Why Do Inventors Continue When Experts Say Stop?

The Effects of Overconfidence, Optimism and Illusion of Control

By

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I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

Data shows that many inventors continue to expend resources on their inventions even after they have received expert advice suggesting that they cease effort. Using a sample of inventors seeking outside advice from a Canadian evaluative agency, this paper examines how overconfidence, optimism, and illusion of control explain this fact. While overconfidence did not have a significant effect on inventor's decisions, illusion of control and optimism did have an effect. An additional interesting finding is that the more time people have spent working on inventions, the more likely they are to discount this expert advice.

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To my mother

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Chapter 1

1.1 Introduction

This thesis studies how cognitive factors affect post-evaluation inventor decision-making. Inventors continue to stimulate changes in industry and society for centuries. These inventions led to industrial revolutions and brought innovation to many markets. Independent inventing accounts for a large part of innovation; however, it provides negative expected returns for inventors (Åstebro, 2003).

Interestingly, inventors appear to contribute to their failures by disregarding expert feedback especially when negative. They persist in the development their inventions when given negative feedback on the prospects of the invention. Åstebro (2003) finds that about 50% of inventors with inventions of very low quality still continue to develop their projects even though their estimated probability of reaching the market is found to be not greater than 0.04. Even when these inventors eventually commercialize their inventions, the median return is negative. These results raise concerns about inefficient allocation of resources.

Are these inventors being 'rational' when they evaluate their inventive opportunities, or do they have large biases? Are they typically over-optimistic, over-confident risk-takers or are they well-calibrated Bayesian decision-makers? These are possible questions which when answered could provide insight into independent inventor behaviour.

In terms of the attitude of discarding expert advice and persisting on low quality inventions, one will suggestively consider cognitive factors in search of a better understanding of how inventors identify and evaluate opportunities. This study is therefore grounded in the heuristics and biases framework. This framework theorizes that errors in judgment are due to cognitive biases and heuristics (Kahneman and Tversky, 1996). Thus, this study will investigate the effect of cognitive factors on the intuitive predictions and judgments inventors employ when they incorporate expert advice into their decision-making.

In sum, this thesis studies how inventors' cognitions affect the product development decisions they make when they receive expert advice from an Inventor Assistance Program (IAP). An IAP provides feedback on the technical and market prospects of inventions as part of an early stage idea evaluation process.

1.2 Objectives

The general objective of this study is to learn about decision-making processes used by independent inventors. Areas of interest are: how they take into account information given to them by an external credible source; how this information affects their persistence; how they act on third party assessments; whether they are at all close to a 'rational' model when they evaluate opportunities, or if they have large biases; and whether these biases imply inefficiencies or are merely reasonable responses given the complexity of the decision-making environment.

The primary objectives are two-fold. The first is to evaluate the impact of the interaction between unbiased expert advice and inventors' confidence, optimism, illusion of control, on the product development decisions taken after evaluation. The second objective is to evaluate the extent to which expert advice and the identified cognitive factors predict commercialisation for inventions that saw an increase in resource allocation after evaluation, all else equal.

1.3 Justification and Use of Results

There is a variety of research done in the area of judgement and decision-making in general. However, there is insufficient research on inventors as specific subjects. Further to that the subjects of most of these studies are proxies, mainly undergraduate students, who are assigned to various roles in controlled laboratory settings in attempt to simulate 'real world' situations. In this study there is unfettered access to independent inventors and therefore 'actual' subjects making 'actual' decisions about 'actual' resources. This is one of the strengths of the study. Hopefully, the approach will capture instances or scenarios that cannot otherwise be accurately depicted in the laboratory. With that said, it is also hoped that an original contribution will be made in the area of research on what motivates technological entrepreneurs to undertake inventive projects.

Furthermore, there would be increased efficiency if inventions that were identified ex-ante as poor quality were not pursued. Also, evaluating agencies may take cues from the results of the study to adopt clearer ways of communicating feedback to prevent inefficiencies in invention. They may be able to identify ways of providing better services. In sum, researchers will understand the inventive process better, whereas evaluation agencies would be able to assist inventors in their efforts to achieve technical and market success for their inventions.

This paper will proceed by reviewing the literature on cognitive biases and their relationship with inventor decision-making. The next section discusses the data gathering procedure including a definition of the IAP. Following this section is the data and methods section where the survey design, models and variables are discussed. It will end with the results, discussions, conclusions and proposals for future research.

Chapter 2

Literature Review

2.1 Introduction

The entrepreneurial literature motivates this study, since there is inadequate empirical work on inventor or specifically independent inventor decision-making. The approach towards venture creation makes it possible to relate inventors to the entrepreneurial literature. Essentially, the individual level characteristics of inventors and entrepreneurs are not very different. Since the term 'entrepreneurship' was introduced by Richard Cantillon in the 18th Century (Cantillon, 1755), significant refinements - creating new combinations (Schumpeter, 1934), exploring opportunities (Kirzner, 1973), bearing uncertainty (Knight 1921), and bringing together factors of production (Say, 1803) – all mirror the endeavours of inventors at inventing.

Therefore, the two groups are likely to share similar cognitive orientations and backgrounds. Inventors and entrepreneurs share common desires and motives such as: 'being their own boss' (Hamilton, 2001) 'the love of inventing', 'the desire to improve' and financial gain (Rossman, 1931). Hence, it is appropriate to relate inventors to the literature on entrepreneurial activities of recognising and exploiting opportunities, developing ideas and persisting to success or failure.

2.2 General Review: Factors Affecting Venture Creation

Research on factors affecting venture creation basically touch on the individual and social settings. Approaches advanced for research in this area consider the three main categories of psychological and situational factors as well as background characteristics. Factors often considered in these three categories are listed as follows.

Psychological factors: Some researchers identify individual characteristics and employ a trait approach to develop what are considered as **'pull'** theories that aim at explaining what attracts people into venture creation. This approach considers regularly recurring attributes such as: the need for achievement (McClelland, 1961), internal locus of control (Gasse, 1985), illusion of control (Barnes, 1984), intrinsic motivation (Deci et al., 1999), overconfidence (Busenitz and Barney, 1997), optimism (Arabsheibani et al., 2000), opportunity identification (Krueger, 2000; Gaglio and Katz, 2001), intentionality (Bird, 1988), efficacy (Boyd and Vozikis, 1994), independence and flexibility (Fuchs, 1982; Rettenmaier, 1996; Rees and Shah, 1996; Taylor, 1996), and procedural utility (Frey and Benz, 2002). Others look at the propensity for risk taking (Shane, 1996; Miner et al., 1989), skewness-loving (Golec and Tamarkin, 1998), risk loving (Bearse, 1982), and psychology of sunk costs (Arkes and Blumer, 1985).

Some findings include the following. Contrary to popular perceptions, McClelland (1961) finds that entrepreneurs had a higher need for achievement than non-entrepreneurs and were only moderate risk takers. Also, Gasse (1985) finds that entrepreneurs have greater internal loci of control than the general population, and thus believe that their own efforts influence the outcome of a business venture. Begley and Boyd (1987) used a sample of 239 members of a small business association to show that founders scored higher on the dimensions of need for achievement, risk-taking propensity and tolerance of ambiguity.

Situational factors: Other researchers look at situational factors that result in some individuals being **'pushed'** into entrepreneurship. Among the negative factors that have been advanced are; conflicts at one's place of employment, job loss (Olofsson et al., 1986), unemployment spells and liquidity constraints (Evans and Leighton 1989), career setbacks (Gilad, 1986), and limited alternative opportunities (Greenberger and Sexton, 1988) or market demand (Nelson, 1959; Schmookler, 1962). Evans and Leighton (1989) find that richer individuals are more likely to become entrepreneurs.

Background characteristics: Arguing against psychological traits and situational factors, some proponents emphasise background characteristics as being better predictors of success or failure (Reynolds, Blythe and Stanworth, 1989). These background characteristics are assumed to affect the personality of the individual and consequently how they make entrepreneurial decisions. Among these factors are previous employment (Storey, 1982; Ronstadt, 1988); family background (Scott and Twomey, 1988; Matthews and Moser, 1995); gender (Buttner and Rosen, 1989; Kolvereid, Shane, and Westhead, 1993); inheritance (Blanchflower and Oswald, 1998); education (Storey, 1982); ethnic membership (Aldrich, 1980); and religion (Weber, 1930). Evans and Leighton (1989) find that the probability of entering self-employment is independent of age or experience for the first 20 years of employment. Blanchflower and Oswald (1998) argue for the inheritance effect substantial among the younger groups as they inherit wealth and skills from senior family members.

It is worthy to note that, despite the large number of factors that have been advanced to understand venture creation, there is no clear consensus in the literature today on a list of reliable factors that might explain why people choose to start and persist in venture creation. However, considering inventors' reaction to expert advice, it is reasonable to consider cognitive factors that affect their decision to persist when given negative feedback. There is a need to acquire insight into how inventors map the inventive process in their minds. Further, the large sample of inventors studied here is expected to provide benefits over the smaller samples of students often used in similar studies to gather judgements on cases presented in laboratory settings.

2.3 Review of Literature on Heuristics and Biases

The main theory in the heuristics and biases framework is that error in judgment comes about due to cognitive biases, heuristics, or the interaction of both. These are said to affect intuitive predictions and judgments (Kahneman and Tversky, 1996). Kahneman and Tversky (1996) define judgmental heuristics as 'a small number of distinctive mental operations'. Although the heuristics technique is often used in problem solving it does not always guarantee a correct solution. The relevance of the heuristics and biases framework to this study is that inventors are likely to be employing heuristics when they make post-evaluation decisions. The reason is that they tend to discard expert advice that they paid for. This implies that there is a high possibility that, given unfavourable ratings, they turn to their own judgements and beliefs to decide to continue developing their inventions.

Research shows that the use of cognitive shortcuts and the effects of biases are prevalent in venture creation. Even though these shortcuts and biases can lead to success they are often shown to lead to failures. Entrepreneurs persist against adversity by creating plans, convincing themselves and others of the greatness of their ideas, and rallying support by projecting an aura of self-confidence, control and optimism (Kahneman and Lovallo, 1993). Such deceptive projections of oneself induce biased decisions often leading to failure or sub-optimal performance. The following reviews the literature on cognitive biases and their effect on risk perception, information search and interpretation in venture creation.

Since McClelland's (1961) assertion that qualities associated with high need for achievement have an impact on the creation of businesses, research in the area has concentrated on the psychological characteristics of people who initiate new ventures (e.g. Brockhaus, 1980; Begley and Boyd, 1987; Timmons, 1994; Boyd and Vozikis, 1994; Krueger and Brazeal, 1994; Littunen, 2000). For instance, Timmon's (1994) analysis of more than 50 studies finds consensus on characteristics such as opportunity obsession, commitment, leadership, tolerance of risk, creativity, and motivation which have an impact on individuals who create ventures. These factors are identified in those studies as attributes of people who create ventures. However, despite persistent calls to consider personality and demographics in the study of venture creation research, the area of cognitive factors continues to thrive (e.g. Baron, 1998; Busenitz and Barney, 1997; Simon, Houghton, and Aquino, 2000).

Some researchers note that people who create ventures do not perceive the riskiness of the venture due to their cognitive biases. Simon et al. (2000) suggest that entrepreneurs may not perceive the riskiness of starting ventures at all. Their work points to the notion that risk perceptions may differ because certain types of cognitive biases such as illusion of control and overconfidence lead individuals to perceive very little risk if at all. Further, Palich and Bagby (1995) find that although entrepreneurs did not rate their risk propensity as higher than non-entrepreneurs did, they did categorize vague business scenarios as significantly more positive, and thus perceiving less risk than non-entrepreneurs.

In addition, researchers indicate that cognitive biases account for failures in venture creation as individuals fail to conduct thorough searches or appropriate and accurate interpretations of information due to their limited cognitive capacity (Cooper, Folta and Woo, 1995; March and Simon, 1958; Simon, Houghton and Aquino, 2000). Cooper, Folta and Woo (1995) find that experienced entrepreneurs and those with high levels of confidence sought less information than novice entrepreneurs. Also, Simon et al. (2000) provide analyses of how cognitive errors, such as overconfidence, illusion of control, and misguided belief in the law of small numbers, affect entrepreneurs in their choice of options. They note that entrepreneurs who exhibit overconfidence treat their assumptions as facts and thus see less uncertainty and risks.

Furthermore, cognitive biases affect what individuals notice and the interpretations they form (Barnes, 1984; Schwenk, 1984). While Schwenk (1984) notes that these biases often arise when making complex and uncertain decisions, Barnes (1984) asserts that although biases help individuals cope with their cognitive limitations they may result in less rational and less comprehensive decision-making. Thus, the effectiveness of decision-making is likely to be an important factor in determining the success of new ventures (Simon et al., 2000). Inventors will fail to give enough credence to the source of information as cognitive biases result in their discounting the negative outcomes and uncertainty surrounding decisions (Barnes, 1984; Hogarth, 1980; Schwenk, 1984).

The inventors might be seen as perceiving high likelihoods of success, conducting inadequate searches and misinterpreting information received due to the behaviour of discarding unfavourable expert advice. This attitude of discarding expert advice and expending resources conforms to the notion of inventors having cognitive limitations. These cognitive limitations enable inventors to employ cognitive heuristics and approaches which, although simplifies their particular situation, often lead to cognitive errors (Schwenk, 1986). Schwenk (1986) argues that managers can induce the belief in the law of small numbers in followers to gain support for risky actions and also points out that leaders exhibiting the overconfidence bias may steer their firms into unknown territories. There are many such heuristics consistent with the behaviour of inventors in this sample.

This study identifies overconfidence, optimism and illusion of control. The identification of these particular factors follows the procedure used by Simon et al. (2000). Three modes aid in choosing the cognitive factors to study the situation in the sample. First, there should be evidence of the factors being used to study a novel situation in exiting literature. The cognitive factors identified have been advanced in researching the area of venture creation where subjects face a novel situation: overconfidence (Camerer and Lovallo, 1999; Simon et al., 2000; Cooper, Woo, and Dunkelberg, 1988; optimism (Arabsheibani et al., 2000; Padilla, 1997); and illusion of control (Simon et al., 2000; Boyd and Vozikis, 1994). Second, there is evidence of the factors having an effect on how subjects perceive risk and uncertainty. Simon et al. (2000) argue that among other factors, overconfidence and illusion of control directly influence risk perception and the decision to start a business venture. Inventors also project these very biases as they convince themselves and sometimes others of the greatness of their ideas (Kahneman and Lovallo, 1993). Third, the factors come about during the evaluation stage of decision-making. With the aim of assessing how inventors incorporate expert advice into their decision-making, it is imperative to consider factors that determine how individuals assess the riskiness of a new venture. Personal evaluation and evaluation by an agency make inventors overrate the prospects of their inventions or their abilities to achieve success. The factors can also cause inventors to embellish the least positive conditions of the inventive environment.

The constructs of overconfidence, optimism and illusion of control closely mirror the characteristics and behaviour of inventors in this sample. To elaborate, the behaviour is consistent with the overrating of abilities to predict with accuracy (overconfidence), to achieve favourable outcomes (optimism), and to control uncertainty (illusion of control). Thus, considering the problem identified, the three cognitive factors may have an effect on the perceptions and subsequent decisions that inventors take. Hopefully, the factors will help explain the decision-making processes that inventors go through.

The next section reviews the literature on the identified cognitive factors. The review section categorises each factor into three components: the first recounts pertinent literature on the factor; the second presents how the factor interacts with expert advice to influence changes in plans to continue developing; and the third discusses the effect of the cognitive factors on the outcome of commercialisation, having taken the decision to continue spending on the invention. The second part lays out mechanisms through which cognitive factors shape or reshape inventor's plans after receiving evaluation results and the consequent effects on their resource allocation. The third part presents the extent to which the factor will predict commercialisation within an advice category. For instance, are inventors who ignore expert advice likely to achieve commercial success?

2.3.1 Overconfidence

Overconfidence is found to be prevalent in a lot of professions such as with clinical psychologists (Oskamp, 1965), physicians and nurses (Baumann, Deber, and Thompson, 1991), investment bankers (Staël von Holstein, 1972), engineers (Kidd, 1970), entrepreneurs (Cooper, Woo, and Dunkelberg, 1988), lawyers (Wagenaar and Keren, 1986), stock investors (Shiller, 2000), negotiators (Neale and Bazerman, 1990), and managers (Russo and Schoemaker, 1992). However, the case of entrepreneurs and inventors is unique compared to others in other professions due to the novel nature of the ideas they work on. In effect, they may have the propensity to exhibit greater overconfidence traits, for instance, than would individuals in other professions. As support for this claim, Busenitz and Barney (1997) find entrepreneurs to display greater overconfidence than managers do.

