Overconfidence, Stability and Investments*

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Abstract

The available evidence from numerous studies suggests that overconfidence varies significantly across countries. We develop a model that endogenizes these differences and examines their economic consequences. A crucial determinant of differences in overconfidence is the degree of expected stability of the environment, with greater changefulness giving rise to more overconfident beliefs. When stability is endogenized, multiple equilibria can emerge, "dynamism" and overconfidence reinforcing each other in one case, stability and realistic self-assessment in another. Evidence from 38 countries is consistent with this relationship. Our model also sheds light on differences in overconfidence across individuals. We conduct a large-scale survey in China and find evidence consistent with the model's cross-sectional implications.

Keywords: Self-confidence, investment, cultural differences, cultural transmission.

JEL Classification: Z1; D03; D83

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"Pride hurts, modesty benefits."

The Counsels of Great Yu in the Document of Shangshu, 6th century BC

"All you need in this life is ignorance and confidence; then success is sure."

Mark Twain (1835 - 1910), *Letter to Mrs Foote, Dec. 2, 1887*

1 Introduction

Individuals often overestimate their ability. For example, in experiments where they take an IQ test, participants asked to guess how well they did tend to exhibit overconfidence[1]. Overestimating their ability can of course lead decision-makers to make inefficient decisions, with potentially large economic costs[2]. A number of recent theoretical contributions have therefore focused on the *causes*, as well as the consequences, of overconfidence. Several approaches have been put forward. In one view, overconfidence is essentially exogenous - a trait that different people possess to a different degree, which should be taken as a primitive in the analysis of individual economic behavior. A second approach, building on experimental evidence in psychology reviewed in section 2, argues that overconfidence is to some extent *endogenous*: it responds to expected future costs and benefits. Bénabou and Tirole (2002) have developed this approach, showing that overconfidence can have instrumental value when individual preferences are time-inconsistent (quasi-hyperbolic discounting).

The hypothesis that overconfidence might be partly endogenous seems worth exploring further, particularly in view of a substantial body of evidence in psychology suggesting that the importance of overconfidence varies significantly across countries. For example, a number of studies have found that the distributions of self-esteem[3] scores for North Americans are heavily skewed towards high self-esteem, while this is *not* the case for the Japanese, whose self-evaluations are lower and approximately normally distributed.[4] A recent meta-analysis by Schmitt and Allick (2005) presents data on average self-competence scores for a large sample of countries (see Table 2 in section 5). In addition to corroborating earlier evidence of a significant difference between the US and Japan, it also highlights other interesting examples, such as Israel, with an average score just above that of the US, and Switzerland, with an average score closer to Japan.

If overconfidence has an endogenous component, it should be possible to identify some of the determinants of this variation across countries, as well as across groups and individuals within

[1] See, e.g., Burks, Carpenter, Goette and Rustichini (2013) and Chew, Huang and Zhao (2017) for recent evidence on this, in experiments with incentivized beliefs.

[2] See, for example, Malmendier and Tate (2005, 2008) for evidence concerning the impact of overconfidence on corporate investment decisions and acquisitions.

[3] Confidence in one's ability is an important component of self-esteem. Indeed, self-esteem scores can be decomposed into two components: self-competence (feeling confident, capable and efficacious), and self-liking. These share a large amount of covariance.

[4] See Heine et al. (1999).

countries, leading to a better understanding of both the causes and economic consequences of overconfidence. In this paper, we take a first step in this direction. We develop a model in which overconfidence can arise endogenously, in response to the economic and social environment. We focus on one characteristic of the environment: the expected degree of *stability*, or conversely the expected degree of *changefulness*.

The key idea we explore is the following. In a very stable environment, where an individual expects to continue a large proportion of his current activities and relationships for a long time in the future, overconfidence can be very costly, by generating complacency, and reducing the willingness to invest in costly improvements. In a more changeful, dynamic environment, individuals are frequently faced with the need to decide whether to undertake new initiatives, investing in new projects and relationships: this requires confidence. When individual preferences exhibit present bias (quasi-hyperbolic discounting), they will tend to under-invest; overconfidence can help alleviate the resulting under-investment problem.[5] Thus the trade-off between the expected costs and benefits of overconfidence is likely to depend on the expected degree of stability or changefulness of the environment.

In our model, we capture this characteristic of the environment through the probability, π, that an individual will continue an existing "project" (activity, task, relationship) in the long term. If the project is continued, the individual has to decide whether to exert effort to improve long-term performance. If instead the project comes to an end earlier, the individual has to decide whether to invest in a new project. We can also think of π as representing the expected fraction of projects that are continued in the long run, as individuals in practice undertake different activities and invest in different relationships. Our baseline model treats π as exogenous, examining the impact of expected stability or changefulness on equilibrium beliefs about the self.

We analyze the intrapersonal game between an individual's current self and his future self, where the current self can influence the future self's recall and interpretation of a (current) "bad" signal about his talent/skill. The game is therefore similar to the one analyzed by Bénabou and Tirole (2002), the key difference being that in our model the current self must take into account the probability that the future self will have to decide whether to invest in a new project, versus the probability that he will have to choose how much improvement effort to exert on the existing, continuing project.[6] We follow Bénabou and Tirole (2002) in modeling the intrapersonal game between the current self and the future self, so as to capture the possibilities for memory management (e.g. through selective attention) and self-serving interpretations highlighted by psychologists and discussed in section 2. However, the model can easily be reinterpreted as an interpersonal game between parents and their children, with the current self representing the parent who cares about the child's welfare and communicates with the child accordingly.

[5] For evidence on the prevalence of quasi-hyperbolic discounting, see Ainslie (1991, 2001).

[6] In Bénabou and Tirole (2002), the individual will have to decide whether to invest in a new project with probability one: in our setting, this corresponds to the special case where $\pi = 0$.

To capture the tradeoff between the costs and benefits of overconfidence described earlier, we assume that overconfidence increases individuals' expected probability of success if they undertake new projects ("*initiative effect*"), but is also likely to reduce the perceived value to them of exerting improvement effort on existing tasks ("*complacency effect*"). For example, a highly talented individual is more likely to succeed in a new role or relationship; he is also more likely to quickly identify and pursue efficient strategies for continuation of existing projects, while a less talented individual would benefit from exerting additional effort to search for help, advice, and/or extra information, which will improve strategy selection and avoid very costly mistakes.

Our first result is that, in the presence of this tradeoff, *overconfidence emerges in equilibrium in more "dynamic" societies (low value of π) and is less common in more "stable" societies* (high value of π). This may help to explain some of the differences between the US and Japan documented by psychologists, reviewed in section 2. Japan has provided until recently a more "stable" environment than the US in the sense of this paper, as captured by a variety of indicators[7] such as unemployment rates, job mobility, takeovers, divorce rates, and the Global Peace Index.[8]

Our first result focuses on sophisticated agents, who update beliefs following Bayes' rule, taking into account the possible effects of selective attention and memory management. We then extend our model to allow for "naive" agents. These may be individuals who suppress bad signals without being aware of it. Alternatively, they may be individuals who are aware of their biases in processing and recalling information, but lack the cognitive skills required for full Bayesian updating of beliefs *ex post*. Unaware agents do not act strategically; cognitively-constrained agents do, taking into account their cognitive constraints. We show that in very "dynamic" societies, all naive as well as sophisticated (Bayesian) agents suppress bad signals in equilibrium. *Ex post*, all naive agents have higher self-confidence than sophisticated agents. On the other hand, in very "stable" societies only unaware agents suppress bad signals; *ex post*, sophisticated and cognitively-constrained agents have the same beliefs. Thus if the population consists of a mixture of sophisticated and naive agents, *average self-confidence will be higher in the more "dynamic"societies*. This is consistent with the evidence on North America and Japan. Moreover, in section 5 we construct an indicator of "stability" for a large sample of countries for which Schmitt and Allick (2005) provide average self-competence scores. The indicator is based on unemployment rates and the Global Peace Index. Intuition might suggest, if anything, that self-confidence would tend to be higher in countries with lower unemployment rates and lower conflict. Yet these are also more stable countries in terms of our model, and we find indeed that they tend to possess *lower* average self-confidence, suggesting that this prediction of our model

[7]See, among others, Hashimoto and Raisian (1985), Imai and Kawagoe (2000), Moriguchi and Ono (2004), Ono (2006, 2010).

