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When higher productivity hurts: The interaction between overconfidence and capital☆

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ABSTRACT

We investigate how the increased availability of a factor of production can make an overconfident agent worse off. In our model, two effects drive this result. First, when a production factor and ability are complements in the production function, the agent may overpay for the production factor. Second, the acquisition of this factor will distort the agent's choice of what activities to pursue. In contrast, when the factor and ability are substitutes, the agent will undervalue the factor. In a laboratory experiment we find that subjects overpay for ability-complements, and underpay for ability-substitutes. Subjects provided with free ability-complements earn less due to how it distorts the subjects' perceptions of what activity to pursue.

1. Introduction

Much research has shown that overconfidence[1] is widespread (Kruger and Dunning, 1999) and has an important effect on many economic outcomes (Barber and Odean, 2000; Malmendier and Tate, 2005; Koellinger et al., 2007; Malmendier and Tate, 2008; Ederer and Manso, 2013; Herz et al., 2014). However, little is known about how overconfidence interacts with the economic environment. How do the welfare implications of overconfidence vary with an increase in a production factor? In this paper we show that having access to more of a factor can lead overconfident agents to strictly worse outcomes. Two effects drive this result. First, an overconfident agent may overpay for the factor, and second, an increase in the factor can magnify the disparity between people's expected performance and actual performance, thereby increasing excess entry into activities that require high performance (in the spirit of Camerer and Lovallo, 1999). We demonstrate this result both theoretically and in a laboratory experiment. These effects carry substantial implications in numerous real-world domains.

Consider, for example, the typical decision problem faced by a financially unsophisticated investor. The investor may consider a passive strategy consisting of holding well-diversified index funds, or an active strategy that requires picking individual stocks. The active strategy requires greater knowledge, but the market offers many resources to acquire knowledge, including prospectuses, news articles, books, courses, and investor newsletters, amongst other resources.

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[1] Moore and Healy (2008) make the distinction between three forms of overconfidence. *Overestimation* occurs when individuals systematically believe their performance to be better than it actually is, *overplacement* occurs when individuals believe they are higher ranked in performance relative to some population of agents, and *overprecision* occurs when people believe that their judgments are more accurate than they are. In both the model and experiment, the paper is concerned only with overestimation.

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An overconfident investor may overestimate his capacity to effectively use this knowledge.[2] Several studies find a negative relationship between investor information and portfolio performance. Survey data on Italian (Guiso and Jappelli, 2006) and Portuguese investors (Abreu and Mendes, 2012) show that overconfident investors are more likely to acquire knowledge about stocks, trade more frequently and achieve lower risk-adjusted returns on their portfolios. Huber et al. (2008) find that more information in an experimental lab asset market is not always associated with better returns. In a similar vein, Barber and Odean (2002) document an increase in trading activity when retail investors switch from phone to more information-rich online trading platforms. While investors in their sample initially beat the market on average by over 2% annually, after switching to online investing they underperformed by 3% annually. In all of these examples, increased information and ability to trade seem to make investors worse off. The authors' interpretation is that the greater access to information and greater autonomy inherent in the online platform led to increased overconfidence among investors.

Firms may exploit this phenomenon of greater information leading to greater excess entry. Casinos in Las Vegas sell blackjack strategy cards and allow players to use them at the tables. Players may enter the game expecting to follow the strategy with near precision but err too often. Following the strategy is by no means trivial. Griffin (1991) finds that typical blackjack play has an error rate that gives the house an additional advantage of 1.41 percentage points above the strategy depicted on the card. Although strategy cards may improve play, gamblers may think they can follow the strategy better than they actually can. This would encourage more frequent and intense gambling that could ultimately lead to greater financial loss for the gambler.

Perhaps the consequences of overconfidence are greatest in the decision to go to war. WWI is a case in point (Johnson, 2004). Germany's war strategy, known as the Schlieffen Plan, depended critically on a quick victory over France so that troops could be raced to the eastern front to defend against a slow but large Russian army. German engineers constructed strategic military railways at the end of the 19th century and based their military strategy firmly on the presumption that this new technological advance would provide the speed necessary for the Schlieffen Plan to succeed (Tuchman, 1962). While addressing German troops prior to battle in August 1914, Kaiser Wilhelm II declared, "You will be home before the leaves have fallen from the trees" (Stoessinger, 1987). Perhaps under superb command the Kaiser's assessment would have been accurate. However the leadership ability needed to successfully implement the Shlieffen Plan may have been exceedingly high. Instead the war lasted over 4 years and cost over 7 million German casualties. The technological and infrastructural advances prior to the war may have been a critical factor that induced German attack.