Overconfidence refers to the failure to know the limits of one's knowledge (Russo and Schoemaker, 1992) or the overestimation of the precision of one's knowledge (Fischhoff, Slovic and Lichtenstein, 1977; Alpert and Raiffa, 1982). Depending on certain factors such as the personal importance of a task or self-declared competence, subjects tend to give higher scores on confidence judgements than are warranted. Overconfidence may arise when individuals fail to incorporate the uncertainty of their knowledge sufficiently (Kahneman and Tversky, 1973). Since decision-makers who exhibit overconfidence treat their assumptions as facts, they may not see the uncertainty associated with conclusions stemming from those assumptions. Therefore, they conclude erroneously that a certain action is not risky. This is consistent with the arguments of several theoretical contributions that suggest the overconfidence bias lowers an individual's perception of the riskiness of a strategy (e.g. Barnes, 1984; Russo and Schoemaker, 1992).

Furthermore, overconfident individuals do not realize the extent to which their estimates may be inaccurate (Tversky and Kahneman, 1974). Individuals do not revise their initial estimates sufficiently after receiving new data, thus, fall prey to the anchoring and adjusting heuristics. Inventors may persist in inventions that have very little potential due to their inability to realise the uncertainty around their knowledge of the invention's technical prospects at the time or due to failure to realise that their estimate of the probability of success is incorrect. Even though the inventions have little potential and the advice points it out, they are unwilling to revise their initial hypothesis on the invention to incorporate the new information.

Yet, another situation for the bias is when individuals become overconfident because they base their certainty on the ease with which they can recall reasons for confidence, also referred to as the availability heuristic (Kahneman and Tversky, 1973; Russo and Schoemaker, 1992). However, an easily remembered rationale may not increase the accuracy of the person's information (Schwenk, 1986). Consequently, inventors will often fail to review all the possible ways the invention could fail as they focus on the positive scenarios that they can easily remember to inflate their belief that their invention will become commercially viable. This notion is also referred to as the "inside/outside" view (Kahneman and Lovallo, 1993) and occurs when people regard their ideas as unique, thereby disregarding base rates and resorting to case-based reasoning (Koehler et al., 2002; Brenner et al., 2004). Generally individuals are insensitive to base rates and discriminability of evidence. They tend to see the cases under consideration different from the norm when, in fact, it is the same as the past or ongoing phenomena.

Finally, another significant source of overconfidence with a very suitable fit to this research is from the situation where people resort to the confirmation bias (Koriat, Lichtenstein, and Fishhoff, 1980; Klayman, 1995). This bias makes people selectively canvass for information in support of their cognitive perceptions and avoid information that does not support these perceptions. It is obvious that people succumb to this bias and often interpret ambiguous information in ways that support their current beliefs. The avoidance of disconfirming advice makes inventors rely too much on what they already know and the confirming information they perceive. Thus, inventors overestimate the precision of their knowledge and discount disconfirming information that might reveal new dimensions to be explored.

Inventors may also focus on the strength of extremeness of available evidence (e.g. the desirability of the information) with insufficient regard for its weight of credence – e.g. the credibility of the source or the size of the sample (Griffin and Tversky, 1992). Overconfidence is generated when the strength they associate with the evidence is high and the weight is low.

The effects of overconfidence and ratings on change in development decision

Inventors who exhibit a high level of overconfidence are expected to expend more effort at developing their inventions than less confident inventors. The availability bias (Kahneman and Tversky, 1973) may be the reason for this phenomenon as the ease of recall causes inventors to commit to easily remembered information. Thus, they fail to consider other circumstances in which they could be wrong about their evaluation of the inventions' success. Rather, they are quick to use available information to strengthen their belief in their ability to predict the inventions' success.

Another plausible cause of overconfidence is the notion of the uniqueness of the invention's situation, which makes inventors resort to case-based reasoning (Koehler et al., 2002). Fixated on the archetypical attributes of the invention, overconfident inventors will disregard base rates or the relevance of past failures. They will not pay attention to the IAP recommendations whether positive or negative since they see their invention as distinctively different from even the seemingly similar products the IAP compared it with.

Hypothesis 1: More overconfident inventors will spend more time and money on inventions than less confident inventors.

2.3.2 Optimism

Individuals are optimistic when they think that they will not be vulnerable to future events beyond their control. Weinstein (1980) notes that people believe negative events are less likely to happen to them than to others and they believe that positive events are more likely to happen to them than to others. He asserts that unrealistic optimism is not just a hopeful outlook on life, but an error in judgment. Further, Weinstein (1983) notes that there is the tendency for people to claim their chances of suffering from various problems are less than the chances of others around them. Armor and Taylor (2002) argue that the clearest demonstrations of optimistic biases are those that have revealed systematic discrepancies between people's predictions and the outcomes they ultimately attain.

Optimistic biases cut across many domains, cultures, and age groups (Weinstein, 1987). People going on vacation are found to anticipate greater enjoyment during upcoming trips than they actually expressed during their trips. People are overly optimistic even when asked to anticipate their own evaluations of their future experiences (Mitchel, Thompson, Peterson, and Cronk, 1997). Further, considering the high rate of divorce optimism is the best description befitting the predictions of newly-weds who almost uniformly expect their marriages to endure a lifetime (Baker and Emery, 1993).

Optimism is also found in business settings. Arabsheibani et al. (2000) find entrepreneurs to be extremely optimistic about their future earnings, much more than employees, but realizing lower earnings than employees do. Entrepreneurs tend to see their ventures in a positive light as they develop a hopeful outlook of the future. Larwood and Whittaker (1977) find a sample of corporate presidents to be unrealistic in their predictions of success. Hamilton (2000) concludes that unrealistic optimism must explain why expected financial returns to self-employment are not high enough to justify the number of entrants even when taking into account non-pecuniary job benefits. Manove and Padilla (1997) note that entrepreneurs are frequently unrealistic to the extent that they may have to practice self-restraint in their current borrowing in order to signal realism, and thus obtain good rates on future loans from banks.

The effects of optimism and ratings on change in development plans

Unlike the case of overconfident inventors who will tend to put too high a weight on their own opinion, optimism will work by the enhancement or discounting of various elements of the expert advice.

Optimists will notice minimally positive information contained in expert advice and embellish the positive elements contained in any report received. Pessimists on the other hand will tend to discount the positive evidence received by looking for reasons why what is said would not be true. These two processes will cause optimists to be willing to spend more than pessimists after positive advice.

When considering negative advice, optimists will look for reasons to discount this negative feedback, motivating them to spend additional resources than pessimists would. Kahneman and Lovallo (1993) note that decision makers have a strong tendency to consider problems as unique by neglecting historical or statistical evidence from the past. By neglecting the advice, which is partly formed on historical evidence, inventors believe their inventions' cases are different and therefore are incomparable. During the pretest of the questionnaire, a number of inventors noted that they felt the IAP measured their ideas against the wrong match. It follows therefore that such optimistic inventors will continue spending resources as they underweight the negative elements in the advice. Pessimists will however enhance the negative elements of this feedback causing them to spend less.

Hypothesis 2: More optimistic inventors will spend more resources than less optimistic inventors.

2.3.3 Illusion of Control

The third cognitive factor considered in this paper is illusion of control. Illusion of control arises when an individual overemphasizes the extent to which his or her skills can increase performance in large chance situations where the skills may not be a dominant deciding factor (Langer, 1975). When faced with uncertain events, individuals believe that they can control situations and achieve success by relying on their skills (Duhaime and Schwenk, 1985). Simon et al. (2000) note that there is evidence that illusion of control may play a role in the decision to start a venture. An individual's belief in his or her abilities to control a venture's outcome affects his or her intentions to form a venture (Boyd and Vozikis, 1994). The problem is that the belief in the ability to control is based on inaccurate or illusionary perceptions (Shaver and Scott, 1991).

In effect, illusion of control will make inventors overestimate their ability to cope with uncertainty or randomness in predicting future events. Inventors with an illusion of control will believe that they can anticipate and control factors (Langer, 1975) affecting their invention’s development process. There is evidence to show that the higher the perception of control on a situation, the higher the likelihood to underestimate the risks associated with a situation (Schwenk, 1986). Duhaime and Schwenk (1985) note that managers suffering from illusion of control engage in escalating commitment and reason by analogy in such situations as acquisitions and divestitures.

The effects of illusion of control and ratings on change in development plan

Given a positive rating, the inventors' beliefs in their ability to control the random events determining the inventions' prospects will inspire them to continue spending resources on their inventions. Having been assured that the inventions have merit and could be pursued as part-time or full-time activity, inventors see success as inevitable especially considering their skills and abilities. Such perceptions give them the impetus to continue expending more resources on the invention.

In the case of a negative rating, inventors high on illusion of control are also expected to spend more resources developing their inventions after the evaluation. Such inventors will fail to accurately analyze the situation pertaining to their inventions when they have an illusion of control. There is empirical evidence that managers come to believe that they can control outcomes of products under their supervision, thus avoiding risk or challenging risk (March and Shapira 1987). Inventors will place more weight on their skills and ability to see their inventions to success without sufficient regard to the uncertainty and complexity of the inventions' situations as depicted by the evaluation report. Even when success indicators are few, venture founders believe their company will outperform similar ventures (Cooper et al., 1988).

Hypothesis 3: Inventors with a high illusion of control will spend more resources than inventors with low illusion of control.

2.3.4 Other Cognitive Factors

Apart from overconfidence, optimism and illusion of control, there are many other variables that could correlate with the inventor's decision to persist. To separate the effects of these three factors from the effects of other cognitive variables, control variables are added to the model. Variables identified that might correlate with the three independent variables include: locus of control, risk-taking, self-efficacy, intrinsic motivation and opportunity recognition. The following paragraphs provide a brief description of each control factor.

The first control factor discussed involves the concept of locus of control which refers to a generalized belief that a person can or cannot control his or her own destiny (Rotter 1966). Considering the initiatives and persistence of inventors and entrepreneurs, locus of control is considered fruitful in understanding how they make decisions (Bygrave, 1993). Many studies find entrepreneurs to have more locus of control than others (e.g. Evans and Leighton, 1989; Brockhaus, 1980; Cromie and Johns 1983; Gilad 1982).

The next focuses on self-efficacy, which is a person's belief in their capacity to perform a specific task (Bandura 1997, 1986). Self-efficacy has been found to be a key determinant of performance and is known to produce perceptions of competence and control which in turn have an effect on such behaviours as risk taking, opportunity recognition, and persistence (Krueger and Brazeal, 1994).

Risk taking is another variable in this set of controls. Risk taking is viewed as an individual's orientation towards taking chances in a decision-making situation (Sexton and Bowman, 1985). Inventors and entrepreneurs take more risks than others because they face a less structured and more uncertain set of possibilities (Bearse, 1982). It is this predisposition towards risk that affects the decision to pursue an entrepreneurial career (Kihlstrom and Laffont, 1997).

Yet another cognitive factor considered as a control factor is opportunity recognition. The definition of entrepreneurship cannot be complete without reference to the perception and evaluation of opportunities. Since this is the significant characteristic shared by inventors and entrepreneurs it is logical to recognize opportunity recognition as critical to the inception of an invention. Opportunity recognition is the critical first step of the entrepreneurship process (e.g. Christensen, Madsen, and Peterson, 1994; Hills, 1995; Timmons, Muzyka, Stevenson, and Bygrave, 1987).

The last cognitive factor considered is intrinsic motivation. Intrinsic motivation comes into play when an individual performs an activity that gives no apparent reward except the activity itself (Deci, 1971). Thus, the activity is valued for its own sake and appears to be self-sustained (Deci and Ryan 1985; Frey 1997). Since inventors face conditions of challenge, competence or self-determination, intrinsic motivation is likely to be higher (Koestner and McClelland, 1990). Also, inventors may not consider monetary gains in their endeavours as evident in a finding corroborated in the literature (e.g. Palmer, 1971; Sutton, 1954; Davids, 1963; Welsh and White, 1981).

In summarizing the constructs, overconfidence will cause inventors to be poorly calibrated in estimating the probability of success of their inventions. Optimism will make inventors think that they are invulnerable to negative future situations that might affect their invention. Inventors with an illusion of control will overemphasize their ability to control the random elements of their inventions outcome. The other cognitive factors are expected to have various effects on the dependent variable as control variables.

2.3.5 Effect of Cognitive Factors on Commercialisation

Having continued spending resources on the invention's development, it will be interesting to observe what effects the cognitive factors will have on the invention's commercialise prospects, all else equal. The notion here is that when given a positive rating, the effects of the advice will override the bias due to the possibility of commercialisation even when the bias is non-existence. However, the heuristics that are employed within the domain of the bias might help to reinforce the prospects of the invention. However, in the case of a negative rating the bias might perpetuate failure. The invention is likely to fail even when there are no effects of the bias. Nevertheless, the bias might perpetuate the negative effects especially when they do not invoke actions that seek to change the inventions negative characteristics, but rather invoke actions that seek to reject the rating and keep an initial hypothesis on the inventions prospects.

The effects of overconfidence and ratings on commercialization

Overconfidence

Positive rating: A positive advice weighs more in effects than the overconfidence bias in considering the commercial prospects of the invention. In the domain of positive feedback, keeping a case-based reasoning or an initial hypothesis is likely to motivate the inventor to work harder on the invention, thereby moving the product nearer to commercialization. The overconfidence bias could result in erroneous decisions but the heuristics could sometimes lead to a certain level performance when they invoke effort. Effort in itself may be sufficient in getting the invention commercialized, even in the absence of overconfidence after receiving a positive feedback. Therefore, when the actual estimate of success for an invention is already high, an overestimation of this same success due to the overconfidence bias may reinforce its bright prospects.

Hence, overconfident inventors will therefore be ambitious in their development decisions and will expect higher earnings. Their confidence could also serve as a signal to investors whose reactions will help increase the total effort put in the invention. Such effort may contribute highly to the commercialization prospects of the invention. Less confident inventors will be better calibrated than overconfident inventors. Although sufficient effort triggered by the positive rating might still get them commercialized regardless of how low their confidence levels are, they do not gain from the bold initiatives that overconfident inventors might take advantage of.

Hypothesis 4a: Overconfident inventors *are* more likely to achieve commercial success than less confident inventors, given positive feedback.

***Negative rating*:** Given a negative rating, the effects of the overconfidence bias are expected to correlate with the rating to lead to a sub-optimal performance. A negative rating on an invention implies that the idea is not worth pursing, while overconfident inventors given a negative feedback implies a gross overestimation of the real prospects of the invention. Continuing to expend resources under these circumstances is not likely to lead to positive results. To illustrate, prototyping, testing and other stages of the product development process require the systematic evaluation of alternatives in line with manufacturing and marketing avenues available (Krishnan and Ulrich, 2001). When given a negative rating, overconfident inventors will believe that their initial estimate is unbiased and will make their spending decisions consistent with this estimate (Hoch, 1985; Klayman, 1995). In addition, overconfident inventors want to think they are intelligent and knowledgeable (Kunda, 1990; Larrick, 1993) and will consider novel attributes of the project and their personal desires as motivation even when advised to stop. Without the possibility of addressing the negative elements identified in the IAP recommendations, continuing to develop as a result of the perceived ability to predict the invention's success is likely to lead to failure.

Hypothesis 4b: Given negative feedback, overconfident and the less confident inventors *are no* more likely to commercialize.

Optimism

Positive rating: Given positive feedback, the optimistic dispositions and actions of inventors could culminate in success. Manove (2000) notes that unrealistic optimism can also stimulate saving and investment and provide added incentives for hard work. When the invention is characterized as 'worthy of pursuit', optimistic inventors will tend to embellish even the most trivial positive aspects during development. The favourable outlook from embellishment will trigger persistent efforts or allocations of resources, which will lead to a positive effect. These positive achievements could for instance be in the form of meeting the technical and market requirements of the product. The pessimist will not be kindled by the positive elements in the report and would tend to embellish the trivial negative effects and therefore will not have enough achievements towards commercialisation.

Hypothesis 5a: Optimistic inventors *are* more likely to commercialize than pessimistic inventors given positive feedback.

Negative rating: When given negative rating, the invention is not likely to succeed. In fact, a hopeful outlook in this case may lead to regrettable decisions which might speed the invention's failure. For instance, when informed that the invention compared to a pool of similar ones does not have commercial prospects; inventors could believe that their chances of suffering failure are less than the chances of those in the pool (Weinstein, 1983). This will lead them to employ unwarranted persistence when in actual fact the negative rating alone may lead failure even without the influence of their erroneous hopeful outlook. Schultz and Braun (1997) note that 'pet projects' cause managers to lose sight of reality, that is, what consumers really want. Schultz (1999) notes that managers overestimate demand by setting off a chain of events that result in actual or relative product failure. So, a negative rating in itself could lead to a failed prototype, unsuccessful licensing initiatives, or a perfect working model with no market prospects. This could happen with or without the effects of an optimistic bias although the bias might perpetuate the failure.

Hypothesis 5b: Optimistic and pessimistic inventors *are no* more likely to commercialize given negative feedback.

