the results of this alternative formulation. We consider the baseline case, where the population of potential entrepreneurs is, on average, not biased (i.e., $\mu_e = 0$). We present three scenarios with different market capacity: c of 5%, 10%, and 30% of the population of potential entrepreneurs. These cases correspond to those presented in Tables 1 and 3 and thus can be compared directly. Within each scenario, we consider six values of σ_e (six columns within each scenario). To facilitate the reading of the table, we also plot selected results in Figure A.1 (which is analogous to Figures 2 and 3).

The results are qualitatively similar to those presented in the main text. First, noisier judgment generates more entrants and thus more failures among these entrants (i.e., excess entry).[4] Second, the proportion of missed opportunities also increases when the noise in the assessment of business opportunities grows larger.

Third, overconfidence observed ex post in different groups of individuals may lead to the conclusion that excess entry is driven by overconfidence, because entrants appear to be more overconfident than non-entrants, and failures are more overconfident than successful entrants. However, the driver of excess entry is the imprecision of individual assessments of business opportunities (i.e., $\sigma_e > 0$) and not the overall population bias toward overconfidence (because $\mu_e = 0$).

Figure A.1 Failures, Missed Opportunities, and Ex Post Overconfidence Under the Alternative Model Formulation



Note. c is the market capacity, and e is the assessment error, N$(0, \sigma_e)$.

Endnotes

[1]Parenthetically, this literature relies on biased samples in that studies only include "successful" survivors, i.e., those unsuccessful entrepreneurs who have left the market are excluded.

[2]Camerer and Lovallo (1999) also ask their participants to estimate the number of entrants on each round. For most participants, forecasts were unbiased.

[3]In fact, venture capitalists themselves are overconfident. Zacharakis and Shepherd (2001) document that 96% of 51 Silicon Valley venture capitalists overestimated their ability to predict the success of new ventures. In addition, more overconfident venture capitalists were less accurate in their decisions.

[4]In contrast to the results presented in the main text, under the "market capacity" formulation, there are some failures even when there is no error in the assessment of business opportunities (i.e., when $\sigma_e = 0$). It happens because occasional extremely high values of x generate a positive number of excess entrants that is not compensated by symmetrical negative numbers of excess entrants because the number is naturally limited by zero.

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