[8]The Global Peace Index (GPI) is produced by the Institute for Economics and Peace, taking into account internal factors such as violence and crime within a country and external factors such as military expenditures and wars.

holds for a larger set of countries.

Our model can also shed light on differences in self-confidence within each country: *individuals who expect the future to be more "dynamic" are likely to be more confident*, other things held equal, than those who expect the future to be more "stable". We took a first step towards investigating empirically this cross-sectional implication by conducting a large-scale survey using an online platform in China. This enabled us to elicit directly participants' expectations about the future stability or changefulness of the environment; at the same time, we obtained individual measures of actual ability and beliefs about ability. As we show in section 5, the evidence from the survey in China is also consistent with our model.

The results discussed so far are derived from our baseline model, in which the degree of stability π is given for a particular society. We then consider the implications of endogenizing π by allowing people to choose, through voting, the institutions that affect stability - for example, through labor market and corporate governance legislation, or membership of international unions and agreements. We find that this leads to the interesting possibility of *multiple equilibria with endogenous* π. In particular, we may observe two *ex-ante* identical societies in quite different equilibria: in one, individuals suppress bad signals and choose a low value of π, while in the other, individuals do not suppress bad signals, and choose a high value of π. Thus *overconfidence and dynamism reinforce each other in one equilibrium, realistic self-assessment and stability in the other.*

Endogenizing π is also interesting in terms of the cross-sectional implications of our analysis. Reinterpreting an individual's decision to vote over π as a choice between undertaking activities in a more dynamic or more stable environment suggests that we may observe more self-confident individuals preferring more dynamic environments, and less self-confident individuals choosing more stable environments. This is consistent with the findings by Chyung (2013), Galasso and Simcoe (2011), and Levine and Rubinstein (2013).

The paper is organized as follows. The remainder of this section relates our work to the existing literature in economics. Section 2 reviews the evidence from psychology that motivates our model. We present the baseline model in section 3, and the main results and extensions in section 4. Section 5 investigates empirically some of our model's predictions, using cross-sectional and cross-country data. The last section concludes.

1.1 Relationship to the literature in economics

Our baseline model, where π is exogenous, builds on the one developed by Bénabou and Tirole (2002). In their setting, the future self always faces a new investment decision, and there is no continuing project or improvement effort. In terms of our model, this corresponds to the special case where $\pi = 0$. There is, therefore, no trade-off between the expected benefits of overconfidence in terms of encouraging initiative and investment in new projects, and its expected costs in terms of generating complacency and reducing improvement effort. This trade-off is central to our paper, and may help to explain some of the observed variation in

self-confidence across countries, and across individuals within each country. Our work is also related to Alesina and Angeletos (2005)[9], and Bénabou and Tirole (2006). These papers study the interaction between beliefs about the relative importance of effort and luck in determining incomes, and choices of redistributive policies. This leads to the possibility of multiple equilibria, with some societies exhibiting low levels of redistribution and beliefs in the importance of effort, while others exhibit high levels of redistribution and beliefs in the importance of luck. In a similar vein, we show how multiple equilibria can arise in our model once π is endogenized, with some societies exhibiting greater dynamism and overconfident beliefs, while others exhibit greater stability and no overconfidence.

Some of the theoretical literature on overconfidence in economics has focused on whether and when the available evidence shows a departure from Bayesian rationality (Benoît and Dubra (2011), Burks, Carpenter, Goette and Rustichini (2013)). Our analysis studies the behavior of fully Bayesian agents, and also allows for the presence of less sophisticated individuals.

A simple way to try to explain observed country differences in self-confidence might be to suppose that they are due to country differences in time preference. In our model, overconfidence only emerges in the presence of a bias towards immediate gratification. The observed difference between the U.S. and Japan could then be due to the Japanese being significantly more patient than North Americans. However, the evidence on country differences in time preference contradicts this: Wang, Rieger and Hens (2009) find that the Japanese have a greater present bias. We therefore abstract from differences in time preference in our model.

Finally, as noted earlier, our model can easily be reinterpreted in terms of intergenerational transmission between parents and their children. Our paper is therefore related to Bisin and Verdier (2000, 2001): they study more generally the intergenerational transmission of cultural traits, while we focus on a specific trait, overconfidence, and its role as a motivational mechanism.

2 Self-confidence in North America and Japan

This section reviews the evidence in psychology that motivated our model.

2.1 Self-esteem and self-competence scores

One very popular approach in psychology is to estimate self-esteem scores by asking individuals to report to what extent they agree or disagree[10] with a number of statements intended to capture self-esteem. The ten-item Rosenberg (1965) scale is the most widely used for this purpose, and has been applied in a very large number of studies. Items include "I am able to do things as well as most other people"; "All in all, I am inclined to feel that I am a failure";

[9] See also Di Tella and Dubra (2013).

[10] Possible answers are "strongly disagree", "disagree", "agree" and "strongly agree", with corresponding scores typically from one to four for positive items, and the order reversed for negative items.

and "I take a positive attitude toward myself". The first of these captures specifically beliefs about ability, while the other two may also capture other influences on self-esteem.

Self-esteem scores appear to differ substantially in North America and Japan, across numerous studies. The distribution of self-esteem scores for *North American* subjects is typically *very skewed towards high self-esteem* (see Baumeister et al. (1989) and Heine et al. (1999) for reviews and discussions); this is *not* the case for *Japanese* subjects (Bond and Cheung (1983), Campbell et al. (1996), Heine et al. (1999), Mahler (1976), Schmitt and Allik (2005)). Moreover, North Americans tend to have significantly higher scores than Japanese for all items but one[11] on the Rosenberg scale, including in particular the item that captures beliefs about ability (Heine et al. (1999)). Thus while differences in self-esteem may also capture other aspects, they clearly reflect important differences in confidence about ability. Indeed, Schmitt and Allik (2005) decompose global self-esteem scores into subcomponents of self-competence (feeling confident, capable and efficacious) and self-liking: the mean score for *self-competence* is significantly higher for subjects in the United States than in Japan.

An important question then is whether these findings reflect *cultural* differences. Evidence in favor of this interpretation is provided by Heine and Lehman (2004). They obtained self-esteem scores at different points in time for two samples of Japanese students visiting Canada. For one sample they found a significant *increase* in self-esteem with exposure to Canadian culture, while for the other sample the increase was not significant. Heine and Lehman similarly obtained self-esteem scores for a sample of Canadian English teachers who went to live in Japan. They found a significant *decrease* in self-esteem with exposure to Japanese culture.

2.2 Other measures of self-confidence and self-enhancement

The findings from studies using self-esteem scores have been corroborated by a large empirical literature in psychology using a variety of related albeit different methods. These include:

(i) studies in which participants evaluate themselves and the average person on the same scale. These studies have found a much greater degree of self-enhancement (the well-known "better-than-average" effect) among North American and Israeli participants than among East Asian (mainly Japanese and Singaporean) participants[12].

(ii) studies in which participants estimate the percentage of people who are more talented than themselves on a variety of dimensions. Here too North American subjects self-enhance much more than Japanese subjects[13], exhibiting the so-called "false uniqueness" effect (a good example of this is given by Svenson (1981): in his US sample, 93% of participants believed themselves to be more skillful than the median in the group).

[11] The exception is the item "I certainly feel useless at times", for which there is no significant difference.

[12] Brown and Kobayashi (2002), Crystal (1999), Endo, Heine and Lehman (2000), Heine and Lehman (1999), Kobayashi and Brown (2003), Kurman (2001, 2003), Kurman and Sriram (2002), Sedikides, Gaertner and Toguchi (2003).