Illusion of Control

Positive rating: In the case of a positive rating, illusion of control might be instrumental in helping inventors keep the aura of competence that might reinforce the invention's positive prospects. With the overrated belief in their skills, they will endeavor to use such skills to add value to the positive attributes of the invention and also improve on the problem areas. Studies manipulating what people expected of how they would perform on particular tasks have found that an orientation towards positive expectations can lead to significant improvements in performance (Armor and Taylor, 2003; Buehler and Griffin, 1996). Thus, having belief in the ability to control the inventions' outcome, inventors initiate design, manufacturing and marketing plans and endeavors to brighten the positive prospects of the invention. However, inventors with low illusion of control will be meek about their skills and will not make as much effort towards commercialization.

Hypothesis 6a: Inventors with a high illusion of control *are* more likely to commercialize than those with low illusion of control when given positive feedback.

Negative rating: In the case of a negative rating, an illusion of control is likely to perpetuate the negative nature of the invention if it will have any effects at all. For instance, entrepreneurs are found to overestimate their ability to ward off competitors, falsely believing that their skills have enabled them to develop a technology that others cannot readily copy (Teece, 1986; Zajac and Bazerman, 1991). Given a negative feedback, the invention's likelihood of success is low. Continuing to develop with an illusion of control implies taking actions that are based on inaccurate or illusionary perceptions (Shaver and Scott, 1991). However, since the factors that led to the negative feedback cannot be counteracted with illusions, the interaction between the poor rating and the illusionary perceptive is not likely to lead towards commercialisation. Inventors with low illusion of control will not be any more likely to commercialize because the invention receives negative feedback and their illusions might play a negative role but possibly to a lower extent.

Hypothesis 6b: Inventors with high and low illusion of control *are no* more likely to commercialize given negative feedback.

In conclusion, this section reviewed the literature in general and the cognitive biases identified to affect inventor decision-making. The biases of overconfidence, optimism and illusion of control were discussed. Also mentioned were cognitive control variables such as locus of control, risk-taking, self-efficacy, intrinsic motivation and opportunity recognition. The section also laid out the various hypotheses on how the cognitive factors affect the decision to continue developing the invention and on the commercialisation outcome.

Chapter 3

Research Setting

3.1 The Canadian Innovation Centre and the Evaluation Process

Evaluation services are not only affordable but also form a tangible part of the invention process. An early and unbiased judgment of the commercial potential of a venture will help avoid high expenditures on projects with low commercial potential as well as encourage further investment on projects with high commercial potential. Mansfield et al. (1977) find clear evidence that the earlier the assessment of an R&D project the greater the future technical, commercial in addition to financial success

Inventors in this sample also seek expert evaluation of the technical feasibility and commercial prospects of their invention at an early stage. They turn to agencies that provide this service as part of an Inventors Assistance Program (IAP). The IAP service was first launched in the U.S.A in 1973 with the support of the National Science Foundation (Udell et al., 1993). The design of the IAP is aid inventors and entrepreneurs in commercializing their ideas. The main role of the IAP is to provide a potential entrepreneur with forecasts on the expected economic value of an invention at an early stage of development. Most inventions are at an early stage of development with average out-of-pocket expenditures of $ 6,625 CDN in 1995 (Åstebro and Bernhardt, 1999).

An IAP was launched in Canada at the University of Waterloo in 1976 and moved to a newly founded non-profit organisation, the Canadian Innovation Centre (CIC) in Waterloo, Ontario (Åstebro and Bernhardt, 1999; Åstebro and Gerchak, 2001). During 1976-1981, the IAP at the University of Waterloo used between 2-3 evaluators who were typically professors and some outside experts. However, after 1982, the CIC have used full-time in-house analysts and have continuously revised and improved their evaluation methods. The CIC evaluates the inventive ideas of potential inventors on 37 different criteria (see Appendix A for more details). These are in four categories of technical, production, market, and risk factors. Thirty-three (33) items of the 37 criteria were developed by Gerald Udell at the Oregon Innovation Centre in 1974 (Udell, 1989) as factors critical for assessing venture success. They were used by the Canadian IAP at inception in 1976 and the CIC adapted the 33 adding four more criteria (Åstebro and Gerchak, 2001).

The potential inventor, upon requesting for an evaluation, is given a disclosure document[1] which includes a questionnaire eliciting background information and a brief description of the idea. A list of supplementary documents, that could be submitted, includes patent applications, sketches, and test reports. Furthermore, the questionnaire elicits information on market, manufacturing and product costs, as well as information on the inventor's skills, plans and professional goals. After the questionnaire is received by the CIC, an in-house analyst reviews the submission in terms of other submissions, online database searches, and some preliminary patent searches. Personal contact by the analyst with the inventors beyond the documentation provided is avoided to ensure an unbiased evaluation.

The analyst subjectively rates the idea on the 37 criteria and assigns a weight to each factor. An overall score for the project is then determined. In addition to the review by the single expert, an inter-departmental group meeting is convened where the evaluating expert presents a summary and a final overall score is agreed upon.

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[1] Critical Factor Assessment: Canadian Innovation Centre, 490 Dutton Drive, Unit 1A Waterloo, Ontario, Canada N2L 6H7

The evaluation process typically takes five to seven hours and may stretch over several weeks as the analyst collects information from various sources. A report is delivered to the entrepreneur consisting of scores on the 37 cues and a recommendation on commercialization options. The five possible ratings (including some minor variations) are E – unacceptable and with strong advice that the project be terminated; D – doubtful, one or more factors strongly unfavourable, advise project termination; C – possible, may be modestly successful, invention has merit as a part-time endeavour; B – invention looks promising, but information is needed; and A – invention is worth commercialising by full-time by inventor. Ratings A – C are basically encouraging (positive feedback), whereas ratings D and E are discouraging (negative feedback). For the B rating, the inventor is advised on what information is missing and urged to collect the additional information before determining whether to continue further work.

The IAP also evaluates the inventors and their institutional support which helps the CIC in providing more specific recommendation on how the invention might best be commercialised considering the rating received (Åstebro and Gerchak, 2001). Depending on the IAP's assessment of the inventor's qualifications and support, the IAP recommends one of five commercialisation options: licence or outright sale, move into existing business (if applicable), new venture potential, part-time effort, or other possibilities. These options and recommendations were added to the repertoire of the advice in 1986 (Åstebro and Gerchak, 2001). Due to the increasing number of projects examined, the CIC reports have evolved. At inception, reports included overall score ratings on each criterion with explanations and a few comments. In the later years, a report is a 25-30 page document containing the overall score and the scores on each of the 37 criteria, summaries of information searches, specific recommendations on how to commercialise the idea if feasible, and how to approach critical weaknesses.

Since its inception in 1976, the Canadian IAP has evaluated more than 14,000 applications as of 2004. The program is being partly (50%) supported by the Canadian Government and from service fees (Åstebro and Bernhardt, 1999). The application fee for an evaluation in 1994 was $250 CDN, $262 CDN in 1995 and $750 CDN in 2001.

3.2 The Diagnosticity of the CIC Advice

There is evidence that the recommendations given by the IAP correlates with the project's subsequent probability of commercial success and is a beneficial exercise to inventors (Åstebro and Bernhardt, 1999; Åstebro and Gerchak, 2001). The inventor is at liberty to ignore the advice and it does not serve as proof of the invention's prospects to be used to access other support services. However, the rating generally has high diagnosticity since it is a strong predictor of the probability of commercialisation and is quite highly correlated with the likelihood of continued development efforts (Åstebro and Bernhardt, 1999; Åstebro and Gerchak, 2001). Evidence of diagnosticity is observed in Table 1, which indicates a clear correlation between the overall rating and the probability of commercial success, suggesting that the advice provided by the IAP is of high predictive value.

Table 1 Base Rate and Diagnosticity of Invention Commer. Review, 1976-1993

Overall Rating	Sample Total	Percent of all	Percent that continue	Number of commercial	Percent commercial
(1)	(2)	(3)	(4)	(5)	(6)
A - recommended for development	24	2%	91%	12	50%
B - may go forward, but need to collect more data	45	4%	84%	7	15.60%
C - recommended to go forward, returns likely modest	204	19%	81%	32	15.70%
D - doubtful, further development not recommended	657	60%	51%	24	3.70%
E - strongly recommended to stop further development	163	15%	47%	0	0%
Weighted Average			58%		
Total	1091	100%		75	

Source: Åstebro and Gerchak (2001)

The recommendation to the inventor is noted to be a strong indicator of the project's underlying commercial quality (Åstebro, 2003; Åstebro forthcoming). It is observed that 47% of those rated E continue for some time after the advice when prospects of success are zero. Also, 51% of those rated D continue for some time after the advice when prospects of success are 3.7%. The IAP advice seems to be quite diagnostic considering the prospects of success when feedback is negative. Furthermore, the advice is quite accurate. The IAP is able to correctly predict outcomes four times out of five. Thus, the IAP seems to be able to predict a good number of commercial successes and failures. A survey of 559 inventors' projects showed that the IAP correctly forecasts 75.8% of the successes and 79.3% of the failures (Åstebro and Chen, 2002). However, the indications are that inventors receiving negative feedback are not giving enough credence to the advice. They do not revise their prior beliefs optimally.

Chapter 4

Data and Methods

4.1 Data

The dataset for the survey conducted for this study is taken from the client list of the Canadian Innovation Centre. A sample of 5,008 inventors who submitted ideas for review at the CIC during 1994-2001 was identified. Since most of these inventors had moved from their original places of residence and had changed their addresses as found in the CIC records, there was the need for an address updating exercise. The client list was taken through address databases to update the residential addresses and phone numbers. By the end of the address updating exercise, the sample was reduced to 1,842 inventors with fully and partially verified addresses and contact numbers.

4.2 Questionnaire Development

Having reviewed possible constructs that could be tested on the sample, a questionnaire was designed for the survey. Two approaches were used to develop the survey questions. For constructs such as overconfidence, which could be tested generally and did not need to be in the invention-specific context, questions were drawn from existing scales or methods previously used in the literature. However, for factors such as opportunity recognition and intrinsic motivation, which are context driven, questions were designed to fit the inventor domain and, where appropriate, existing questions were modified to do the same. Cognitive burden in answering the survey questions and the risk of non-response were also taken into consideration in designing the survey. Since a telephone survey was used for the data collection, the questions had to be designed such that they were easy for the interviewer to administer to the interviewee and for the interviewee to follow. It was important that cognitive burden in comprehending the question over the phone was reduced. Also a telephone survey that is not well catered to the characteristics and expectations of the subjects is likely to result in a high number of incomplete surveys increasing the non-response count.

The definition of overconfidence used in the confidence test is that of the overestimation of the precision of one's knowledge (Fischhoff et al., 1977). Questions were on general knowledge (Russo and Shoemaker, 1992) and the design was based on the notion of moderate to extreme difficulty (Fischhoff et al., 1977). Simon et al. 2000 note that since inventors draw upon a wide array of information in their search endeavours, eliciting overconfidence with general questions is appropriate. The Fischhoff, et al. (1977) method is used in various empirical work related to business (e.g. Russo and Shoemaker, 1992; Simon et al. 2000). Simon et al. (2000), like Russo and Shoemaker (1992), ask respondents to answer 10 questions. Each question has only one correct numerical answer. Then for each question, respondents established a range (i.e. low and high) of possible values that they 90% certain would capture the correct answer. If for all the questions more than 10% of the correct answers fell outside of the range then respondent was overconfident because the subject developed ranges that were too narrow. Each correct answer that fell outside of the range was scored as one rather than zero. The scores for the 10 questions were summed to measure overconfidence. Although the method is a good fit with this sample, the question works best with a graphic illustration where subjects conveniently mark the low and high points around their confidence estimates. However, the telephone interview method of data collection did not make it possible to use the method in the same format. A close adaptation was therefore developed.

The questions developed for this survey tested the respondent's beliefs in their ability to give accurate answers and their beliefs on how many right answers they could predict in the lot. Five city comparisons of big and small popular and unpopular cities, in Canada and other parts of the world, were presented to respondents. Three pairs were from Canada while the other two pairs were international. The question asked respondents to note which of each pair was the larger city and then to note their confidence level on a scale of 50% to 100%. The scale started from 50% since confidence levels below 50% imply that the respondent prefers the other city instead. After this input, respondents were then asked to indicate how many of the five comparisons they thought they got right (See Appendix B.1 for question and scale). Respondents who got fewer actual correct answers than they thought they would get right were judged less confident.

Optimism was measured using previous scales. Six out of ten questions were taken from the Personal Attributes Survey (PAS) (IPIP, 2001; Scheier, Carver and Bridges, 1994). The IPIP[2] is a credible database of psychology constructs where researchers choose questions for their surveys. The questions enquired about the respondent's dispositions towards future uncontrollable events. Examples of the statements included 'I just know that I will be a success' and 'I feel that my life lacks direction'. Studies using general measures have found optimism to affect both cognition and behaviour (Larwood and Whittaker, 1977). Respondents were asked in this study to indicate the extent to which they agreed or disagreed with the statements on a scale from one to five where 1 meant strongly disagree, 2 meant disagree, 3 meant undecided, 4

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[2] http://ipip.ori.org/ipip/new_home.htm accessed June 12, 2004

meant agree and 5 meant strongly agree (see Appendix B.2 for questions and scale). Questions on the rest of the constructs were developed with the same scale.

Questions on illusion of control were modelled on methods used in studies conducted by Keh, Foo, and Lim (2002), Simon et al., (2000) and Langer and Roth (1975). Adapting their measure from Simon et al. (2000), Keh, Foo and Lim (2002) measured subjects' perception of their own ability to predict certain uncontrollable outcomes on a seven-point scale. The questions used by Keh, Foo and Lim (2002) were set in the domain of businesses making it necessary to re-model the question for this study. Therefore in this study, four questions were developed, some in the invention domain, to elicit respondents' dispositions on control and predictions of the outcomes of events in their lives and about their inventions. Some of the statements respondents were asked to agree or disagree upon on a five-point scale included; 'It is important for me to convince myself that I can control my future' and 'I can make my invention a success even though others might fail'. (See Appendix B.3 for questions and scale).

For the other cognitive factors, questions on risk-taking and locus of control were taken from psychology inventories. Risk-taking, from the risk taking aspects of the multi-faceted Jackson Personality Inventory (JPI-R : Jackson, 1989; Jackson, 1994) and locus of control, from the Levenson (1974) internal-external scale for locus of control (see Appendix B.4 and B.5 for details). Questions on self-efficacy and opportunity recognition were modelled on work from the literature. Self-efficacy, on a study by Markman, Balkin and Baron (2002) and opportunity recognition, on work by Gaglio and Katz, (2001) (see Appendix B.6 and B.7 for details). Finally questions on intrinsic motivation were developed to fit the inventor domain (see Appendix B.8 for details).

The order of the statements used in the measurement of the constructs was randomized across subjects during the survey. This was to eliminate order effects that might be associated with grouping questions under one construct. Order effects refer to the situation where the information subjects receive alters or distorts their perceptions and evaluations (Schmitt and Klimoski, 1991). In addition to the controls, background information and general questions on the invention and its progress since the CIC evaluation were asked. Background information included questions on age, gender, education, employment, marital status, income and experience (see Appendix B.9a-c for questions on the background variables included in the model). For the dependent variable, respondents were asked about how much money and time they spent on developing the invention before and after the CIC evaluation (see Appendix B.10a-c). There were also questions on the inventions' commercialisation, timelines, procedure, industry, patents, and outcome. Lastly, other items on the questionnaire included questions on the inception of the inventive idea, the circumstances, the drives and motives for deciding to develop the idea.

4.3 Survey

4.3.1 Pre-tests

Two levels of pre-tests were conducted. The first was on a group of 5 inventors who had gone through the IAP. They were given a paper copy of the questionnaire to evaluate. Their feedback on clarity, flow and the general structure of the questions were taken. They were also timed to gather information on survey completion times. Most of these inventors were eager to participate and their feedback and comments, on their inventions as well as their perceptions of the IAP advice, gave insight into possible ways of improving on the questionnaire. The second level of pre-tests was conducted by the Survey Research Centre (SRC) University of Waterloo[3], which also administered the main survey. A pre-test sample of 50 was chosen to test the survey instrument and the sampling frame while collecting information on average interview lengths, station hours, and dispositions. Almost 2 weeks after introductory letters were mailed out to the respondents, the main inventor survey commenced.

4.3.2 Inventor Survey

The Computer-Assisted Telephone Interview system (CATI) was used to conduct the survey. Studies have shown that in telephone surveys, computer assisted data collection using CATI is less expensive and yields better data more quickly than traditional techniques (Harlow, 1985). The method is also more likely to show greater improvements in quality (Birkett 1988). Interviewers underwent training and familiarisation sessions on the survey instrument and its background. At the start of the survey the sample of 1,842 was reduced to 1,770 due to declines and refusals. With an average interview time of 30 minutes, the survey was quite successful considering a 61% response rate (780 fully completed survey cases) and the fact that only 7% of the respondents who started the survey did not finish.