In each of these examples (investing, gambling, conflict), there is an acquisition of a production factor, which we will simply refer to as capital, that increases output (knowledge about stocks or stock-picking strategies, blackjack strategy card, new technology and infrastructure), and an exogenous ability (ability to interpret stock charts and apply strategy, ability to remember and implement rules, military leadership and acumen).[3] In each of these examples, the capital appears to be a complement to ability: data about stocks is useless if one cannot interpret it, a strategy card does little good if one cannot implement the rules quickly, military railways will not help a German general win the war unless he has the acumen to defeat France quickly. This acquisition of capital increases overestimation of output, which induces pathological entry (active investing, more gambling, war).[4] The unintuitive result that increasing a production factor can *decrease* welfare follows from the logic of a simple model. Suppose production is a function of ability and capital, where ability is exogenous and where capital is to be interpreted very broadly as any endogenously chosen factor that increases production.[5] If ability and capital are complements in the production function, then an agent's overestimation of his ability causes him to overvalue capital. Thus the agent will overpay for capital. Furthermore, because the agent overestimates his ability, an increase in capital increases his overestimate of output. Access to this capital may further make the agent worse off because it results in an excessive purchase of capital that then magnifies the agent's bias in his estimate of his output. This bias can lead to any number of poor decisions such as pathological entry in active investing, gambling, or military engagements.

Not all forms of capital are overvalued and induce greater bias in overconfident agents. If ability and capital are substitutes in the production function, these results are reversed. Acquiring an ability-substitute decreases an overconfident agent's overestimate of his productivity. Although the ability-substitute reduces bias, the agent will generally undervalue this type of capital and often purchase too little of it. Indeed, Bhattacharya et al. (2012) study investors at a brokerage firm who were offered free financial advice. Less than 5% of investors obtained the advice and even fewer followed it despite the fact that following it would have improved portfolio performance.

In the next section we present a formal model of this framework. We show that capital that is a complement with ability can make agents worse off but capital that is a substitute with ability will often make agents better off. We then provide a proof-of-concept in a laboratory experiment. Subjects begin the experiment by answering a 10-question multiple-choice trivia quiz. Subjects are paid $2.50 for every question they answered correctly. After subjects answer each question we elicit their belief that they answered the question correctly in an incentive-compatible manner. The trivia quiz was very difficult and, consistent with previous work (Moore and Healy, 2008; Grieco and Hogarth, 2009), subjects overestimate their score by 2.871 questions on average (or 174% above their actual score), indicating widespread overconfidence in ability.

In the second and third stage subjects are again paid $2.50 for each question they answer correctly on a second quiz but can now purchase one of two types of capital to improve their

[2] Although some active investors do beat the market, the majority do substantially worse. Barber et al. (2009) show that 2.8% of all Taiwanese personal income is lost in the Taiwanese stock market due to overly aggressive trades. On average, each stock sold by an individual investor does worse than a stock purchased. This represents a huge redistribution of 2.2% of Taiwanese GDP from overconfident individual investors to institutional investors.

[3] Modeling knowledge as a production factor has a long tradition in economics. Technological knowledge is a factor in a representative firm's production function in several growth models (Romer, 2011), knowledge as the product of education is modeled as human capital in a firm's production function (Becker, 1962), and more recently, knowledge in the form of financial literacy is modeled as a factor in a consumer's production function to generate higher returns through better financial decisions (Lusardi, Michaud, and Mitchell, 2011).

[4] In some models, excess entry is caused by overplacement, as in Camerer and Lovallo (1999). In this context, the the market for the ability-based activity has a finite capacity and the optimality of entry is based not on productivity, but the ranking of productivity amongst the other entrants. In this paper, we are considering suboptimal entry from overestimation. As long as the payoff after entry is determined to some extent by absolute productivity (as it often is), and not only productivity ranking, then overestimation may also cause suboptimal entry.

[5] We use this very broad interpretation because the distinction between capital and other production factors is not necessary for the purposes of this paper. We use the term capital to potentially refer to all production factors. Thus knowledge, effort, and even potentially labor are all to be interpreted as capital, at least for the purposes of this paper, as well as the more traditionally-interpreted forms such as financial resources, machines, tools, buildings, and learnable skills.