[13] Heine, Kitayama and Lehman (2001), Heine and Lehman (1997), Markus and Kitayama (1991), Norasakkunkit and Kalick (2002).

(iii) studies in which participants indicate how much their successes and failures are due to their own abilities. American students are much more likely than Chinese or Japanese students to attribute their successes to their ability and their failures to external factors[14].

(iv) studies eliciting participants' memories of their successes and failures. Endo and Meijer (2004) found evidence of self-enhancement among American subjects, but the opposite among Japanese subjects.

All these and other studies have been reviewed in a meta-analysis by Heine and Hamamura (2007): they conclude that North Americans show a clear self-serving bias while East Asians do not.

2.3 Self-esteem maintenance and self-enhancement strategies

How are overconfident beliefs sustained? In psychology, a large North American literature has documented the existence of self-serving biases, whereby individuals essentially suppress "bad" signals about their ability and other attributes. This is achieved in a number of ways, including the following:

(a) selective recall of information (e.g. Sanitioso, Kunda and Fong (1990));

(b) subjecting "negative" information to greater scrutiny to find flaws in it or reasons to dismiss its significance (see Baumeister and Newman (1994), Kunda (1990)), and possibly develop alternative explanations that effectively suppress the bad signal (Ditto and Lopez (1992), Ditto et al. (1998));

(c) dismissing the importance of skills one does not have and emphasizing the value of traits one does possess (Dunning and Cohen (1992), Dunning et al. (1989), Tesser and Paulhus (1983));

(d) perceiving own shortcomings as common, own strengths and abilities as uncommon (Mullen and Goethals (1990)).

Yet where attempts have been made to find similar evidence of self-serving biases among Japanese subjects, they have generally failed to do so. For example, as noted earlier, North American subjects tend to attribute their successes to their ability and their failures to external factors such as bad luck (see Zuckerman (1979) for a review). However, studies of Japanese subjects tend to find instead that they attribute failures as much as successes to own (in)abilities (Kitayama et al. (1995), Brown, Gray and Ferrara (2005)).

Relatedly, Baumeister and Jones (1978) found that American participants compensated for negative self-relevant feedback in one domain by inflating their self-assessments in another domain. Heine, Kitayama and Lehman (2001) have investigated whether Canadian and Japanese participants exhibit a similar tendency. All participants were given success or failure feedback following a creativity test; they were then asked to evaluate themselves on dimensions unrelated to creativity. Canadian participants did not show any significant difference in self-evaluations on unrelated dimensions following success or failure feedback on the creativity task. Japanese

[14] Anderson (1999), Endo and Meijer (2004).

participants provided *less* favorable self-evaluations on the other dimensions following failure on the creativity test.

Further evidence suggesting that self-esteem maintenance strategies play a more important role for North Americans than for Japanese is provided by studies of self-affirmation and dissonance. In these studies, participants typically choose between two desirable alternatives; they also evaluate the two alternatives before and after making their choice. North American participants usually evaluate their chosen alternative more positively, and the rejected alternative less positively, after making their choice (e.g. Steele, Spencer and Lynch (1993), Heine and Lehman (1997)). This behavior is consistent with a desire to maintain self-esteem by rationalizing one's choices ex post as "the right ones". Japanese participants, in contrast, do not systematically change their evaluations after making their choice (Heine and Lehman (1997)).

3 Baseline model

Our baseline model modifies the one introduced by Bénabou and Tirole (2002). It has two periods and three dates, $t = 0, 1, 2$. At the beginning of the first period ($t = 0$), each individual starts a project (activity, task, relationship). At this stage, individuals are indistinguishable. For simplicity, there is no cost of starting the project. Once they have started, individuals (privately) receive a signal informative about their ability/skill, θ. They choose their interpretation and recall strategy. At $t = 1$ the individual can continue the same project with probability π. In this case, he can, at a cost, invest in improvement, thereby increasing the expected returns from the project. With probability $1 - \pi$, on the other hand, the individual cannot continue the existing project. That is, the existing project may disappear. In this case he has to decide whether to undertake a new project. All project outcomes are realized at $t = 2$. The timing is depicted in Figure 1.[15]

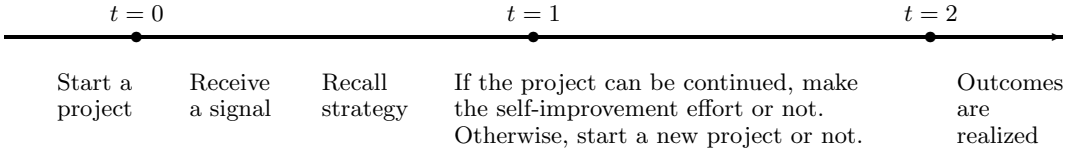


Figure 1: Timing

Interpretations of the model

The model, described below, is deliberately stylized, to capture as simply as possible the general tradeoff between the costs and benefits of overconfidence discussed in the Introduction. Several interpretations are possible, each one yielding different insights. According to one interpretation, which will be the main focus of our analysis, individuals receive information about different aspects of their ability/skill from a variety of sources: academic achievements, social interactions, non-academic activities, work, etc. There is plenty of scope for "creative

[15]When $\pi = 0$, our model degenerates to that of Bénabou and Tirole (2002) in which the individual only decides whether to invest in a new project.

interpretation" of some of the information, and for selective attention to different pieces of information, in ways that generate biased recollections and assessments, as discussed in section 2. In this interpretation, it is today's self (self-0) that influences the information that tomorrow's self (self-1) will recall: the game is intra-personal.

An alternative interpretation would be in terms of parental transmission of information. Then self-0 would be the parents, and self-1 the child: the game is inter-personal. In view of the evidence from the psychology literature discussed in section 2, we focus on the intra-personal game of endogeneous interpretation and recall of information as the main mechanism underlying personal (over)confidence. It should be clear, however, that both mechanisms are at work in determining confidence, and the main insights from our analysis apply to both.

In our model, the early end of the existing project (at $t = 1$) is intended to capture a variety of situations in which individuals cannot continue with the "status quo", and need to decide whether to undertake new activities, initiatives, etc. For example, when a firm is taken over, the change of ownership may bring with it a number of changes in the way the firm is run, so that individual employees have to decide whether to invest in new opportunities within the firm, or possibly search for an alternative employer. Employees who are laid off often have to decide whether to invest in acquiring new skills, or incur the costs of moving. Start-up entrepreneurs whose business fails have to decide whether to seek a "safe" job as employees or invest in trying to start a new business.

These examples mainly concern decisions to do with work in one form or another, but the set of circumstances that may require investment in new activities and initiatives is much broader. A change of government, for instance, may entail significant changes in a variety of policies, making it impossible for many people to hold on to the previous "status quo": each person who is affected by the changes then has to decide how much effort and resources to invest in response to the new circumstances. At a more personal level, changes in family circumstances, such as divorce, also confront individuals with choices about new investments (relationships, home, work, etc.).

3.1 Projects

The initial project brings a benefit W if it succeeds and zero otherwise. The probability of success depends on the individual's ability; for simplicity, it is equal to θ. We assume that $\theta \in [0, \theta^{\max}]$, where $0 < \theta^{\max} < 1$. Thus even the most talented/skilled individual cannot be sure of success. If the project is continued at $t = 1$, the individual decides whether to exert improvement effort: by incurring the cost k, he can increase the probability of success by $\phi(\theta^{\max} - \theta)$, where $1 \geqslant \phi > 0$. By focusing on his failings and weak points, paying attention to criticism and other negative feedback, searching for new information and exploring alternative approaches and ideas, the individual can identify and seek out opportunities for improvement, and thereby achieve a better performance. The *scope* for such improvement will be greater for

individuals with lower initial skill (simply put, there is more room for improvement[16]): this is reflected in the term $\theta^{\max} - \theta$. On the other hand, the parameter ϕ, measuring the individual's *effectiveness* in improvement, may depend on his ability; in particular, we will allow for the possibility that more talented individuals are more effective.