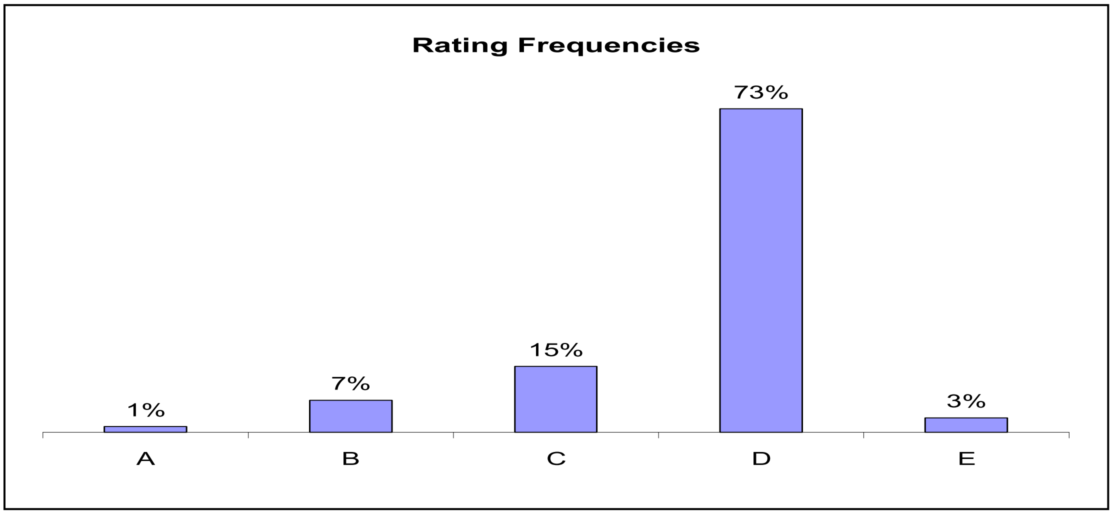
4.4 Ratings

The frequencies for ratings given in the A, D, C, D and E categories from the CIC records were computed as shown in Figure 1. It could be seen that majority (73%) of inventors received the D rating. The D rating summarises into 'doubtful, further

[3] http://www.stats.uwaterloo.ca/Stats_Dept/SRN/index.html accessed June 15, 2004

development not recommended'. 15% received the rating C which says 'recommended to go forward, returns likely modest'. For inventors receiving the C rating, they are sometimes told to pursue the venture as a part-time activity since the returns are anticipated to be only modest and a breakthrough that would justify a full-time commitment is not guaranteed. Seven percent (7%) of the inventions receive the B rating, which means that inventors may go forward but need to collect more data. Only 1% of the inventions received the A rating which means that the invention is recommended for further development. Three percent (3%) received the E rating which means that the inventors are strongly encouraged to stop further development of the invention. These rating statistics bear strong similarity in pattern to the findings of Åstebro and Gerchak (2001) from an earlier sample of inventors from the same pool (1976-1993). Comparing their sample to this sample (1994-2001), more than 50% of inventors got the D rating in both samples while the smallest percentage got the A rating in both samples.

Figure 1 Rating Frequencies



4.5 Dependent Variables

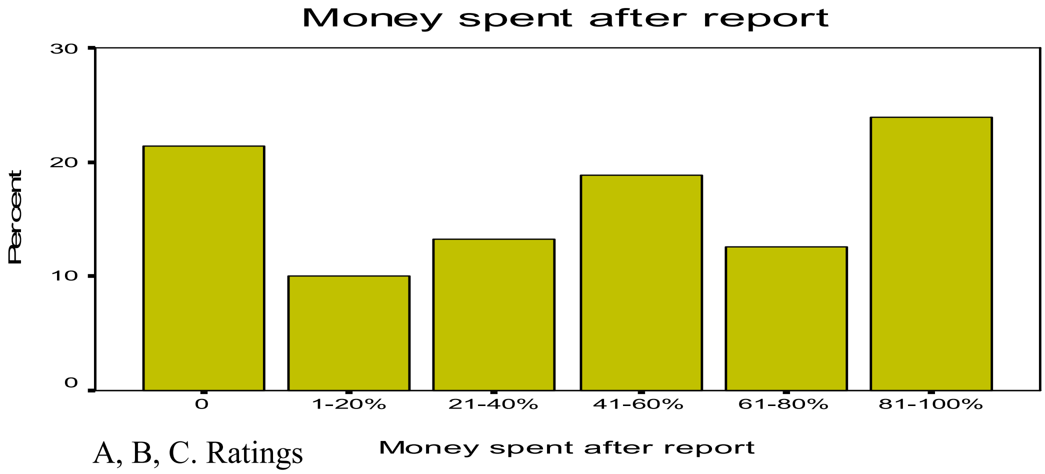
4.5.1 Proportion of Money Spent

Spending money on the invention is an indication of commitment to the project's success since the inventor forms some intention that requires directing resources at developing that invention (Bird, 1988). The measure used is the proportion of money and time spent (before and after the CIC review). It is assumed that the amount of additional money and time expended after the evaluation correlates with the expected value of the investment (probability x payoff).

Respondents reported spending, on average $20,800 CDN (Std. Dev. $250,400) (all dollar values reported are Canadian) before obtaining a review and $23,800 (Std. Dev. $145,000) after obtaining a review. The distributions are highly skewed with large maximum values: $6,000,000 and $2,000,000, respectively. However, 60% spent less than $500 before the review, indicating that majority of inventors do not do much development work before approaching the CIC. The norm for this group of inventors is to provide a rough sketch or a very basic prototype of the invention. Finally, 70% spent less than $500 after the review, indicating that majority of inventors stop development efforts after obtaining the report.

Nevertheless, a significant proportion of 26% of inventors go on to further develop their inventions after obtaining the review. Figure 2 shows the frequency distribution of inventor spending within the A, B and C ratings. As many as 21% abandon the project even though they have been encouraged to proceed. Also, more than half of inventors in these rating groups spent nearly as much money as they had spent initially before the evaluation.

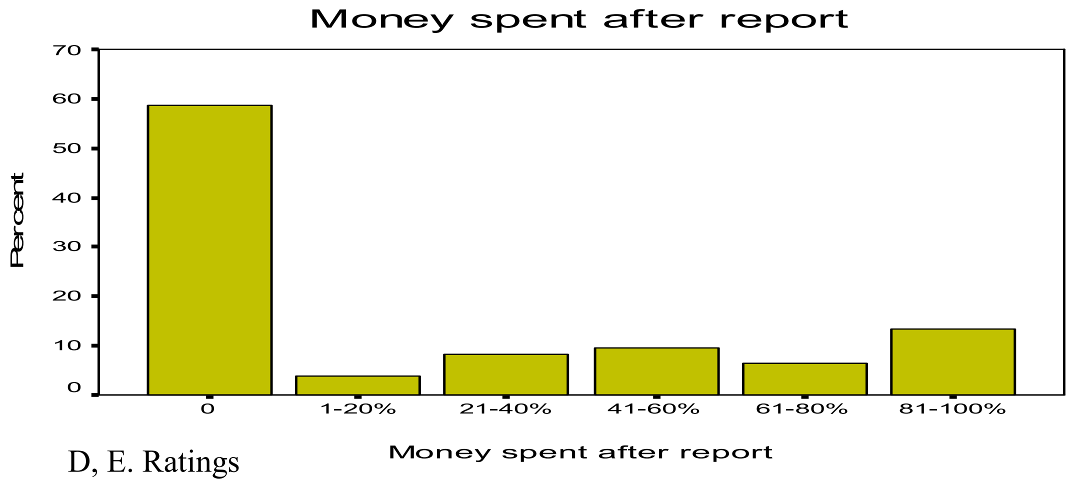
Figure 2 Percentage of Inventors Spending Additional Money (A, B & C ratings)



A, B, C. Ratings

However, the inventions in the D and E ratings together form 76% of the total number of inventions in the sample. Figure 3 shows the frequency distribution of inventor spending after the CIC evaluation. More than half (59%) of inventors who are advised to stop developing their inventions spend $0 after the evaluation. These inventors are heeding to the paid advice from the IAP. However, the remaining (41%) go on to further spend money on developing their inventions while about 30% spend as much money on the inventions after the evaluation as they spent before the evaluation. Thus , it is therefore interesting to learn about why these inventors will persist when advised to stop developing.

Figure 3 Percentage of Inventors Spending Additional Money (D & E ratings)



D, E. Ratings

The measure developed to compute the proportion of money spent dependent variable is presented as follows:

$$MA_i = \frac{\text{Money expenditures after evaluation}}{\text{Total money expenditures}} \quad \ldots\ldots(1)$$

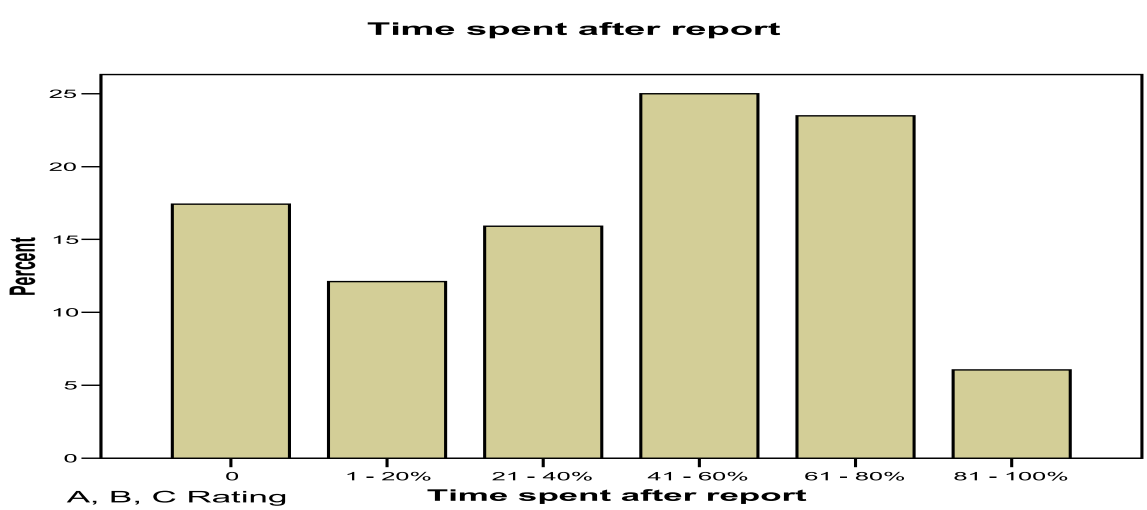
4.5.2 Proportion of Time spent

Time spent after the evaluation is another dependent measure that was considered. Questions asked were on the number of hours of unpaid time the inventor and others together spent to develop the invention. Proportion of time spent also shows the intentions and behaviour of inventors representing their beliefs (Ajzen, 1987,1991). A potential problem with this measure is that it carries low or no opportunity cost. In effect, it may reflect many other decision-making biases, or non-monetary factors, such as the intrinsic value of inventing, which could be related to factors such as intrinsic motivation and opportunity recognition. Even though there is likely to be a lot of noise in this variable it is nonetheless a good measure of inventor commitment towards invention. The amount of total development time spent on the invention averaged 784 hours (Std. Dev.

1,324 hours). Inventors spent on average 23% of the development time after receiving the review, and 40% spent less than 1% of their time on the inventions after the review.

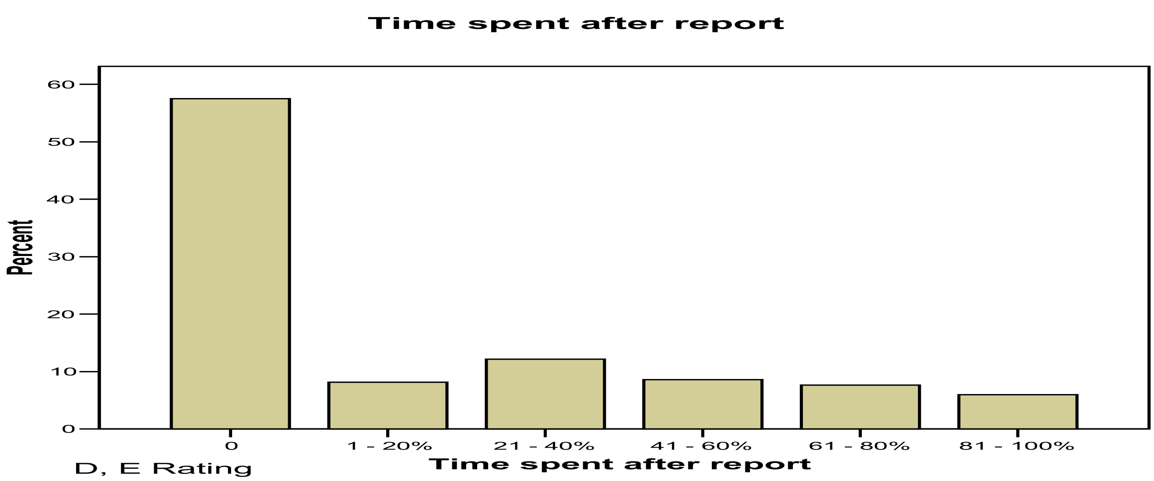
The descriptive structure of the data for time spent before and after the evaluation is not very different from that of the amount of money spent. Time spent after the evaluation when given the A, B or C rating (Figure 4) and time spent when given the D and E ratings (Figure 5) are compared. It is observed that about 50% of the inventors spent between 40% and 80% of their time inventing after the CIC review. About 18% of the inventors spent no time on the invention after the evaluation and therefore did not continue with the idea even though they were encouraged to do so. This could happen when circumstances unrelated to the evaluation cause inventors to decide that they would not continue with the development of the invention.

Figure 4 Percentage of Inventors Spending Additional Time (A, B & C ratings)



In the D and E rating set, the pattern of time spent (Figure 5) bears close resemblance to the pattern of money spent (Figure 3). About 60% of inventors in the D and E rating would be considered good Bayesian decision makers who incorporate the IAP advice into their decision-making thus, using the base rates to update their prior beliefs on their inventions' probability of success. These inventors spent zero time on their inventions after they were advised to stop development. However, the remaining 40% discarded the advice and continued to spend different proportions of time on the invention.

Figure 5 Percentage of Inventors Spending Additional Time (D & E ratings)



The measure developed to compute the proportion of time spent dependent variable is presented as follows:

$$TA_i = \frac{\text{Time spent after evaluation}}{\text{Total time spent}} \quad \ldots\ldots\ldots(2)$$

Thus, using the two dependent measures of money and time allows the effects of costly versus non-costly efforts to be identified. These effects are associated with money, having a high opportunity cost, and time having a low opportunity cost.

4.5.3 Commercialisation

Commercialisation is the dependent variable used to study how the cognitive factors affected the outcome of the decision to continue developing an invention after evaluation. Frequencies of those who commercialized were computed, given that they spent more after receiving the evaluation results. Table 2 and 3 show the frequencies and percentages for all ratings, for the two rating sets, and for individual ratings. It is observed that out of 477 inventors (from the sample of 780) who continued to spend money on their inventions, 87 (18%) commercialized their inventions while the remaining 390 (82%) did not commercialize.

Table 2 Frequency of Inventions Commercialized within Ratings

	All Ratings		A, B, C Ratings		D, E Ratings	
	Frequency	Percent	Frequency	Percent	Frequency	Percent
Didn't commercialize	390	81.8	106	68.4	273	83.3
Commercialized	87	18.2	49	31.6	36	11.7
Total	477	100	155	100	309	100

It is further observed that closely mirroring earlier research (Åstebro and Gerchak, 2001) the IAP advice is quite highly diagnostic as they are 83% accurate in their predictions that inventions receiving D and E ratings would not make it to the market. However, out of the total number of inventors who continued spending on the invention, 69% of those who did not commercialize received the rating D. Within the group that received ratings categorised as negative (D&E), 96% of those who did not commercialize received the rating D (see Table 3)

For the inventions that the IAP indicated could be successful when pursued, only 32% made it to the market. This is driven by ratings B and C. For all inventors receiving positive feedback, 33% of those who did not commercialize received the rating B, 62% received the rating C, and 5% received the rating A. Thus 32% success could not be considered as low diagnosticity of the advice. As part of the uncertainties in the inventive environment, those receiving the B rating might find it too difficult to collect the additional information that the recommendations advised. Likewise, those receiving the C rating could be in the same position, and they also could have been discouraged by the moderate prospects predicted by the recommendation.

Table 3 Frequency of Inventions Commercialized within Individual Ratings

Ratings	Action	Frequency	Percent	% within action	% within positive rating
A	Didn't commercialize	5	71	1	5
	Commercialized	2	29	2	4
	Total	7	100		
B	Didn't commercialize	35	71	9	33
	Commercialized	14	29	16	29
	Total	49	100		
C	Didn't commercialize	66	67	17	62
	Commercialized	33	33	39	67
	Total	99	100		
					% within negative rating
D	Didn't commercialize	263	89	69	96
	Commercialized	33	11	39	92
	Total	296	100		
E	Didn't commercialize	10	77	3	4
	Commercialized	3	23	4	8
	Total	13	100		

Commercialization was computed as a binary indicator variable as follows:

$\text{Commercialization}_i$ $(C_{1,0})$ = I (invention is commercialized) …………………………(3)

where C_{1i} denotes the invention is commercialized and C_{0i} is denotes the invention is not commercialized. 'I' denotes indicator.

4.6 Independent Variables

The independent variables are overconfidence, optimism, illusion of control, and control variables; locus of control, risk-taking, self-efficacy, intrinsic motivation and opportunity recognition. Background variables such as time developing inventions, highest level of education, and total household income are also included as independent control variables. The reasons are discussed below.

Overconfidence. Overconfidence is measured as the degree to which an individual expects that they have made a correct judgment on a judgment task over the average degree of correct judgments in the population (Griffin and Tversky, 1992). A measure of overconfidence from the city comparisons is constructed as follows:

$$conf = \sum_k \left(a_{ik} - \bar{b}_k \right) / 5 \quad \text{...(4)}$$

where a_{ik} is respondent *i*'s estimated confidence of being right on judgment *k* and $\bar{b}_k$ is the average percent correct choice of judgment *k* in the population. Respondents show only a slight average overconfidence (*conf1mean*=0.17, std. dev.=0.12) with a range from -0.07 to 0.43.

Following Griffin and Tversky (1992) *conf* is expected to be an accurate estimate of overconfidence as inventors are more likely to maintain a high degree of confidence in the validity of specific answers even when they know that their overall accuracy in judgment is not that good. Overconfidence for the judgment of Canadian cities is expected to be greater than for foreign cities although the three Canadian comparisons had cities reasonably close in size because people more readily form a stronger opinion on tasks they believe they know using associative or salient information while they are less ready to form an opinion on a task where they have less salient information although the task is easier (Griffin and Tversky, 1992).

Of the five judgments, respondents seemed to be more overconfident on comparisons close to home. The majority of subjects (69%) reside in Ontario. And, the two comparisons of cities located in Ontario had overconfidence judgments of 0.39 for both comparisons while two provincial capitals, Saskatoon and Regina, (located outside Ontario) recorded average overconfidence of 0.09. Respondents were on the other hand underconfident, possibly well calibrated, on the two foreign judgments [0.003, -0.005]; supporting the idea that confidence is a function of case-based judgment (Koehler et al., 2002; Kahneman and Lovallo, 1993).

Other Constructs. In preparing the measures of the other constructs, factor analysis was considered a suitable method. Each construct contains a group of correlated items (statements) representing that construct. For instance, optimism contained statements that will correlate positively or negatively. To identify the structure in the relationships between these items and develop a single line of data representing each construct, exploratory factor analysis [first introduced by Thurstone (1931)] was applied as a data reduction method. Exploratory factors analysis was more appropriate as the constructs consisted of a mix of existing scales and adapted versions tailored to suit the subjects and the data collection method.

The principal factor analysis (Stevens, 1986) was conducted in SPSS 12.0[4]. In this method, a regression line is fitted to represent the best summary of the linear relationship between the items. A factor is then defined approximating the regression line and capturing the relevance of the items in a single score for each construct that can be used

[4] http://www.spss.com/ accessed June 28, 2004

in the multivariate regression analysis with other variables. To elaborate on the process, principal components (Afifi and Clark, 1990) were extracted through a process which amounts a variance maximizing (varimax) rotation of the original variable space. This type of rotation is called variance maximizing because the criterion for the rotation is to maximize the variance of the factor, while minimizing the variance around the new variable[5]. This gave a pattern of loadings on each factor that are supposed to be as diverse as possible. Given the factor loadings, the factor structure was analysed to identify patterns that show which constructs correspond to high loadings in the factors (see Appendix C for factor loadings). The columns of factor scores that had high loadings for a particular construct were chosen to represent that construct in the regression. The factors are normally distributed N [0,1].

Constructs that were taken through this exercise were optimism (α=0.6445), illusion of control (α=0.5610), locus of control (α=0.4624), risk taking (α=0.6120), opportunity recognition (α=0.6662), intrinsic motivation (α=0.7535) and self-efficacy (α=0.8284)6. These are Cronbach alpha coefficients (Cronbach, 1951) which check for internal consistency between items of a construct as a way of assessing the reliability of the construct. The theory behind the measurement of the Cronbach coefficient Alpha is that the observed score is equal to the true score plus the measurement error. The Alpha is thus, a measure of squared correlation between observed scores and true scores. In other words it is measured in terms of the ratio of the true score variance to the observed score variance. For a test to be reliable, the measurement error should be minimized so that the error is not highly correlated with the true score while the relationship between

[5] Statsoft : http://www.statsoftinc.com/textbook/stfacan.html accessed June 28, 2004
[6] Cronbach Alpha comparison of the scores for the 3 main constructs with other scales: Optimism (α=0.86 – IPIP scale); Illusion of Control (α=0.67 – Simon et al (2000): α=0.80 – Kee, Foo & Lim, 2002).

the true score and the observed score should be strong. In general, the higher the Alpha is, the more reliable the test is. Although there is no clear consensus on a standard benchmark, Alphas of 0.7 and above are acceptable (Nunnally, 1978). It will be noted then that except for intrinsic motivation and self-efficacy, low Alphas were reported for the other constructs and controls. On possible reason for the low scores is the randomisation of items during the data collection process. The items were randomised across subjects to eliminate order effects. The randomisation may be preventing subjects from priming their answers to the previous questions as would be the case if the items under each construct were kept together. The remedy for low Alpha scores is to run factor analysis specifically principal factor analysis (as discussed above) to see which items load the highest (Hatcher,1994). The loadings could then be used in the regression model.

Descriptive statistics for background variables. Descriptive statistics were also computed for the background variables identified; the highest level of education, years of experience developing inventions and household income. For the highest level of education, the descriptive statistics are summarised in Table 4 with comparisons among ratings. Overall, 80% of inventors have a level of education ranging from high school diplomas to post-graduate degrees. Inventors in the rest 20% group either did not complete high school or had a post-graduate degree. Although not significantly high, most inventors had an undergraduate degree.

Table 4 Highest Level of Education - Descriptive Statistics

	Descriptive stats			Prob. of obtaining positive ratings		
	All (%)	A,B,C (%)	D, E (%)	B	Sig.	Exp(B)
*Didn't complete High School	11.4	6.2	12.9			
High school diploma	14.2	12.9	14.9	0.599	0.134	1.820
Trade school diploma	14	16.3	13.8	0.904	0.020	2.470
Some college or university	16.4	12.9	17.8	0.417	0.294	1.517
Undergraduate degree	18	23	16.3	1.087	0.004	2.966
Professional degree	15.1	12.9	15.2	0.576	0.149	1.778
Post-graduate degree	10.9	15.7	9.1	1.287	0.001	3.622
Constant				-1.906	0.000	0.149
Total	100	100	100			

*comparison group

In terms of comparisons between ratings, the results showed that inventors with undergraduate degrees stood out more significant ($p<0.004$) among inventors receiving approval from the IAP while those with some college or university degree received more negative feedback. However, compared with inventors who did not complete high school, those who have a post-graduate degree were most likely to receive positive ratings (highest odds=3.622; $p<0.001$). The next likely group were those with undergraduate degrees ($p<0.05$) followed by those with a trade school diploma ($p<0.05$) Education is found to correlate with venture creation (Storey, 1982). Essentially, all those with education at or above high school were more likely to receive a positive rating than those who did not complete high school.

For years of experience developing inventions, inventors were asked how long they have been developing inventions (see Table 5). Experience inventing may increase the cognitive abilities needed to evaluate information gathered through search (McGrath, 1996). More than 50% of inventors noted that they have spent more than 5 years working on inventions. 35% of inventors have been developing inventions for more than 10 years. The indication here is that inventors in the sample are quite experienced in the field.

Table 5 Years of Experience Developing Inventions - Descriptive Statistics

	Descriptive stats			Prob. of obtaining positive ratings		
	All (%)	A,B,C (%)	D,E (%)	B	Sig.	Exp(B)
*No experience	2.1	1.7	2.3			
Less than 1yr	17.3	7.3	20.7	-0.722	0.305	0.486
1 - 2 yrs	9.7	10.2	9.6	0.368	0.597	1.444
3 - 5 yrs	16.8	20.3	15.7	0.573	0.393	1.773
6 - 10 yrs	19.2	26.6	16.9	0.763	0.251	2.144
More than 10yrs	34.8	33.9	34.8	0.288	0.662	1.333
Constant				-1.466	0.022	0.231
Total	100	100	100			

*comparison group

Again, descriptive statistics for time spent developing inventions was computed across ratings. The probability of receiving a positive rating was also computed among categories of experience developing inventions. Comparing the frequencies of inventors who got favourable and unfavourable ratings there is no significant differences in time spent developing inventions except for inventors who had less than one year experience. For these amateur inventors, the ones who received an unfavourable advice were 21% compared to the 7% who received a positive advice. However, comparing experienced inventors with those who have none, those with 6 to 10 years experience were most likely to receive positive ratings. Inventors with more than a year's experience were essentially more likely to receive positive ratings than those with none.

The last background covariate chosen for the model estimation is total household income before taxes, which also includes savings income where applicable (see Table 6). It is observed that only 28% of inventors earn over a $100,000. However, about 71% of inventors earn over $50, 000, which indicates that majority are above the average income group. Further, total household income was computed across ratings.

Table 6 Total Household Income - Descriptive Statistics

	Descriptive stats			Prob. of obtaining positive ratings		
	All (%)	A, B, C (%)	D, E (%)	B	Sig.	Exp(B)
*Less than $20k	4.9	5.3	4.6			
$20k - $30k	7.1	2.3	8.5	-1.462	0.049	0.232
$30k - $40k	7.7	6	8.2	-0.454	0.440	0.635
$40 - $50k	9	6.8	9.8	-0.514	0.369	0.598
$50 - $70k	20.7	25.6	19.7	0.122	0.801	1.130
$70k - $100k	22.4	24.8	21.7	-0.008	0.988	0.992
More than $100k	28.1	29.3	27.5	-0.074	0.876	0.929
Constant				-1.050	0.017	0.350
Total	100	100	100			

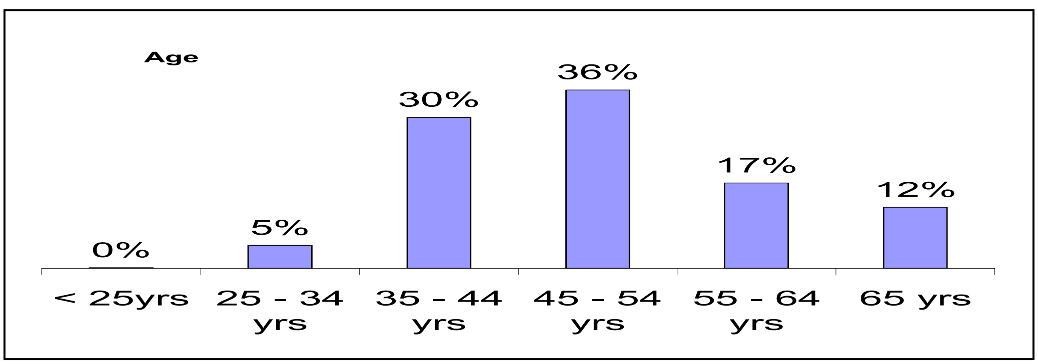
*comparison group

From the descriptive statistics reported in Table 6 it is observed that there are no significant differences among inventors who received favourable and unfavourable advice within the various income groupings except for those within the $20,000CDN and $30,000CDN income group ($p<0.05$). Inventors in this inventor group however had the most decreased odds compared to those in the less than $20,000 CDN income group.

The background variables included in the model are years of experience developing inventions, education and household income. There is some empirical work using these variables; education (Storey, 1982); experience (Leighton, 1989); wealth Evans and Janovich (1989) and household wealth (Hurst and Lusardi, 2004). Further, considering the sample in this study, these variables are appropriate background variables expected to pick up information on the variability in the dependent variables. Experience and education are expected to affect the information search and interpretation that inventors employed. Household income is also expected to affect the level and nature of resource allocations.

Other background variables of interest that were not used in the model estimation are age, gender and province of residence. The sample comprised of 91% male inventors as against 9% female inventors, while 69% of the respondents are from the province of Ontario. Considering age, Figure 6 shows the frequency distribution of inventors within certain age ranges, it is observed that more than 50% of inventors are within the age range of 35 and 54 years. There are however, quite a few elderly and generally retired inventors who tinker on ideas probably because they have time on their hands. The age variable was not included in the model due to its high correlation with experience in developing inventions, which was a more appropriate variable for the analysis.

Figure 6 Age



4.6.1 Relationships between Variables

As noted in the section on models identified for this study, multivariate linear regression and logistic regression frameworks were chosen for the analyses. However, before these frameworks are applied there is the need to ascertain the relationships between the variables. According to Norusis (2000) the main assumptions for multiple regression are that the observations are independent, the relationship between the dependent and independent variables is linear, and that for each combination of values of the independent variables, the distribution of the dependent variable is normal with a constant variance. To ensure that these assumptions hold in the linear estimation models used, a number of statistics were computed.

The dependent and independent variables were subjected to a correlation test to determine the extent to which the variables are inter-related with each other and the extent to which the independent variables are linearly related to the dependent variables. This is essential, since high correlations between the independent variables, for instance, will render some covariates impotent in explaining variability in the dependent variable. Pearson's correlation coefficient with two-tailed tests (Norusis, 2000) was computed and results summarised in a correlation matrix reported in Appendix D.1-2.

Correlations between dependent variables. The dependent variables of proportion of money and time spent are significantly correlated (r=0.685, p< 0.01). The indication is that the two measures will attract similar effects in the analysis. The correlation between commercialisation and proportion of money spent (r=0.383) and between proportion of time spent (r=0.390) were significant (p<0.01).

Correlations between independent variables. Most of the correlations between only the independent variables had the desired low coefficients (r< 0.30) at less than 0.05 levels of significance. The implication of the low coefficients of correlation among independent variables is that the variables appear independent of each other and they would all significantly contribute to explaining observed variability in the model (Norusis, 2000). Overconfidence was positively correlated with self-efficacy and opportunity recognition (p<0.01) and with total household income (p<0.05). Intrinsic motivation was positively correlated with time spent developing inventions (p<0.01).

Optimism was positively correlated with the highest level of education and the total household income ($p<0.01$) whereas illusion of control was positively correlated with time spent developing inventions ($p<0.01$). Risk-taking was surprisingly positively correlated with higher levels of education and total household income ($p<0.01$) and time spent developing inventions ($p<0.05$). As expected, opportunity recognition was positively correlated with time spent developing inventions. Likewise, a higher level of education was positively correlated with total household income ($p<0.01$). This is expected since higher levels of education should go hand-in-hand with higher income levels.

Tolerance. Further, the strength of the linear relationships between the independent variables is measured by the statistic named tolerance (Norusis, 2000). Tolerance is a proportion which measures the variability of each independent variable that is not explained by its linear relationships with the other independent variables. Consulting Appendix D.2, it is observed that the tolerance values are all above 0.700 which is close to one, indicating that the independent variables have very little of their variability explained by the other independent variables.

4.7 Estimation Models

Ordinary Least Squares. A multivariate framework (Stevens, 1986) is applied to investigate the relationships and correlations between the cognitive and background factors and the dependent variables. The ordinary least square (OLS) method is a process of parameter estimation, done through the minimisation of the sum of squared errors (Kennedy, 1998). The linear regression models built for this study are given below;

$$MA_i = \beta X + \varepsilon_i \text{ ....(5)}$$

$$TA_i = \beta X + \varepsilon_i \text{ ....(6)}$$

where β is the coefficient vector of α_j for j = 0,…,9; and X is the vector of independent variables (1, $Conf1_i$, Opt_i , $IllC_i$, OpR_i, TDI_i, HY_i, $RkTkg_i$, LOC_i, HLE_i).

Definitions:

i represents a case

MA_i is the proportion of money spent after the CIC evaluation

TA_i is the proportion of time spent after the CIC evaluation

α_j for j = 0,…,9; are the coefficients of the regression model, where α_0 is the constant

$Conf1_i$ is overconfidence measure

Opt_i is optimism measure

$IllC_i$ is illusion of control measure

OpR_i is opportunity recognition measure

TDI_i is years of experience developing inventions

HY_i is total household income

$RkTkg_i$ is risk taking

LOC_i is locus of control

HLE_i is highest level of education

ε_i is the error term

Logistic Regression Framework. The logistic regression framework is applied to evaluate the effects of the cognitive factors on the outcome of commercialisation, having taken the decision to continue spending on the invention. The effect of cognitive illusions is examined in the context of actions taken during the development phase of the invention and the subsequent commercialization outcome.

Many factors condition the commercial success of an invention. These include the inventor's background characteristics, cognitive dispositions, beliefs and goals, the technical and market prospects of the invention, resource availability, among others. As noted in the OLS framework, there is the need to control for certain factors, as their co-variation with the identified factors will not ensure clean results. In an attempt to control for some of these factors, the cognitive factors and some background variables are included in the model as was done in the OLS framework.