If the existing project cannot be continued at $t = 1$, the individual is faced with a different choice. He can incur a cost c to undertake a new project, which will yield benefit V if successful and zero otherwise. The probability of success in this case is θ. Alternatively, he can undertake another activity whose outcome is less sensitive to ability. For simplicity, we assume that the return from this alternative activity is fixed, and normalize it to zero.

3.2 Preferences

We allow for time-inconsistent preferences by assuming that individuals at $t = 1$ discount expected payoffs at $t = 2$ with a discount factor equal to $\beta\delta$, where δ is the normal discount rate, while $\beta < 1$ corresponds to hyperbolic discounting. In this case, people give an "excessive" weight to the present.[17]

3.3 Information and beliefs

Self-0 receives a signal s concerning his ability θ. In the baseline model, for simplicity, we focus on the case where s can take just two values: $s = B$ ("bad" signal) and $s = \varnothing$ (no signal). Prior beliefs concerning the signal are described by the probability q; that is, $s = \varnothing$ with probability q and $s = B$ with probability $1 - q$. We can think of q as the proportion of higher-ability individuals in the population. The expected values of θ and ϕ, conditional on each possible realization of the true signal s, are given by:

$$\theta_L = E[\theta|s = B] < \theta_H = E[\theta|s = \varnothing].$$

$$\phi_L = E[\phi|s = B] \leqslant \phi_H = E[\phi|s = \varnothing].$$

Let $\hat{s}$ be the signal transmitted by self-0 to self-1. We can think of this as (endogeneous) memory. Given our assumptions, if the true signal is $s = \varnothing$, there is no opportunity for signal manipulation; thus $\hat{s} = \varnothing$. On the other hand, if the true signal is $s = B$, self-0 may either communicate the signal truthfully to self-1 ($\hat{s} = B$), or he may decide to suppress the bad signal ($\hat{s} = \varnothing$), as discussed in section 2. At date 1, the state is realized: with probability π the project is continued, otherwise the first project ends and self-1 has to decide whether to undertake a second project. At this date, and before making his investment or effort decision, self-1 privately learns respectively his cost c or k. At date 0, the cost c is known to be uniformly distributed over the interval $[c_L, c_H]$. Similarly the cost k is known to be uniformly distributed over the interval $[k_L, k_H]$.

[16] For a variety of examples, see our discussion in section 4.

[17] See Strotz (1955) and Laibson (1997).

To make the analysis interesting, we assume that:

$$\delta \min \{\phi_H(\theta^{\max} - \theta_H), \phi_L(\theta^{\max} - \theta_L)\} W > k_L$$

improvement is always efficient if the cost is sufficiently low; and

$$\delta \max \{\phi_H(\theta^{\max} - \theta_H), \phi_L(\theta^{\max} - \theta_L)\} W < k_H$$

improvement is always inefficient if the cost is sufficiently high. Similarly, we assume that:

$$\delta \theta_L V - c_L > 0$$

investment in the new project is always efficient if the cost is sufficiently low, and

$$\delta \theta_H V - c_H < 0$$

investment in the new project is always inefficient if the cost is sufficiently high.

Self-0 has just one decision to make, the recall strategy; that is, the probability that the bad signal will be recalled by self-1:

$$h = \Pr[\hat{s} = B | s = B].$$

We shall denote by h^* the beliefs held by self-1 concerning self-0's strategy.

4 The costs and benefits of overconfidence

This section derives the equilibria of the baseline model and then presents some extensions.

4.1 Baseline analysis

We begin by solving the model, starting with the behavior of Self-1, followed by Self-0's optimal strategy.

4.1.1 Self-1 belief updating and behavior: sophisticated individuals

Consider self-1's decisions at date 1, in the light of the information available to him. Self-1 has to form expectations over his ability θ. In doing so, he will take into account the possibility that self-0 may have suppressed the true signal s. When $\hat{s} = B$, clearly there has been no suppression; self-1 will therefore have revised beliefs θ_L, ϕ_L. When $\hat{s} = \varnothing$, self-1 estimates the following probability that the signal is accurate (the signal's "reliability"):

$$r^* = \Pr[s = \varnothing | \hat{s} = \varnothing; h^*] = \frac{q}{q + (1-q)(1-h^*)}$$

implying that his revised beliefs are given by:

$$\theta(r^*) = r^*\theta_H + (1 - r^*)\theta_L$$

and

$$\phi(r^*) = r^*\phi_H + (1 - r^*)\phi_L.$$

Denoting these revised beliefs by θ^* and ϕ^*, clearly self-1 will exert improvement effort if, and only if,

$$\beta\delta\phi^*(\theta^{\max} - \theta^*)W \geqslant k.$$

If the first project has ended, self-1 will undertake the new project if, and only if,

$$\beta\delta\theta^* V - c \geqslant 0.$$

4.1.2 Self-0 strategy

When $s = B$, self-0 has to choose the recall strategy, h. If he transmits the signal accurately to self-1 ($\hat{s} = B$), his expected utility (ignoring discounting between date 0 and date 1 in what follows for simplicity) is given by:

$$\begin{aligned} U_T = \pi &\left[\delta\theta_L W + \int_{k_L}^{\beta\delta\phi_L(\theta^{\max} - \theta_L)W} \{\delta\phi_L(\theta^{\max} - \theta_L)W - k\} g dk\right] \\ &+ (1 - \pi) \int_{c_L}^{\beta\delta\theta_L V} \{\delta\theta_L V - c\} f dc \end{aligned}$$

where the subscript T stands for "truth". If on the other hand self-0 suppresses the bad signal ($\hat{s} = \varnothing$), his expected utility depends on self-1's beliefs about the reliability of the signal, r^*, and is given by:

$$\begin{aligned} U_S = \pi &\left[\delta\theta_L W + \int_{k_L}^{\beta\delta\phi^*(\theta^{\max} - \theta^*)W} \{\delta\phi_L(\theta^{\max} - \theta_L)W - k\} g dk\right] \\ &+ (1 - \pi) \int_{c_L}^{\beta\delta\theta^* V} \{\delta\theta_L V - c\} f dc \end{aligned}$$

where the subscript S stands for "suppression". The net gain from suppressing the bad signal is therefore equal to:

$$\begin{aligned} &X(r^*, \pi) \\ &= U_S - U_T \\ &= -\pi X_1 + (1 - \pi) X_2 \end{aligned}$$

where

$$X_1 \equiv \int_{\beta\delta\phi^*(\theta^{\max}-\theta^*)W}^{\beta\delta\phi_L(\theta^{\max}-\theta_L)W} \{\delta\phi_L(\theta^{\max}-\theta_L)W-k\}gdk$$

and

$$X_2 \equiv \int_{\beta\delta\theta_L V}^{\beta\delta\theta^* V} \{\delta\theta_L V-c\}fdc.$$

The first term X_1 represents the impact of overconfidence on improvement effort when the existing project is continued. The second term X_2 captures the effect of overconfidence on the decision to invest in the new project when the existing one is not continued. In this case overconfidence yields a gain to the extent that it corrects the under-investment problem due to hyperbolic discounting; if this problem is small, though, there may be excessive confidence and over-investment. For expositional simplicity, we shall focus on the more interesting case where $\beta < \theta_L/\theta_H$, which rules out the possibility of over-investment irrespective of the beliefs held by self-1.

4.1.3 Perfect Bayesian equilibria (PBE)

Let $\bar{\phi} = q\phi_H + (1-q)\,\phi_L$ and $\overline{\theta} = q\theta_H + (1-q)\,\theta_L$. We now characterize the set of Perfect Bayesian equilibria in pure strategies.