Furthermore, the term 'commercialisation' as used here does not necessarily imply making positive returns on the product. An invention is considered commercially successful if it reaches the market and sells at least one unit in a bona-fide market transaction with a third party[7]. So inventors who stopped selling their invention are still included in the analysis since their inventions were once commercially successful.

As noted earlier, this exercise will provide an insight into whether inventors who continued spending were justified in taking that action given the two rating sets and their cognitive dispositions.

The logistic regression framework (Maddala, 1983) is used to compute this probability of commercialising with the dependent variable being 1 if the invention was commercialised and 0 if it was not. The logistic regression model is presented as;

$$\log\left[P\left(C_{1i}\right)/P\left(C_{Oi}\right)\right] = \beta X \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(7)$$

where $P(C_{1i})$ is the probability of commercialising, $P(C_{Oi})$ is the probability of not commercialising, β is the coefficient vector of α_j for j = 0,…,9; and X comprises of the same set of independent variables used in the OLS regression; (MA_i, TA_i, $Conf1_i$, Opt_i, $IllC_i$, OpR_i, TDI_i, HY_i, $RkTkg_i$, LOC_i, HLE_i). The coefficients represent the changes in the log odds of commercialising the invention with each unit change in the

[7] This definition provided by Tom Astebro accompanies some questions on commercial success in the survey instrument.

independent variables. The signs of the coefficients indicate whether an independent variable increases or decreases the odds of commercialization.

Chapter 5

Results

5.1 Effects on Change in Development Efforts

Models (5) and (6) were estimated in SPSS 12.0 and summary results are given in Table 7 (see Appendix E1.4 for details).

Table 7 Effects on Change in Development Efforts

	Money		**Time**	
	A,B,C	**D,E**	**A,B,C**	**D,E**
Overconfidence	1.7	-5.8	3.3	3.9
	(39.9)	(19.3)	(34.1)	(13.9)
Optimism	0.2	5.4*	-1.4	2.6†
	(4.6)	(2.1)	(3.9)	(1.5)
Illusion of Control	4.0	2.8	-2.1	5.7**
	(5.2)	(2.0)	(4.4)	(1.5)
Locus of Control	-0.1	-2.7	-0.3	-1.6
	(3.9)	(2.2)	(3.4)	(1.6)
Self-Efficacy	-0.3	2.8	1.3	1.0
	(4.3)	(2.3)	(3.7)	(1.6)
Risk taking	-1.7	-2.2	4.7	-1.2
	(3.9)	(2.2)	(3.4)	(1.6)
Opportunity Recognition	-1.4	-4.1†	0.1	-0.9
	(4.0)	(2.1)	(3.4)	(1.6)
Intrinsic Motivation	4.1	0.8	0.1	1.4
	(3.6)	(2.4)	(3.2)	(1.8)
Years experience developing inventions	5.3†	3.7*	-0.4	3.2*
	(3.2)	(1.5)	(2.6)	(1.0)
Household Income (before tax)	1.1	3.0*	-1.3	-0.1
	(2.2)	(1.3)	(1.9)	(1.0)
Highest level of education	1.7	-0.9	2.5	1.1
	(2.2)	(1.3)	(1.9)	(0.9)
Constant	5.2	-0.4	32.9	1.6
	(23.2)	(10.3)	(20.2)	7.4
N	130	281	105	332
	R=*0.087*	R=*0.087*	R=*0.049*	R=*0.102*

*† p < 0.100 * p < 0.05 ** p < 0.001* *NB: Standard errors in parenthesis*

In addition, Table 8 reports a summary of results in terms of hypothesis supported and not supported. A hypothesis is conditionally supported when it is supported in one case, but not in another. For instance, hypotheses H2 and H3 are tested under the conditions of a positive and a negative feedback. When the hypothesis is supported under the condition of a negative feedback, it is said to be conditionally supported.

Table 8 Summary of Results –Support for Hypotheses

Hypotheses	**Supported/Unsupported**
H1**:** More overconfident inventors will spend more time and money on inventions than less confident inventors.	Not supported
H2: More optimistic inventors will spend more resources than less optimistic inventors.	Conditionally supported
H3: Inventors with a high illusion of control will spend more resources than inventors with low illusion of control.	Conditionally supported

Overconfidence - Overconfidence does not seem to play any role in inventors' decision to spend money and time after an evaluation irrespective of the advice. The data show that there were no effects found for overconfidence.

Optimism - Optimism had an effect on the decision to continue spending time and money ($p < 0.05$), but only when given negative feedback. The effect is not seen in the case of positive feedback. Hypothesis 2 is supported for both time and money spent when given negative feedback.

Illusion of control – When advised to stop, illusion of control played a role in the decision to discard the advice and continue spending resources on the invention's development. However, this was only in the case of increases in time spent ($p < 0.001$) after the evaluation. Hypothesis 3 is supported. However, these effects are found only for time spent given negative feedback and not for positive feedback. There were no effects found for money spent.

Other Factors: There were no effects found for the cognitive controls of locus of control, self-efficacy, risk-taking, intrinsic motivation and highest level of education. There were however some effects found for opportunity recognition, experience and household income. Experience developing inventions seemed to be generally significant in conditioning inventors' behaviour in spending money on their invention's development when given positive feedback. Experienced inventors significantly spent money and time developing their inventions when they received negative feedback. Opportunity recognition was barely significant ($p < 0.100$) in the D and E rating for money spent and correlated negatively with the dependent variable. Thus, inventors with high opportunity recognition were found to spend fewer resources when the ratings were negative. Household income before tax contributed to the decision to continue spending money spent when the ratings are negative. That is, inventors in the higher household income brackets spend more money after receiving negative feedback.

5.2 Effects on Commercialization

The binary logistic model (7) was estimated and the results are summarised in Table 9 with the details given in Appendix F.

Table 9 Probability of Commercializing within Ratings

	A, B, C Ratings		D,E Ratings	
	B	Exp(B)	B	Exp(B)
Money spent after evaluation	0.69	2.00	3.94**	51.62
	(1.07)		(1.39)	
Time spent after evaluation	2.06	7.80	3.26**	26.13
	(1.29)		(1.20)	
Overconfidence	-0.22	0.80	-1.15	0.32
	(2.70)		(3.22)	
Optimism	0.08	1.08	0.87*	2.38
	(0.32)		(0.44)	
Illusion of Control	-0.03	0.97	-0.59*	0.55
	(0.36)		(0.32)	
Self-Efficacy	0.00	1.00	0.79†	2.20
	(0.30)		(0.47)	
Intrinsic Motivation	0.28	1.32	-0.15	0.86
	(0.29)		(0.40)	
Risk-taking	0.06	1.06	-0.27	0.77
	(0.27)		(0.39)	
Opportunity Recognition	-0.22	0.81	-0.22	0.80
	(0.27)		(0.34)	
Locus of Control	0.10	1.11	-0.15	0.86
	(0.27)		(0.39)	
Highest Educational Level	-0.01	0.99	0.14	1.15
	(0.15)		(0.21)	
Years experience developing inventions	0.21	1.23	0.07	1.07
	(0.25)		(0.33)	
Household income	0.14	1.15	0.00	1.00
	(0.16)		(0.24)	
Constant	-3.79†	0.02	-7.31**	0.00
	(1.98)		(2.46)	
N	90		169	

† $p < 0.100$ * $p < 0.05$ ** $p<0.005$

Table 10 provides a summary of results in terms of the hypotheses developed.

Table 10 Summary of Results –Support for Hypotheses

Hypotheses	**Supported/Unsupported**
4a: Overconfident inventors are more likely to achieve commercial success than less confident inventors, given positive feedback.	Not supported
4b: Given negative feedback, overconfident and the less confident inventors are no more likely to commercialize.	Supported
5a: Optimistic inventors are more likely to commercialize than pessimistic inventors given positive feedback.	Supported
5b: Optimistic and pessimistic inventors are no more likely to commercialize given negative feedback.	Not supported
6a: Inventors with a high illusion of control are more likely to commercialize than those with low illusion of control, given positive feedback.	Not supported
6b: Inventors with high and low illusion of control are no more likely to commercialize given negative feedback.	Supported

Overconfidence - Overconfidence has no effect on commercialisation.

Optimism – In the case of negative feedback, optimism has an effect on commercialisation ($p < 0.05$). Hypothesis 5b is therefore not supported. When faced with negative feedback, the odds of commercializing are 2.38 more for optimistic than for pessimistic inventors. Thus, optimistic inventors have increased odds of commercialising than pessimistic inventors, after receiving negative feedback. There is no effect however when inventors received positive feedback.

Illusion of Control - Illusion of control plays a role in inventors' inability to commercialise ($p<0.05$) when they received negative feedback. Thus, hypothesis 6b is supported. The odds of commercializing are just 0.55 times for inventors high on illusion of control than for those for whom illusion of control is low. When given negative feedback, inventors high on illusion of control are unable to commercialize even though they continued to spend resources on the invention. However, illusion of control has no effect on commercialisation in the positive rating set.

Other factors - Except for self-efficacy which shows an effect at 0.095 level of significance, none of the other control variables or background variables was significant when considering commercialization. The odds of commercializing are 2.20 times more, for self-efficacious inventors than for those who have low self-efficacy.

Generally, inventors have increased odds of commercialising when they spent more resources on the invention after evaluation (51.62 for proportion of money spent, and 26.13 for proportion of time spent).

Chapter 6

Discussion

6.1 Effects on Change in Development Efforts

Optimism – Optimism is significant in money and time expenditures when faced with a negative feedback. Thus, when advised to stop developing their inventions, the behaviour of spending more time and money after the evaluation is consistent with the optimistic ideal of having a hopeful outlook (Weinstein, 1980), which leads to the discounting of the advice. The behaviour is also consistent with the idea that the optimistic believe that the ills that the feedback prophesises will not happen to them personally (MacCrimmon and Wehrung 1986). As a result, they persist even as the advice calls for a safer strategy of abandoning the project. It is also consistent with the optimistic tendency to discount the negative elements in the report and stand by the conviction that there is a brighter future and that persistence might lead to success.

Illusion of Control – Inventors high on illusion of control spent more time when given negative feedback. This is consistent with the tenets of illusion of control where these inventors can be said to the overrating their perceived ability to control future events (Langer, 1975), thereby playing down the uncertainty spelt out in the advice. Spending more time after receiving negative feedback is consistent with the idea that inventors tend to think they can overcome challenges when the invention's success is uncertain and chance is likely to play a large part in any success achieved (Duhaime and Schwenk, 1985).

The large effect of illusion of control found for time could be explained in situations where the invention characteristically needed time to develop and not necessarily large sums of money. Support for this assertion is due to fact that many inventions are low-tech, low -capital. Thus, for low capital inventions that need hours of work are likely to attract the inventor's time investment in successfully operationalizing the vital components considered novel.

Other Factors - Opportunity recognition is significant in reducing investment in development of inventions that receive negative feedback. There are possible explanations for this finding. One expects inventors to be opportunistic learners, spend more time searching for information; use different information sources; pay more attention to cues about the risks of new opportunities, than non inventors (Kaish and Gilad, 1991; Gaglio and Taub, 1992). With this attitude and the wealth of knowledge, the chances that an inventor has numerous potential inventions waiting to be developed at any point in time are high especially when considering the experience profile of these inventors. It follows then that when given negative advice, inventors who show opportunity recognition will acknowledge the diagnosticity of the expert advice. However, they appear to be conservative and focus on their ability to predict the successes of the numerous other potential inventions lying in wait, and consequently decreasing commitment to the invention currently being worked on.

Years of experience developing inventions are significant in affecting resource allocation when given a negative rating. Thus the more experienced the inventor is, the more likely he or she is to discard expert advice that prescribes project termination. To recapitulate, more than 50% of inventors have spent more than 6 years developing inventions while 35% of them have been developing inventions for more than 10 years. Therefore, one would expect inventors who spend many years developing inventions to learn from feedback they receive on the accuracy of their opinions and doubts (Russo and Schoemaker, 1992). With experience increasing the cognitive abilities needed to evaluate information gathered through search (McGrath, 1996), inventors are expected to be more willing to give credence to expert advice and accept it when negative. Therefore, experienced inventors should not be spending more resources developing the invention when given a negative rating.

However, experienced inventors do spend more resources even when given diagnostic negative feedback. One explanation for this phenomenon is that inventors do not learn from experience (Russo and Schoemaker, 1991). On another hand, they may learn from experience that their competence is due to their abilities in the cases of earlier successful inventions. In that sense, they may be suffering from the self-attribution bias (Langer, 1975) and have their learning short-circuited, thereby spending more resources in the face of negative advice.

Lastly, household income is found to be significant in money spent when given negative feedback. Inventors in the higher income brackets discard expert advice when negative and decide to spend more money on the development of the inventions. A possible explanation stems from the low capital-intensive nature of most projects. Furthermore, inventors in the higher income group have the financial capability to pursue low-techno products. Thus, with more than 50% of the inventors earning more than $50,000, inventors may persist because they can afford to.

The other cognitive factors did not have any effects on resource allocation decisions after expert advice. The literature review shows that there are significant reports regarding the effects of factors such as risk taking, intrinsic motivation, and self-efficacy, just to mention a few.

6.2 Effects on Commercialization

Optimism - Optimism has an effect on the commercialization of an invention, when inventors advised to stop developing, go on to expend resources towards product development. Going back to the OLS results, inventors significantly spent more money and time after the evaluation given a negative rating. The data shows that they are more likely to commercialise. Within the negative rating set, about 96% of the inventors who spent more money received the D rating. Receiving a D rating indicates that the invention's success is doubtful, that one or more factors are strongly unfavourable and therefore project termination is advised. Inventors seem to be counteracting these indications and prescriptions and working to get their inventions commercialised.

Inventors could be disagreeing on certain negative elements of the report and persisting contrary to the prescriptions. Or, they may be agreeing to these same negative elements, admitting the shortcomings and persisting to improve on identified problems or working to completely change the context of the invention so as to eradicate the problems identified.

Illusion of Control - Findings show illusion of control to be significant in reducing commercialization prospects when continuing to spend resources in the domain of a negative rating. Recall that in the OLS framework, illusion of control was significant in inducing the spending of time when given a negative rating. However, the commercialization results show that inventors are not likely to succeed when they persist after being advised to stop developing. They have decreased odds (0.55) of commercialising. The IAP evaluation seems to be reflected in the outcome in this situation. An explanation in line with the tenets of the bias is that, inventors overrate the potency of their skills and abilities in counteracting the uncertainty surrounding the inventions' commercialization.

Chapter 7

Conclusions

7.1 General

The primary objective of this study was to evaluate the impact of the cognitive factors of overconfidence, optimism and illusion of control on how inventors interpret unbiased expert advice and on the commercialisation outcome. These analyses looked at the decision or intentions of inventors on whether to continue to commit resources to an invention with respect to a positive or negative feedback from evaluation.

The results indicate that overconfidence had no effect on the decision to continue spending after an evaluation and was not instrumental in predicting successful commercialisation of the invention. Optimistic inventors as well as inventors with a high illusion of control, both generally commit more time to their inventions while only optimistic inventors commit more time and money, when given negative advice. However, the effects are noisy in general and more so in particular cases. For instance, substantial effects are not found in the case of time spent after receiving a positive rating for inventors scoring high on illusion of control and on optimism.

Other cognitive factors such risk-taking, self-efficacy, intrinsic motivation and locus of control do not have any significant effects. However, opportunity recognition is marginally significant in coercing inventors to look elsewhere possibly at other potential inventions when they receive negative advice. It was interesting to observe that experience in developing inventions and household income are significant in giving encouragement to inventors to commit resources especially money. When given negative feedback, experienced inventors are expected to recognise the reliability of the advice due to their experience over the years. Inventors in the high income bracket are also expected to be risk-averse and spend less especially when risk-taking had no effect.

On the whole, there is evidence that expert advice has an effect on product development decisions that inventors make. Inventors continue spending resources after receiving a positive and even a negative feedback. However, close to 50% do boycott their inventions' development after being advised to do so. In addition, evidence supports the assertion that positive feedback given with caution (B and C ratings) has an effect since not all inventors who receive advice to pursue their inventions follow the advice. This could be due to various reasons such as the inability to solve the critical problems identified (as often noted for B or C ratings) even though the invention has high prospects.

The comparison of commercialisation success among inventors who continued spending resources on their invention within the various ratings gives some interesting results. The comparison is done without laying claim to the notion that commercialization is a function of only the inventor's endeavours. Of inventors who continued development, 32% of those who got positive ratings went on to commercialize while only 12% of those discouraged continued to commercialize.

The indications are that while inventors receiving a positive rating react rationally to the expert advice (with 68% failure), there is a large number receiving negative advice, who do not revise their initial plans to the extent to which the IAP prescribes. In this vein, the findings are consistent with findings in other studies (Cooper, Wu, Dunkelberg, 1988; Arabsheibani et al., 2000; Duhaime and Schwenk, 1985). Inventors do not give the appropriate credence to the IAP advice. As noted by Griffin and Tversky (1992) individuals may focus on the strength of extremeness of available evidence (e.g. the desirability of the information) with insufficient regard for its weight of credence (e.g. the credibility of the source or the size of the sample). It is arguable though that inventors might not be aware of or do not realise the diagnosticity of the CIC advice, a possible explanation of this phenomenon.

In considering the probability of commercialising in terms of the cognitive factors and feedback from evaluation, some inventors who continued to spend resources on the invention were more likely to commercialise when they received negative feedback. Out of the three main factors, optimism and illusion of control were significant in predicting commercialisation while overconfidence was not. Optimistic inventors spending after the evaluation were likely to commercialize their inventions while inventors with a high illusion of control were not likely to commercialize.

All the same, the cognitive factors examined in this study did not seem to have very high effects on inventors who submit ideas for evaluation. Other studies in similar business domains such as with entrepreneurs (Cooper, Wu, Dunkelberg, 1988), stock investors (Shiller, 2000), and with managers (Russo and Schoemaker, 1992), have revealed high effects. It is possible that the factors studied were not the most appropriate for this sample. However, considering the lack of significance for the cognitive controls included in the model, the argument might be to look beyond cognitive factors. Furthermore, the measures themselves could be a source of noise. The Cronbach alphas were low and this implies reduced reliability in the scales used. However, the items were randomly selected across constructs during data collection. This random order of questions might have led to the low item-to-item correlation as subjects were not primed in their answers by the preceding questions. Random ordering was done to eliminate order effects, but could have induced ‘independent’ responses to the questions which could lead to the low inter-item correlation observed.

This study has many implications for inventors, evaluation agencies and sponsors of evaluation programs. In the case of inventors there seems to be mixed implications as on the one hand optimism is favourable, and on the other hand illusion of control is not when considering the effects of the biases right through to commercialisation. Within the heuristics and biases framework, cognitive shortcuts inspire people to develop ventures as well as cause a decrease in performance. Inventors who are optimistic are led to allocate more resources to the invention and are motivated to commercialise. However, in terms of illusion of control, the cognitive shortcut leads inventors to spend more resources inefficiently. In effect, even though biases might be desirable sometimes, inventors still need to minimise these biases by paying heed to the prescriptions of the IAP recommendations. When they decide to continue spending on the invention, they need to learn from and adjust to the venture creation environment and constantly review their initial hypothesis so as to incorporate additional and pertinent information accurately. Inventors need to provide adequate information about the idea during presentation to the IAP.

For evaluation agencies such as the Canadian IAP, the implications drawn from this study are numerous. The IAP could include some information on base rates in the evaluation report which might help inventors to effectively incorporate the elements of the report into their decision-making. Summary statistics of the performance of similar inventions or competitive inventions could help inventors give appropriate credence to the prescriptions of the IAP.

Furthermore, there are a high number of submissions that show no evidence of prototype development or basic information search[8]. Therefore, there might be the need for a program that will aim at eliciting as much information from inventors, during idea presentation, as possible. Also, inventors could provide their personal views on the inventions when submitting to the IAP. After evaluation, inventors could be encouraged to respond to the recommendations and a quick review could be done to assess and bridge any information gaps that might exist. Bridging information gaps could lead to a revision of some of the ratings.

Inadequate information during idea presentation on the invention implies that the IAP has to spend a high number of man-hours gathering information for the evaluation. This inefficiency could be curtailed if the majority of high-income inventors spent a bit more on doing their homework well before presenting their ideas for evaluation. In effect, there might be the need to introduce some efficiency into the system. It may be prudent to adopt an equitable scale for charging evaluation fees. Inventors could be made to report their taxable income for the year before, based on which a service charge for the evaluation would be computed. The aim will be to provide the lower income inventors with affordable evaluation opportunities since their need levels seems to be higher than that of inventors in the higher income brackets. Furthermore, to prevent poorly conceptualised and poorly researched products from being presented for evaluation, well-packaged presentations could be given recognition or rewarded with fee discounts while poorly presented ideas could be made to suffer higher fees if feasible. An alternative

[8] This is gathered from perusing CFA disclosure records of inventors polled.

system under consideration at the CIC as a result of budget constraints is to request pre-screening of ideas at the community level. Thus, inventors will approach the CIC with proof of the idea having received preliminary evaluation from local service providers such as the Canadian Business Service Centre[9] or Community Business Development Corporations[10].

Finally, the sponsors of evaluation programs need to continue providing support for such programs even though there seem to be signs of inefficient use of these funds. Indeed, inventions that get commercialized do add to the social pool of innovations. In fact, Åstebro and Bernhardt (1999) estimate a social rate of return of advising inventors to be between 36% and 70%. Therefore, it is imperative for social and national interest to provide continual government support for inventors (Lerner, 1999). The Canadian IAP is in fact highly subsidised by the National Research Council[11]. The program monitoring committees, through their performance evaluation guidelines, could require the IAPs to institute strategies that aim at equitably distributing the funding allocated.

7.2 Limitations of the Research

One unique feature of this study, which makes it distinct from the larger majority of similar studies testing for cognitive effects, is that the sample is an actual list of decision-makers faced with the need to make decisions (on their inventions) under uncertainty. There were no simulations of 'real world' situations as is often done in calibration tests (e.g. Lichtenstein et al., 1982). In the same vein, this is the disadvantage with this study. Constructs such as overconfidence and risk-taking need elicitation methods that involve different levels of manipulations to unearth the 'real' effects.

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[9] Canadian Business Service Centre: http://www.cbsc.org/english/
[10] Community Business Development Corporations: http://www.acoa.ca/e/financial/community.shtml
[11] National Research Council: http://www.nrc-cnrc.gc.ca/

However, the telephone survey conducted not only made these manipulations difficult but also prevented a high number of items from being included in the various constructs to ensure measures with very little noise. In addition, the study is bedevilled with the possibility of assessments varying due to differences in actual risk perception, from one invention to another. Simon, et al. (2000) used a case study to determine if subjects will start a venture or not, based to the risks presented. A system to harmonize the different risk standing of the inventions would be more appropriate. This ensures the same risk level in the study. All in all, much of the noise envisaged in the various measures could be reduced with a pen and paper survey instrument and setting where a higher level of manipulation was possible. Other limitations are addressed as part of suggestions for future research noted in the next section.

7.3 Future Research

Considering the noisy nature of the effects and the low magnitudes of the biases, it might be fruitful to measure the constructs simultaneously, prior and immediately following the advice. This might guarantee better measures since most the decision-making biases that occur are situational. When intentions and inventors' perceptions are measured twice at two different time periods before and after the evaluation it will yield a more efficient measure than what is seen in this study. Furthermore, some manipulations such as pictorial representations of hypothetical scenarios could be introduced especially if using a paper and pencil method rather than elicitation through a phone survey.

For the prior elicitation, a first set of questions will be developed to accompany the invention disclosure package. This questionnaire will seek to capture the estimated prior probabilities, and intentions that the inventor has for the invention before submitting it for evaluation. The second set of questions would be administered after the evaluation. The questionnaire would either be sent with the evaluation results or soon after, but early enough to be able to capture the reactions to the evaluation results. Questions needing posterior reassessments would then be repeated. Analysis of the prior and posterior estimates in the Bayesian framework for instance, can lead to very good insights into the behaviour and changes in beliefs for inventors.

Considerations of Future Research

1. Most inventors who approach the CIC just have an idea and have conducted insufficient information search or inadequate prototype development. About 60% spent less than $500 before the review and majority have not conducted any information search. They seem to rely on the CIC to do the initial market research and the initial evaluation of the idea. This might have implications for what they expect from the advice and how they perceive the feedback.
2. Before entering into commercialisation, many inventors choose licensing (52%) as their preferred option for commercializing the invention. However, when it comes to taking the actual commercialisation decision, 53% of inventors decided to manufacture and sell their invention while only 5% license to third parties. This indicates a possible change of commercialisation focus during the development process. It will be interesting to study the reasons for that change in focus from one commercialisation option to another and to see if cognitive factors play a role. For example, do inventors who initially planned to licence failed to do so, hence the small number actually licensing, or do they actually see the need to involve themselves in other options after a while? This will help shed light on the possible

effects that the perceived opportunity to licence might have on post evaluation decisions.

3. The factors of experience in developing inventions and household income are significant in developing inventions. The possible implications need investigations. For instance, inventors in this sample may be inventing because they have time on their hands (retired) and can afford to tinker, thus spending escalating amounts in the raw materials needed to develop the invention. If inventions are developed as hobbies[12], then given their large number of potential inventions, inventors are likely to crumble in the face of challenges only to pursue their other ideas; a transition so easily made due to little attachment to any one particular idea from the pool. The interaction between these factors and the cognitive factors are worth modelling and examining. Also an investigation into the factors that would cause the transition from one potential invention to another might reveal some interesting findings.
4. The idea of controlling for awareness of the diagnosticity of the IAP advice is also important. There is the need to collect information on the perceptions inventors have of the diagnosticity of the IAP advice. Multiple inventors who received favourable, unfavourable, unfavourable yet useful and favourable yet useless advice (from the inventors' point of view) are likely to develop a stereotype of the IAP which will affect the way they view subsequent advice.
5. Lastly, of importance is the notion of which 'kinds' of inventors approach the CIC. There is the need to collect information in some form, on the characteristics

[12] 88% of inventors say the inventive effort was not part of their normal duties at work while 73% say the idea was not stimulated by something at work.

of a sample of the general inventor in Canada and make comparisons between the peculiar characteristics of the CIC inventor and those that do not approach the CIC or other evaluation agencies. It is possible that for overconfident inventors for instance, the intended or ideal sample for such a study consists of inventors who have not or will not approach an evaluation agency for fear of encountering disconfirming information.

Why do inventors continue when experts say stop? All in all, optimism plays a role in inventors' post evaluation decisions and realization of outcomes, while illusion of control plays a role in the decision to continue spending, but not on the outcome of commercialisation. Overconfidence does not have any effect.

Appendixes

Appendix A : Criteria for Rating Inventors

1. 37 Criteria for Rating Inventors

Technical	1	Technical Feasibility		
	2	Functional Performance		
	3	Research & Development		
	4	Technology Significance		
	5	Safety		
	6	Environmental Impact		
Production	7	Technology of Production		
	8	Tooling Cost		
	9	Cost of Production		
Market *Demand*	10	Need		
	11	Potential Market		
	12	Trend of Demand		
	13	Duration of Demand		
	14	Demand Predictability		
	15	Product Line Potential		
Acceptability	16	Societal Benefits		
	17	Compatibility		
	18	Learning		
	19	Function		
	20	Visibility		
	21	Appearance		
	22	Durability		
	23	Service		
Competition	24	Existing Competition		
	25	New Competition		
	26	Price		
Effort	27	Marketing Research		
	28	Promotion Cost		
	29	Distribution		
Risk	30	Legality		
	31	Development Risks		
	32	Dependence		
	33	Protection		
	34	Investment Costs		

	35	Potential Sales		
	36	Payback Period		
	37	Profitability		
Options	38	License or Outright Sale		
	39	Existing Business		
	40	New Venture Potential		
	41	Part-Time Effort		
	42	Other Possibilities		

Appendix B : Questionnaire development – Questions on constructs

1 Overconfidence

The following question compares cities here in Canada and around the world. I will read out two cities, for example, **Bangkok and Havana.** If you believe the population of Bangkok is larger than that of Havana, you would say "Bangkok". Then, please state the chance you think this is the right answer. If you think that there is a 90% chance of this being the right answer, you would say "90". Please state a number between 50 and 100; where 50 means you are uncertain about which of the two cities has a larger population, and 100 means you are certain that you are right.

			Chance of being correct
1.	[ ] Saskatoon	[ ] Regina	
2.	[ ] Guelph	[ ] Sudbury	
3.	[ ] Sault Ste. Marie	[ ] Peterborough	
4.	[ ] Seoul	[ ] Istanbul	
5.	[ ] Cairo	[ ] Tokyo	

Out of the five pairs of cities, for how many pairs do you think you got the city with the **larger population right**? [ ]

2 Optimism

I will now read a few statements relating to you and your invention. On a scale from one to five where 1 means strongly disagree, 2 means disagree, 3 means undecided, 4 means agree and 5 means strongly agree, please answer the extent to which you agree or disagree with the following statements:

[ ] I just know that I will be a success
[ ] I feel comfortable with myself
[ ] I look at the bright side of life
[ ] I feel that my life lacks direction
[ ] I see difficulties everywhere
[ ] I am often in a bad mood

3 Illusion of Control

I will now read a few statements relating to you and your invention. On a scale from one to five where 1 means strongly disagree, 2 means disagree, 3 means undecided, 4 means agree and 5 means strongly agree, please answer the extent to which you agree or disagree with the following statements:
[ ] It is important for me to convince myself that I can control my future
[ ] I can accurately forecast the demand for an invention
[ ] I can accurately forecast when larger competitor will enter the market
[ ] I can make my invention a success even though others might fail

4. Risk-Taking

Questions on risk–taking were taken from a psychology survey inventory. Considering the sample characteristics and the telephone survey limitations, it was not feasible to construct risk gambles to test situational risk-taking characteristics of the inventors. Following the assertion that risk is predispositional rather than simply situational (Jackson, Hourany, and Vidmar, 1972; Plax and Rosenfeld, 1976), the risk taking aspects of the multi-faceted Jackson Personality Inventory (JPI-R) (Jackson, 1989; Jackson, 1994) were adapted. Seven out of seventeen items on Jackson Inventory were selected leaving out questions that were not related to business risks. Some questions left out were on thrill seeking activities such as skin-diving in the ocean and going for broke in gambling. The question was as follows:

I will now read a few statements relating to you and your invention. On a scale from one to five where 1 means strongly disagree, 2 means disagree, 3 means undecided, 4 means agree and 5 means strongly agree, please answer the extent to which you agree or disagree with the following statements:

[ ] Taking risks does not bother me if the gains involved are high
[ ] I would participate only in business undertakings that are relatively certain
[ ] When in school, I rarely took the chance of bluffing my way through an assignment
[ ] I rarely if ever, take risks when there is another alternative
[ ] I consider security an important element in every aspect of my life
[ ] I probably would not take the chance of borrowing money for a business deal even if it might be profitable

5 Locus of Control

Locus of control was tested using another inventory of questions. Six out of fourteen questions on control of life events were taken from the Levenson (1974) internal-external scale for locus of control. Questions taken were on the 'internal' and ‘chance’ concepts while the questions on ‘powerful others’ were left out. Respondents were asked to agree or disagree upon statements as follows:

I will now read a few statements relating to you and your invention. On a scale from one to five where 1 means strongly disagree, 2 means disagree, 3 means undecided, 4 means agree and 5 means strongly agree, please answer the extent to which you agree or disagree with the following statements:

[ ] To a great extent my life is controlled by accidental happenings.
[ ] Whether or not I get to be a leader depends mostly on my ability.
[ ] When I make plans, I am almost certain to make them work.
[ ] Often there is no chance of protecting my personal interest from bad luck happenings.
[ ] When I get what I want, it's usually because I'm lucky.
[ ] Whether or not I get into a car accident is mostly a matter of luck.

6. Self-Efficacy

Self-efficacy questions were modelled after the methods used in a study by Markman, Balkin and Baron (2002). Questions looked at the respondent’s belief in their ability to accomplish tasks under different conditions. The question was as follows;

I will now read a few statements relating to you and your invention. On a scale from one to five where 1 means strongly disagree, 2 means disagree, 3 means undecided, 4 means agree and 5 means strongly agree, please answer the extent to which you agree or disagree with the following statements:

[ ] I am strong enough to overcome life’s struggles
[ ] I often think that I am a failure
[ ] I can handle the situations that life brings
[ ] I usually feel I can handle the typical problems that come up in life
[ ] At root I am a weak person
[ ] I’m usually an unsuccessful person
[ ] I feel competent to deal effectively with the real world
[ ] I often feel there is nothing I can do well

7. Opportunity Recognition

Opportunity recognition was also tested using domain specific questions. The statements were however modeled on work by Gaglio and Katz, (2001) and were on looking for opportunities to improve on products or make new ones. Statements were given and respondents as usual were asked to indicate the extent to which they agreed or disagreed to them on a five-point scale. The question is as follows;

I will now read a few statements relating to you and your invention. On a scale from one to five where 1 means strongly disagree, 2 means disagree, 3 means undecided, 4 means agree and 5 means strongly agree, please answer the extent to which you agree or disagree with the following statements:

[ ] I often find products that I think can be improved upon.
[ ] I often examine new products on store shelves to figure out how they could be improved.
[ ] Reading the newspaper I often get ideas for new products.
[ ] I sometimes buy new things just so I can figure out how to improve them.
[ ] I often think of nontraditional or unconventional solutions to problems.