Proposition 1 *(a) If* $\min\left\{\phi_H(\theta^{\max}-\theta_H), \bar{\phi}(\theta^{\max}-\bar{\theta})\right\} > \phi_L(\theta^{\max}-\theta_L)$*, there is a unique PBE with* $h^*=0$*;*

(b) if $\phi_L(\theta^{\max}-\theta_L) > \bar{\phi}(\theta^{\max}-\bar{\theta})$*, there exist two threshold values,* π_H *and* π_L *(with* $\pi_H > \pi_L$*), such that: (I) if* $\pi < \pi_L$*, there is a unique PBE with* $h^*=0$*; (II) if* $\pi > \pi_H$*, there is a unique PBE with* $h^*=1$*; (III) otherwise, there are two PBEs with* $h^*=1$ *and* $h^*=0$*;*

(c) otherwise, there is a PBE with $h^*=0$*, and a threshold value* π_M *such that a PBE with* $h^*=1$ *exists when* $\pi > \pi_M$*.*

In some situations (Proposition 1(a)), when the positive impact of higher ability on the *effectiveness* of improvement effort (i.e., the difference between ϕ_H and ϕ_L) is sufficiently greater than its impact on the *scope* for improvement (i.e., the difference between $\theta^{\max}-\theta_L$ and $\theta^{\max}-\theta_H$), overconfidence tends to encourage improvement effort, as well as new investments. In this case, the optimal strategy for self-0 is always to suppress the bad signal ($h=0$).

However, in other situations the scope for improvement is much greater for less talented individuals, and this effect is likely to dominate. For example, a highly talented individual who can already achieve an excellent performance in a competition or test will gain far less than a moderately talented peer from spending many more hours preparing and revising. This applies in a wide range of circumstances: from preparation to obtain academic or professional qualifications, to preparation for any public performance (e.g. presentation, speech) or competition in the workplace and beyond. Empirical evidence for students includes Roszkowsk and Spreat (2016), who find that the lower the initial score the greater the gain from retaking the SAT; and Frisancho et al. (2016), who show larger learning gains in terms of improvements in the

exam scores for less advantaged students, using administrative data on the university entrance exam in Turkey. Aaronson, Barrow and Sanders (2007) study the effect of teachers on different student populations, and find that the impact of teachers is the largest on the students with the lowest levels. Moreover, greater talent makes it possible to identify sooner the most promising strategies, while less talented individuals may need to invest more time and effort to select appropriate strategies and avoid costly mistakes. Thus highly talented individuals are more likely to pick the best strategy in the first period, and have a very high probability of success when the project is continued, with little need for improvement effort (θ_H is close to $\theta^{\max}$). In contrast, less talented individuals are less likely to pick the best strategy in the first period, but may improve their strategy substantially in the second period by exerting effort (e.g. by searching for additional evidence, and/or obtaining help and advice).[18] The effect on the scope for improvement is also likely to dominate when it comes to many tasks that simply require correct completion, where more talented individuals tend to achieve this with less time and effort. Less talented individuals, on the other hand, are more likely to benefit from investing in additional effort (e.g. to carry out additional checks, or complete the task correctly employing less clever methods). Clearly then, in many situations overconfidence can have substantial costs, as individuals underestimate the true value to them of exerting greater effort, resulting in poor decision-making: we will refer to this as the "complacency effect".[19]

This leads to a key *tradeoff*: overconfidence can be beneficial, because it alleviates the under-investment problem for new project decisions ("*initiative effect*"), but it can also be costly, by exacerbating the under-provision of improvement effort ("*complacency effect*"). In the presence of this tradeoff, Proposition 1(b) shows that when the probability of continuation of the existing project is sufficiently large, the expected loss from suppressing the bad signal, which discourages improvement effort, is more important than the expected gain, arising from the positive impact of overconfidence on new project investment decisions. Thus the optimal strategy for self-0 is to transmit the signal truthfully. On the other hand, when the probability of having to choose whether to undertake the new project is high enough, the expected gain from suppression of

[18]This applies to many settings, including innovation and research, management, and a wide range of other creative activities.

[19]Studies in very different settings have found a negative relationship between self-confidence and performance, suggesting that the "complacency effect" can apply in a broad set of circumstances. For example, higher self-confidence has been found to be correlated with persistence in unproductive activities in spite of negative feedback (Whyte and Saks (2007)). Vancouver and Kendall (2006) measured self-confidence and subsequent exam performance for the same individuals taking five different exams. They found a negative relationship at the within-person level of analysis. Leung (2002) examined data from the Third International Mathematics and Science Study (TIMSS), showing that Hong Kong, Japan, Korea and Singapore students outperformed their counterparts in other countries in mathematics achievement. He found that the most striking common factor in these four countries, different from the rest, was the relative low confidence in doing mathematics of the students. Berner and Graber (2008) review the evidence on the link between physician overconfidence and errors in medical diagnosis. While a causal link in this context is particularly difficult to establish, there is some suggestive evidence. For example, in a study of radiologists given sets of "unknown" films to classify as normal or abnormal, the confidence level of the worst performers was higher than that of the top performers.

the bad signal, which alleviates the under-investment problem, is greater than the expected loss, so that the optimal strategy for self-0 is to suppress the bad signal. The tradeoff further allows for the possibility of multiple equilibria (with truthful transmission, and with bad signal suppression): these can arise for intermediate values of π (Proposition 1(b (III))), or when the impact of ability on the effectiveness of improvement effort and the scope for improvement is such that neither effect dominates (Proposition 1(c)).

4.1.4 Implications and discussion

We now discuss the main implications of Proposition 1 and how they relate to differences in overconfidence across countries as well as individuals.

Overconfidence and underconfidence

The results summarized in Proposition 1 identify the conditions for different equilibria to emerge: in particular, an equilibrium in which the individual accurately recalls bad signals, and an equlibrium in which he suppresses them. What are the implications for confidence when we aggregate over individuals in a society?

Consider first the baseline case in which all individuals are in the same equilibrium. For a sufficiently large population, our assumptions mean that a fraction $1 - q$ will observe the bad signal, while the remainder will observe no signal. In an equilibrium with accurate recall, updated beliefs about ability at $t = 1$ will be θ_L for those who observed the bad signal, and θ_H for those who did not: there will be no overconfidence and no underconfidence.

In an equilibrium with suppression of the bad signal, updated beliefs at $t = 1$ will be the same for all individuals, equal to $\overline{\theta} \equiv q\theta_H + (1 - q)\theta_L$. Clearly, therefore, there will be both overconfidence and underconfidence in absolute terms. This is because less talented individuals essentially pool with more talented individuals: as a consequence, low-ability individuals will have overconfident beliefs, while high-ability individuals will have under-confident beliefs.

The stark prediction that all individuals will have either accurate beliefs (equilibrium with accurate recall) or identical beliefs (equilibrium with suppression of the bad signal) follows from the assumption that all individuals are in the same equilibrium. Proposition 1 however shows that individuals may be in different equilibria depending on the expected degree of stability π, and on the extent to which they face a tradeoff between the "initiative effect" and the "complacency effect". This can generate significant individual heterogeneity within a society.

When we compare across societies, on the other hand, there are important influences on the expected degree of stability at the country level, which are experienced by all the inhabitants of a given country but differ between countries. Thus we can expect that in a more "dynamic" society, the value of π will be higher for most people than in a more "stable" society. This implies that in a very dynamic society the suppression of bad signals will be widespread. In a very stable society, we can still observe some suppression of bad signals (e.g. because of individuals for whom the "complacency effect" is sufficiently weak), but we are more likely to observe accurate recall.

United States and Japan

The US can be thought of as a very dynamic society in the sense of this paper: takeovers play an important role in corporate governance; employee turnover is relatively high; layoffs are common during economic downturns; entrepreneurial activity (business start-up and failure rates) is high. Politically, two main parties alternate in government, sometimes bringing substantial changes to the *status quo* established under the previous administration. Divorce rates are relatively high.

Japan, during much of the post-war period (the period that shaped the confidence attitudes examined in the psychology studies discussed in section 2), has been a relatively more stable society, with one main party in power during much of the period, low divorce rates, an emphasis on lifetime employment with the same firm, a very minor role for takeovers in corporate governance, combined with a tendency to invest for the long term, and to form stable industrial/financial groups.

Our results are therefore consistent with the evidence reviewed in section 2.

Cross-sectional implications

Our model can also shed light on differences in overconfidence between individuals, and groups, within a given society. The analysis developed in this section suggests that individuals who expect the future to be more changeful ("dynamic") are more likely to adopt self-enhancement strategies (suppression of bad signals), resulting in overconfidence. We are not aware of any study that has investigated the causal impact on overconfidence of expectations about the future stability or changefulness of the environment. In section 5, we will present some initial evidence based on a large-scale survey we conducted in China. As for the existing literature, we found some intriguing evidence in a study that compares self-perceptions of rural and urban children, including measures of global self-worth (akin to the global self-esteem scores discussed in section 2) and scholastic competence (closer to the self-competence scores also discussed in section 2). The U.S. urban-rural comparison is interesting because, as Yang and Fetsch (2007) point out, rural communities have changed considerably, and the contemporary rural areas in their study, compared to the adjacent Metropolitan Statistical Areas, have lower median family-household and per-capita incomes, higher poverty rates for families and individuals, and higher unemployment rates. Moreover, the decline in family-based agricultural production means that many rural adults now commute long distances to wage-level jobs.

Yang and Fetsch consequently argue that "there are reasons why children's self-assessed competencies should be affected, and probably negatively, by the deteriorating social environments in these rural communities" (p.5). This expectation is in line with the recent finding of a positive relationship between socio-economic background and self-confidence by Filippin and Paccagnella (2012)[20] : lower incomes as well as higher rates of poverty in rural areas might be expected to be associated with lower self-confidence. Interestingly, however, Yang and Fetsch did *not* find lower self-confidence among rural children (third through seventh grade) than

[20]Filippin and Paccagnella (2012) use data from the OECD-PISA study, which provides a large-scale, international, representative sample of students.

among their urban counterparts. Moreover, when they compared the two samples separately for each grade, and for girls and boys, they found a consistent pattern, with higher mean global self-worth and self-rated scholastic competence for the rural sample in most comparisons.[21]

We find this evidence intriguing, since children in the rural sample appeared to face a less "stable" environment in terms of our model (lower employment and income opportunities within their communities, increasing the probability of needing to move or commute long distances to seek out better opportunities elsewhere). The unexpected findings on self-confidence would therefore be consistent with our model. While this kind of evidence is intriguing, what we really need is data directly eliciting individuals' expectations of future "stability", as well as measures of actual ability and beliefs about ability. We will return to this in section 5, where we present our survey data.

4.2 Naive agents

Our analysis so far has assumed that individuals are rational and cognitively sophisticated. They are therefore aware of their own incentives to engage in memory-management and self-esteem maintenance strategies, and able to update their beliefs accordingly. In reality, there may also be some naive individuals who suppress bad signals about their ability without being in any way aware that they are doing so, and hence without taking this possibility into account in updating their beliefs ex post. These unaware agents always have *ex-post* beliefs equal to θ_H. Their presence can therefore generate some overconfidence, on average, even in a population where other agents do not engage in self-esteem maintenance strategies.

A different way in which individuals may depart from the assumption of rationality and cognitive sophistication is that they may lack the cognitive skills for full Bayesian updating of beliefs *ex post*, even though they are aware of the potential scope for memory management *ex ante*. These agents can behave strategically *ex ante*, taking into account their cognitive constraints. To see the implications, consider again the baseline version of our model, and suppose for simplicity that self-1 lacks the cognitive skills for Bayesian updating completely, so that his belief upon observing no signal ($\hat{s} = \varnothing$) is simply $\theta^* = \theta_H$. Knowing this, self-0 expects the net gain from suppressing the bad signal to be equal to:

$$\begin{aligned} & X^{CC}(\pi) \\ & = -\pi X_1^{CC} + (1-\pi) X_2^{CC} \end{aligned}$$

where

$$X_1^{CC} \equiv \int_{\beta\delta\phi_H(\theta^{\max}-\theta_H)W}^{\beta\delta\phi_L(\theta^{\max}-\theta_L)W} \{\delta\phi_L(\theta^{\max}-\theta_L)W - k\} g dk$$

and

$$X_2^{CC} \equiv \int_{\beta\delta\theta_L V}^{\beta\delta\theta_H V} \{\delta\theta_L V - c\} f dc.$$

[21] The mean self-worth was significantly higher in 5 of the 10 comparisons, while the mean self-rated scholastic competence was significantly higher in 7 of the 10 comparisons.

Thus if $\phi_L(\theta^{\max} - \theta_L) > \bar{\phi}(\theta^{\max} - \bar{\theta})$, (i.e. the "scope" effect is sufficiently important, as in Proposition 1(b)), $X_1^{CC} > 0$ and $X_2^{CC} > 0$. It is straightforward to verify that there is then a threshold value π^N such that $0 < \pi^N < 1$ and the net gain from suppressing the bad signal is strictly positive (negative) for $\pi < (>)\pi^N$.

An immediate implication is that for low values of π, these "cognitively-constrained" agents will suppress the bad signal *ex ante*, and have higher self-confidence than sophisticated agents *ex post,* since their updated beliefs will always be equal to θ_H. For high values of π, on the other hand, the same cognitively-constrained agents will not suppress the bad signal (unlike unaware agents): their updated beliefs *ex post* will be the same as those of sophisticated agents (i.e. accurate beliefs). The *average (mean) level of self-confidence* in the population will therefore be *higher*, for a given mixture of sophisticated, cognitively-constrained and unaware agents, in very *dynamic* societies than in more stable ones. This is consistent with the evidence on the United States and Japan discussed in section 2. We will return to this prediction of our model in section 5, where we examine evidence for a larger set of 38 countries.

4.3 Endogenizing dynamism and stability

So far, we have treated π as a given characteristic of the economic and social environment, reflecting existing institutions as well as other exogenous factors influencing the degree of stability. We now extend the baseline model to allow individuals in a society to vote over institutions, and thereby affect π: for example, by voting for reforms of the labor market and of corporate governance legislation, or membership of international unions and agreements. This enables us to examine the interaction between belief formation and institutional choices underlying the degree of dynamism or stability in the society. In practice, the degree of stability in a country at any given time will reflect both, institutional choices and a variety of other exogenous influences (e.g. shocks to technology and the natural environment, wars, relevant changes in other countries, etc.). Thus we see the analysis presented earlier and the one developed below as complementary perspectives.

To keep the model as simple as possible, the extension has four dates, $t = 0$, 1, 2, 3, and we focus on Bayesian agents. At $t = 0$, each individual starts a project, and receives a signal informative about his ability θ. He chooses his recall strategy. At $t = 1$ each individual updates his beliefs. He then votes on institutions that determine π. For simplicity, π may be high, π_H, or low, π_L. At $t = 2$, each individual learns whether the current project is continuing or ending. He then chooses his effort on the continuing project, or if the project has ended, he decides whether to invest in a new project. All outcomes are realized at $t = 3$.

The novel part occurs at $t = 1$, when individuals update their beliefs and decide how to vote. We assume they vote sincerely for the policy (value of π) that maximizes their expected payoff at $t = 1$, given their updated beliefs. Note that if all individuals choose accurate recall at $t = 0$, a fraction q will have updated beliefs θ_H at $t = 1$, and a fraction $1 - q$ will have updated beliefs θ_L. They may vote differently. On the other hand, if they all choose to suppress bad

signals at $t = 0$, they will have the same updated beliefs at $t = 1$, and vote in the same way.