8. Intrinsic Motivation

Intrinsic motivation was tested with domain specific questions developed to fit the inventive context. Using the concepts of challenge, satisfaction, creativity, monetary rewards, curiosity, problem solving, growth and personal development, eight statements were developed to depict inventors' dispositions towards these values. Some of the eight statements on which respondents were asked to show their level of agreement are as follows;

I will now read a few statements relating to you and your invention. On a scale from one to five where 1 means strongly disagree, 2 means disagree, 3 means undecided, 4 means agree and 5 means strongly agree, please answer the extent to which you agree or disagree with the following statements:
[ ] I invent because I enjoy it
[ ] I invent to achieve personal growth and development
[ ] I enjoy the feeling of solving problems
[ ] I invent because I like being creative
[ ] Inventing is challenging and satisfying

[ ] I invent for the monetary rewards
[ ] I invent because I am curious
[ ] Inventing gives me the opportunity to be my own boss

9. Background Variables

a. Highest Level of Education

Q33a	What is your highest educational level attained?
	
	(Read out list)
	
	IF (ANS = 05|ANS = 06|ANS =07) SKP q33b
	IF (ANS != 05 & ANS != 06 & ANS != 07) SKP q34
		01 Did not complete high school
		02 High School diploma
		03 Trade school diploma
		04 Some college or university studies, did not complete degree
		05 University undergraduate degree
		06 Professional college degree
		07 Post-graduate studies (Master's or Ph.D.)
		8 Don't Know
		9 Refused

b. Years of Experience Developing Inventions

Q36	How long have you worked at developing inventions?	01 None 02 Less than one year 03 1 - 2 years 04 3 - 5 years 05 6-10 years 06 More than ten years 8 Don't Know 9 Refused

c. Household Income (before tax)

Q38	What was your total household income (before tax) last year? (Include income from savings).	01 less than $20,000 02 $20,000 - $30,000 03 $30,000 - $40,000 04 $40,000 - $50,000 05 $50,000 - $70,000 06 $70,000 - $100,000 07 over $100,000 8 Don't Know 9 Refused

10. Dependent Variables

a. Questions on Money Spent

Q1ai	First, we would like to know how much money was spent on developing XX. Include all costs for product development, marketing research, making of prototypes, etc. Do not include costs for developing other ideas or inventions. However, do include development costs for revisions or improved versions of XX.
	Just sum the costs as they appeared over the years when incurred.
	How much did you spend before you contacted the CIC for an evaluation?
	
	IF (ANS = 01) SKP Q1ainum
	IF (ANS != 01) SKP Q1aii
		01 Yes, gives amount
		8 Don't Know
		9 Refused

Q1ainum		01 Enter Amount
Q1aii	How much did you spend after you contacted the CIC for an evaluation?	01 Yes, gives amount 8 Don't Know 9 Refused
Q1aiinum		01 Enter Amount

b. Questions on Time Spent

Q3c	Could you give me an estimate of the percentage of that time that was spent actually working on the invention:
	
	IF (ANS = 01) SKP Q3cp
	IF (ANS != 01) SKP Q3d
		01 Yes, gives percentage
		8 Don't Know
		9 Refused

Q3cp	Percentage	Enter percentage
Q3d	What percentage of that time was spent after the invention was evaluated by the CIC:	01 Yes, gives percentage 8 Don't Know 9 Refused
Q3dp		Enter percentage

c. Question on Commercialisation

Q12c	Did you ever commercialize your invention?
	
	IF (ANS = 01) SKP Q13
	IF (ANS != 01) SKP Q12d
		01 Yes
		02 No
		8 Don't Know
		9 Refused

Appendix C : Independent Variables – Factor Loadings

1 Factor loadings for constructs – Inventor population

Rotated Component Matrix

	1	2	3	4	5	6	7	8	9	10
Intrinsic mot	0.107	0.807	0.018	0.085	0.018	0.128	-0.044	0.072	0.022	-0.028
Q262	0.027	0.592	0.101	0.143	-0.071	0.137	0.113	0.394	0.096	0.157
Q263	0.486	0.503	0.183	0.013	0.082	-0.030	-0.057	-0.115	0.031	0.024
Q264	0.179	0.757	-0.006	0.073	0.005	0.142	0.003	0.039	0.072	-0.032
Q265	0.216	0.650	0.120	0.033	-0.004	0.041	-0.055	0.042	-0.095	0.223
Q266	0.043	-0.020	-0.053	0.001	-0.003	0.101	-0.065	0.657	0.213	-0.067
Q267	0.073	0.682	0.051	0.006	0.030	0.155	-0.080	-0.058	0.150	-0.039
Q268	0.123	0.438	0.075	0.235	-0.047	-0.077	0.003	0.506	-0.149	0.131
LOC	0.254	-0.066	0.173	-0.041	0.122	0.079	0.588	0.050	-0.143	0.134
Q2610	0.292	0.074	0.148	0.052	-0.002	0.021	0.013	0.080	0.649	-0.051
Q2611	0.257	0.163	0.193	0.218	-0.061	-0.029	0.128	0.056	0.178	0.446
Q26121	0.158	-0.060	0.091	0.084	0.090	-0.099	0.588	0.109	-0.069	-0.281
Q2613	0.487	0.172	0.045	0.027	-0.128	0.093	0.127	0.210	0.314	0.026
Q26141	-0.055	-0.028	0.130	0.008	-0.034	-0.092	0.688	-0.172	0.124	-0.003
Risk taking	0.114	0.050	0.136	0.149	0.509	0.028	0.018	0.271	0.261	0.310
Q26161	-0.049	0.078	0.050	-0.003	0.680	-0.086	0.018	-0.081	-0.039	-0.043
Q26181	-0.009	-0.085	0.017	-0.125	0.609	0.121	0.090	-0.074	0.063	-0.015
Q26191	-0.102	0.019	-0.011	0.067	0.561	-0.124	-0.081	-0.159	-0.249	-0.366
Q2620	0.202	0.118	0.039	0.195	0.485	0.178	-0.180	0.117	0.221	0.201
Q26211	0.158	-0.047	0.117	0.071	0.527	0.056	0.245	0.191	-0.278	-0.054
Optimism	0.406	0.091	0.219	0.540	0.080	-0.002	0.081	0.122	-0.013	0.039
Q2623	0.600	0.197	0.400	0.131	0.026	0.020	-0.032	0.037	0.081	-0.012
Q2624	0.526	0.161	0.405	0.091	-0.009	0.020	-0.176	0.245	-0.048	-0.093
Q26251	0.142	-0.024	0.640	-0.056	0.152	0.100	0.152	-0.056	-0.065	0.112
Q26261	0.006	-0.036	0.356	-0.008	0.028	0.006	0.221	0.060	0.088	-0.567
Q26271	0.128	0.050	0.601	0.005	-0.046	-0.059	0.061	0.185	0.041	-0.310
Opport. recog	0.049	0.349	0.080	0.351	-0.057	0.388	0.059	-0.232	0.029	0.057
Q2629	-0.003	0.346	0.036	0.228	-0.010	0.672	-0.001	-0.005	-0.029	0.131
Q2630	0.103	0.063	-0.012	0.103	0.016	0.686	-0.122	0.162	-0.125	-0.080
Q2631	-0.076	0.200	-0.053	0.181	0.098	0.670	-0.003	-0.014	0.203	-0.008
Q2632	0.254	0.455	0.067	0.219	0.099	0.087	-0.084	-0.303	0.194	-0.146
Self-Efficacy	0.697	0.104	0.190	0.014	0.079	-0.006	0.107	0.068	0.089	0.149
Q26341	0.257	0.046	0.717	0.154	0.083	-0.069	-0.078	0.046	0.027	0.076
Q2635	0.701	0.086	0.223	0.073	-0.010	0.080	0.139	-0.021	0.105	0.010
Q2636	0.735	0.147	0.179	0.150	-0.018	-0.040	0.048	-0.001	0.090	0.051
Q26371	0.342	0.054	0.570	-0.032	0.045	-0.010	0.137	-0.094	0.037	0.004
Q26381	0.173	0.155	0.697	0.029	0.029	-0.013	0.121	0.011	0.090	0.035
Q2639	0.737	0.122	0.212	0.072	0.064	0.002	0.042	-0.035	-0.028	-0.030
Q26401	0.234	0.035	0.628	0.074	-0.007	0.017	0.088	-0.093	-0.007	-0.117
Illus. of control	0.065	0.180	-0.085	0.299	-0.026	-0.035	-0.098	0.150	0.431	0.200
Q2642	0.092	0.070	-0.014	0.689	0.000	0.234	-0.008	-0.095	0.086	-0.055
Q2643	-0.010	-0.029	-0.008	0.650	0.010	0.243	-0.048	0.030	-0.028	0.128
Q2644	0.128	0.226	0.080	0.638	0.023	0.025	0.072	0.131	0.120	-0.025

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser NormalizationRotation converged in 9 iterations.

Appendix D : Partial Correlations of dependent and independent variables

1. All dependent variables
Pearson Correlations coefficients

		1	2	3
1	Commercialisation	1		
2	Ratio of money spent	0.383**	1	
3	Ratio of time spent	0.390**	0.685**	1

2. All independent and dependent variables
Pearson Correlations coefficients

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	Ratio of money spent	1												
2	Ratio of time spent	.685**	1											
3	Self Efficacy	-.010	.029	1										
4	Intrinsic Motivation	.108*	.091*	.000	1									
5	Optimism	.107*	.070	.000	.000	1								
6	Illusion of Control	.094*	.182**	.000	.000	.000	1							
7	Risk taking	.000	.039	.000	.000	.000	.000	1						
8	Opportunity Recognition	-.073	.003	.000	.000	.000	.000	.000	1					
9	LOC	.016	-.010	.000	.000	.000	.000	.000	.000	1				
10	Highest level education	.085*	.112*	-.001	.019	.147**	.055	.200**	.013	.042	1			
11	Time spent developing inventions	.138*	.194**	.020	.290**	.027	.114*	.103*	.171**	-.034	.053	1		
12	Total household Y	.084	-.002	.077	-.056	.143*	-.041	.201**	.011	.079	.264**	.036	1	
13	Over-confidence	-.019	.004	.152**	.043	-.015	.070	.070	.105*	.074	.036	.042	.087*	1

***p<0.001 *p<0.05*

2. Tolerance proportion estimates from Regressions of money and time on the covariates

	Money		Time	
Variables	**A,B,C**	**D,E**	**A,B,C**	**D,E**
Self Efficacy	0.788	0.961	0.796	0.977
Intrinsic Motivation	0.835	0.886	0.798	0.858
Optimism	0.888	0.961	0.898	0.958
Illusion of Control	0.892	0.983	0.885	0.967
Risk taking	0.902	0.868	0.918	0.894
Opportunity Recognition	0.931	0.952	0.923	0.937
LOC	0.844	0.965	0.895	0.970
Highest level education	0.872	0.863	0.822	0.888
Time spent developing inventions	0.790	0.857	0.762	0.817
Tot household income	0.840	0.830	0.848	0.879
Overconfidence	0.788	0.934	0.787	0.936

Appendix E : Linear Regression Results

1. Regression Results: Spending money after the evaluation within the A, B, C ratings

Spending Money within ratings A, B, C					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.052	0.232		0.224	0.823
Self Efficacy	-0.030	0.043	-0.078	-0.701	0.485
Intrinsic Mot	0.041	0.036	0.123	1.133	0.260
Optimism	0.002	0.046	0.004	0.041	0.967
Illusion of Cont	0.040	0.052	0.082	0.780	0.438
Risk taking	-0.017	0.039	-0.046	-0.440	0.661
Opport Recog	-0.014	0.040	-0.037	-0.356	0.723
LOC	-0.001	0.039	-0.002	-0.022	0.983
highest level educ	0.017	0.022	0.083	0.779	0.438
Time dev invts	0.053	0.032	0.186	1.672	0.098
Tot hshold income	0.011	0.022	0.055	0.504	0.615
Overconfidence	0.017	0.399	0.005	0.044	0.965
R =0.087					

2. Regression Results: Spending money after the evaluation within the D, E Ratings

Money within ratings D, E					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-0.004	0.103		-0.041	0.967
Self Efficacy	0.028	0.023	0.073	1.231	0.219
Intrinsic Mot	0.008	0.024	0.020	0.326	0.744
Optimism	0.054	0.021	0.151	2.546	0.011
Illusion of Cont	0.028	0.020	0.080	1.370	0.172
Risk taking	-0.022	0.022	-0.060	-0.964	0.336
Opport Recog	-0.041	0.021	-0.117	-1.964	0.051
LOC	-0.027	0.022	-0.074	-1.251	0.212
highest level educ	-0.009	0.013	-0.046	-0.738	0.461
Time dev invts	0.037	0.015	0.157	2.501	0.013
Tot hshold income	0.030	0.013	0.148	2.316	0.021
Overconfidence	-0.058	0.193	-0.018	-0.300	0.765
R=0.087					

3. Regression Results: Spending time after the evaluation within the A, B, C Ratings

Time within ratings A, B, C					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.329	0.202		1.628	0.107
Self Efficacy	0.013	0.037	0.039	0.345	0.731
Intrinsic Mot	0.001	0.032	0.005	0.047	0.962
Optimism	-0.014	0.039	-0.037	-0.347	0.730
Illusion of Cont	-0.021	0.044	-0.051	-0.479	0.633
Risk taking	0.047	0.034	0.147	1.395	0.166
Opport Recog	0.001	0.034	0.004	0.040	0.968
LOC	-0.003	0.034	-0.011	-0.104	0.918
highest level educ	0.025	0.019	0.147	1.319	0.190
Time dev invts	-0.004	0.026	-0.017	-0.146	0.884
Tot hshold income	-0.013	0.019	-0.073	-0.668	0.506
overconfidence	0.033	0.341	0.011	0.098	0.922
R=0.049					

4. Regression Results: Spending time after the evaluation within the D, E Ratings

Time within ratings D, E					
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.016	0.074		0.215	0.830
Self Efficacy	0.010	0.016	0.034	0.637	0.524
Intrinsic Mot	0.014	0.018	0.045	0.783	0.434
Optimism	0.026	0.015	0.091	1.690	0.092
Illusion of Cont	0.057	0.015	0.207	3.835	0.000
Risk taking	-0.012	0.016	-0.043	-0.759	0.448
Opport Recog	-0.009	0.016	-0.033	-0.596	0.552
LOC	-0.016	0.016	-0.054	-0.995	0.320
highest level educ	0.011	0.009	0.072	1.281	0.201
Time dev invts	0.032	0.010	0.181	3.085	0.002
Tot hshold income	-0.001	0.010	-0.004	-0.076	0.939
overconfidence	0.039	0.139	0.015	0.279	0.781
R=0.102					

Appendix F : Logistic Regression Results

1. Logistic regression results: Prob. of commercializing invention within A, B, C ratings.

Probability of Commercializing within the A, B, C Ratings					
	B	S.E.	Wald	Sig.	Exp(B)
Prop. of money spent	0.69	1.07	0.42	0.517	2.00
Prop. of time spent	2.06	1.29	2.55	0.110	7.82
Self-Efficacy	0.00	0.30	0.00	0.997	1.00
Intrinsic Motivation	0.28	0.29	0.93	0.334	1.32
Optimism	0.08	0.32	0.06	0.807	1.08
Illusion of Control	-0.03	0.36	0.01	0.942	0.97
Risk-taking	0.06	0.27	0.05	0.823	1.06
Opportunity Recognition	-0.22	0.27	0.65	0.421	0.81
Locus of Control	0.10	0.27	0.14	0.708	1.11
Highest Educational Level	-0.01	0.15	0.00	0.971	0.99
Time spent developing inventions	0.21	0.25	0.66	0.417	1.23
Household income	0.14	0.16	0.79	0.373	1.15
Overconfidence	-0.22	2.70	0.01	0.935	0.80
Constant	-3.71	1.98	3.50	0.061	0.02
N	90				

Model Summary		
-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
101.2737	0.123486	0.172584

2 Logistic regression results: Prob. of commercializing invention within D, E ratings

Probability of Commercializing within the D,E Ratings					
	B	S.E.	Wald	Sig.	Exp(B)
Prop. of money spent	3.94	1.39	8.08	0.004	51.62
Prop. of time spent	3.26	1.20	7.40	0.007	26.13
Self-Efficacy	0.79	0.47	2.79	0.095	2.20
Intrinsic Motivation	-0.15	0.40	0.15	0.700	0.86
Optimism	0.87	0.44	3.89	0.049	2.38
Illusion of Control	-0.59	0.32	3.48	0.062	0.55
Risk-taking	-0.27	0.39	0.48	0.490	0.77
Opportunity Recognition	-0.22	0.34	0.41	0.520	0.80
Locus of Control	-0.15	0.39	0.16	0.693	0.86
Highest Educational Level	0.14	0.21	0.44	0.508	1.15
Time spent developing inventions	0.07	0.33	0.04	0.840	1.07
Household income	0.00	0.24	0.00	0.991	1.00
Overconfidence	-1.15	3.22	0.13	0.720	0.32
Constant	-7.31	2.46	8.81	0.003	0.00
N	169				

Model Summary		
-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
72.9096	0.256067	0.495533

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