Multiple equilibria with endogenous π Our main interest here is to investigate the possibility of multiple equilibria with endogenous π. In particular, we explore conditions for two pure strategy equilibria to arise: one in which individuals suppress the bad signal at $t = 0$, and then vote for π_L, and one in which they choose accurate recall at $t = 0$, and then vote (at least, a majority of them) for π_H.

At $t = 1$, each individual observes (recalls) either $\hat{s} = B$ or $\hat{s} = \varnothing$. We know from our earlier analysis that updated beliefs will be θ_L and ϕ_L if $\hat{s} = B$, θ^* and ϕ^* if $\hat{s} = \varnothing$, where

$$\theta^* = r^*\theta_H + (1 - r^*)\theta_L$$

and

$$\phi^* = r^*\phi_H + (1 - r^*)\phi_L.$$

The individual's expected payoff when $\hat{s} = B$ is $W_1(B) \equiv U_T(\theta_L)$, given by

$$\begin{aligned} U_T(\theta_L) = E(\pi) &\left(\delta\theta_L W + \int_{k_L}^{\beta\delta\phi_L(\theta^{\max}-\theta_L)W} (\delta\phi_L(\theta^{\max} - \theta_L)W - k)\, g dk \right) \\ &+ (1 - E(\pi)) \int_{c_L}^{\beta\delta\theta_L V} (\delta\theta_L V - c)\, f dc \end{aligned}$$

where $E(\pi)$ denotes the expected value of π.

The individual's expected payoff when $\hat{s} = \varnothing$ is $W_1(\varnothing) \equiv r^*U_S(\theta_H) + (1 - r^*)U_S(\theta_L)$, where

$$\begin{aligned} U_S(\theta_i) = E(\pi) &\left(\delta\theta_i W + \int_{k_L}^{\beta\delta\phi^*(\theta^{\max}-\theta^*)W} (\delta\phi_i(\theta^{\max} - \theta_i)W - k)\, g dk \right) \\ &+ (1 - E(\pi)) \int_{c_L}^{\beta\delta\theta^* V} (\delta\theta_i V - c)\, f dc. \end{aligned}$$

It follows that the individual's expected payoff when $\hat{s} = B$ increases (decreases) with E(π) whenever $A > (<)B$, where:

$$\begin{aligned} A &\equiv \delta\theta_L W + \int_{k_L}^{\beta\delta\phi_L(\theta^{\max}-\theta_L)W} (\delta\phi_L(\theta^{\max} - \theta_L)W - k)\, g dk \\ B &\equiv \int_{c_L}^{\beta\delta\theta_L V} (\delta\theta_L V - c)\, f dc \end{aligned}$$

Similarly, the individual's expected payoff when $\hat{s} = \varnothing$ increases (decreases) with E(π) whenever $X > (<)Y$, where:

$$\begin{aligned} X &\equiv \delta\theta^* W + \int_{k_L}^{\beta\delta\phi^*(\theta^{\max}-\theta^*)W} (\delta[\phi^*\theta^{\max} - r^*\phi_H\theta_H - (1 - r^*)\phi_L\theta_L]W - k)\, g dk \\ Y &\equiv \int_{c_L}^{\beta\delta\theta^* V} (\delta\theta^* V - c)\, f dc \end{aligned}$$

Clearly for W sufficiently large relative to V, everyone will vote for π_H, irrespective of their updated beliefs on θ. Similarly for V sufficiently large relative to W, everyone will vote for π_L. The more interesting case for our purposes is where W and V are such that voting behavior does depend on updated beliefs. In particular, for some parameter values we can have $A > B$, implying that a low-ability individual who accurately recalls the bad signal prefers π_H, while $X < Y$, implying that a low-ability individual who suppresses the bad signal will prefer π_L. Thus if low-ability individuals are the majority, it is possible to have two equilibria, one where individuals suppress bad signals and then vote for π_L (*overconfidence and dynamism*), and one where individuals choose accurate recall and then vote for π_H *(no overconfidence and stability).* In particular, these two equilibria can emerge when $A > B$ and $X' < Y'$, where X' and $Y'$are the values of X and Y above evaluated at $\theta^* = \overline{\theta}$ and $\phi^* = \bar{\phi}$; i.e.,

$$X' \equiv \delta\overline{\theta}W + \int_{k_L}^{\beta\delta\bar{\phi}(\theta^{\max}-\overline{\theta})W} \left(\delta[\bar{\phi}\theta^{\max} - q\phi_H\theta_H - (1-q)\phi_L\theta_L]W - k\right) g dk,$$

$$Y' \equiv \int_{c_L}^{\beta\delta\overline{\theta}V} \left(\delta\overline{\theta}V - c\right) f dc.$$

The intuition for this result is straightforward. A more confident individual is more likely to invest in a new project if the old one comes to an end, and less likely to under-invest because of hyperbolic discounting. His expected payoff is higher when faced with a new investment decision; *ex ante*, this increases the expected benefit from a more dynamic environment. Thus $Y' > B$. On the other hand, when the "scope effect" is sufficiently important a more confident individual is less likely to exert improvement effort if the old project is continued, which exacerbates the under-provision of effort in the presence of hyperbolic discounting. This effect tends to reduce X as θ^* increases. At the same time, in the absence of improvement effort, a more confident individual will have higher expectations of success if the old project is continued: this effect tends to increase X as θ^* increases. When this last effect is relatively weak compared to the first two, we can have $A > B$ and $X' < Y'$, yielding the possibility of multiple equilibria just discussed.

Cross-sectional implications

We can now return to the issue of cross-sectional differences within a country. If we reinterpret "voting over π" as an individual's choice to pursue activities in a more stable or more dynamic environment, our analysis suggests the possibility of a positive correlation between self-confidence and dynamism, with more self-confident individuals choosing to pursue activities in more dynamic environments, while less self-confident individuals prefer more stable environments. In our model, more dynamic environments are those in which the individual is more likely to be faced with decisions that entail change and new departures: whether to invest in new projects, whether to take new initiatives. Thus one area where we can look for evidence on the model's cross-sectional implications is the choice between more "entrepreneurial" and more "employee-like" occupations.

Chyung (2013) studies precisely this choice, using a large dataset of real estate agents in San Diego County. After a two-year required sales apprenticeship, individuals in this dataset

could choose among several options, including starting an independent business (the most entrepreneurial option), and remaining a salesperson supervised by a broker (the most employee-like option). Chyung's findings provide some support for our model: greater overconfidence significantly increases the likelihood of choosing the more entrepreneurial option. Moreover, the result is robust to the inclusion of a wide range of controls, including measures of risk attitudes. Further support for our model comes from Levine and Rubinstein (2013), who disaggregate the self-employed into incorporated and unincorporated, arguing that the former are a much better proxy for "entrepreneurs" than the latter. They find that, even as teenagers, individuals that incorporate later in life exhibit greater self-esteem. Moreover, Galasso and Simcoe (2011) find a positive relationship between CEO overconfidence and citation-weighted patent counts. They interpret this as evidence that overconfident CEOs are more likely to take their firms in a new technological direction, in line with the predictions of our model.

While this evidence is suggestive, we would like to go further in investigating the empirical evidence for our model. We turn to this in the next section.

5 Self-confidence and stability: empirical evidence

Our model yields a rich set of empirical implications, discussed in section 4. Ideally, we would like to test these fully, using panel data on individuals' expectations, self-confidence, and choices (economic, social, political). To the best of our knowledge, the data that would be required to do this is not currently available: it would take considerable time and resources to collect it. We therefore leave this ambitious project for future research. However, we can take a first step in the direction of empirical investigation: this is our more modest aim in this section.

We focus on the following empirical implication, identified in section 4: *self-confidence is likely to be higher when the environment is expected to be more changeful ("dynamic")* than when it is expected to be more "stable", other things held equal. We use two different and complementary methodologies. First, we report results from a survey we conducted in China using the platform WeChat[22], yielding responses from 3175 individuals aged between 10 and 89, living in both urban and rural areas throughout China[23]. This allows us to investigate the cross-sectional relationship between self-confidence and expected stability/dynamism. Second, we examine the same relationship at the country level, using available data for a sample of 38 countries. Each methodology has its advantages and its limitations, discussed below, but taken together they provide initial evidence consistent with our model, and highlighting a promising area for future research.

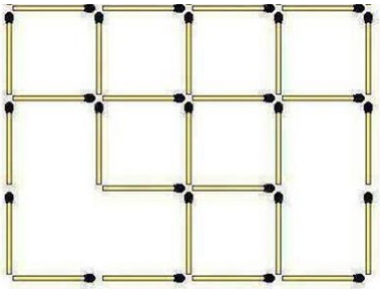
[22]WeChat is a Chinese social media application developed by Tencent. By 2017, it was one of the largest standalone messaging apps by monthly active users with over 938 million active users; see the Wikipedia entry of WeChat.

[23]We are grateful to Ruonai Fang and Shenzhen Quantum Net Technology Co., LTD for very valuable help in conducting the online survey.

5.1 Cross-sectional evidence

The key advantage of conducting our own survey is the ability to obtain measures of actual ability, confidence about ability, *and* expectations about the future changefulness or stability of the environment. The main disadvantage of using an online platform is the inability to tightly control the environment in which participants respond to the questions put to them, in contrast to a laboratory experiment. On the other hand, the online survey made it possible to obtain a large sample and wide cross-section of individuals, which is particularly interesting for our purposes. The ability to collect data from people with a variety of different ages, occupations and backgrounds, living in 32 out of the 34 province-level political districts in China, was valuable in obtaining significant variation in beliefs and expectations of future stability or changefulness.

Details of the online survey are available in the Appendix. The survey, which was administered anonymously, contains 22 questions. One of these is a picture-based test: participants are shown the following picture for up to 60 seconds



and during this time they have to answer the following question: "How many squares and rectangles can you find in this picture?". We use answers to this question as an indicator of ability. To obtain an indicator of self-confidence, participants are then asked "What do you think is the probability you gave the right answer?". They are allowed to select one of five possible answers, ranging from (1) "less than 20%" to (5) "more than 80%". We also need, crucially, to elicit individuals' expectations of future stability or changefulness. The main question for this is phrased as follows: "To what extent do you agree with the following statement: I expect a great deal of change in the way I live in the future, with many new challenges as well as opportunities". Participants can select one of five possible answers, ranging from (1) "strongly disagree" to (5) "strongly agree". This question attempts to capture all the possible influences on individuals' expectations over future stability or "dynamism". We code the corresponding variable $EXPDYNAMICLIFE$. We also include three other questions that focus on expectations of specific events: how likely do you think it is that (i) you will move to another city/village; (ii) you will change job (school); (iii) you will spend time abroad. We code the corresponding variables $EXPCHANGETOWN$, $EXPJOBCHANGE$ and $EXPABROAD$.

Table 1 presents results obtained from odered probit regressions for our self-confidence indicator.

Column 1 shows the results when we use the variable $EXPDYNAMICLIFE$ to capture expectations of future changefulness ("dynamism"), and a variety of controls. The results are

Table 1: Regression Results: Cross-Sectional Evidence

	Dependent Variable is Self-Confidence		
	(1)	(2)	(3)
EXPERIENCE	0.142***	0.140***	0.140***
	(0.049)	(0.049)	(0.049)
TIMEABROAD	0.035	0.020	0.020
	(0.022)	(0.023)	(0.023)
NSINGLE	0.082	0.085	0.086
	(0.091)	(0.092)	(0.092)
AGE	0.010***	0.011***	0.010***
	(0.002)	(0.003)	(0.002)
MALE	0.235***	0.234***	0.235***
	(0.047)	(0.047)	(0.047)
RURAL	−0.032	−0.022	−0.021
	(0.049)	(0.050)	(0.050)
MARRIED	0.110	0.114	0.113
	(0.070)	(0.070)	(0.070)
PRIMARY	−0.043	−0.040	−0.037
	(0.300)	(0.300)	(0.300)
JUNIOR	0.152	0.155	0.161
	(0.291)	(0.292)	(0.292)
SENIOR	0.215	0.212	0.217
	(0.292)	(0.292)	(0.292)
POLY	0.323	0.318	0.322
	(0.294)	(0.294)	(0.294)
UNI	0.421	0.400	0.405
	(0.295)	(0.295)	(0.295)
STUDENT	0.113	0.103	0.093
	(0.090)	(0.093)	(0.091)
PRIVATE	0.084	0.072	0.080
	(0.070)	(0.071)	(0.070)
HOUSEWIFE	0.133	0.127	0.135
	(0.083)	(0.083)	(0.083)
UNEMPLOYED	0.010	0.014	0.020
	(0.102)	(0.103)	(0.102)
SELFEMPLOYED	0.017	0.007	0.014
	(0.067)	(0.068)	(0.067)
NGO	−0.010	−0.014	−0.008
	(0.160)	(0.160)	(0.160)
PEASANT	−0.017	−0.009	−0.004
	(0.153)	(0.153)	(0.153)
OTHEROCC	0.068	0.060	0.065
	(0.117)	(0.117)	(0.117)
RETIRED	0.062	0.075	0.058
	(0.081)	(0.086)	(0.081)
WRONGSQ	$-1.59e-07$	$-1.57e-07$	$-1.57e-07$
	(1.39e-07)	(1.39e-07)	(1.39e-07)
RIGHT	0.196***	0.197***	0.197***
	(0.051)	(0.051)	(0.051)
EXPDYNAMIC E	0.050***	0.034*	0.038**
	(0.019)	(0.020)	(0.019)
EXPCHANGET N		0.005	
		(0.016)	
EXPJOBCHANGE		0.011	
		(0.018)	
EXPABROAD		0.037**	0.039**
		(0.018)	(0.018)
Pseudo R-squared	0.018	0.019	0.019
No of obs	3175	3175	3175

Note: ** significant at the 5 % level, *** significant at the 1 % level

consistent with the empirical prediction: *participants who expect to experience greater change in the future are significantly more confident.* Among the controls, we find the following significant influences: men tend to be more confident than women, older respondents more confident than younger respondents, and more experienced participants more confident than less experienced ones. This holds controlling for actual ability (which, as might be expected, has a significant positive coefficient).

Columns 2 and 3 present results for the same specification but also including some or all the other variables capturing expectations. Adding all these variables is likely to generate significant collinearity; moreover, we find that it increases explanatory power hardly at all. Two of the additional variables are insignificant when we include all of them (column 2); when we drop these, $EXPDYNAMICLIFE$ and $EXPABROAD$ are both positive and significant (column 3), suggesting that the possibility of spending time abroad can be an important component of expected future changefulness. Overall, these results are in line with previous findings concerning the relationship between gender and self-confidence[24]; moreover, they highlight a novel relationship between self-confidence and expected future change, consistent with our model.

5.2 Cross-country evidence

Much of our motivating discussion in section 2 focused on the difference between the United States and Japan, which has attracted considerable attention in the psychology literature. We now investigate evidence for other countries as well. As we have seen in the previous section, the evidence for China appears to be consistent with our model. What about other countries? The main challenge in using available data across countries to investigate this is the paucity of information concerning key variables in our model. For self-confidence, to the best of our knowledge, the most comprehansive source is the study by Schmitt and Allick (2005), who provide average (mean) self-competence scores for a large sample of countries. These were obtained by administering the Rosenberg Self-Esteem Scale (described in section 2), where the self-competence component of self-esteem measures individuals' sense of being "confident, capable, and efficacious". Participants' responses were provided anonymously in all countries. This large-scale international study was carried out in the year 2000, with a total of 16998 participants.

It is straightforward to verify that our prediction concerning average self-confidence holds when we compare Japan and the United States: the average self-competence score in Japan is 13.33, while in the United States it is 17.21. But what about the other countries in the Schmitt and Allick sample? To begin to explore this question we need to find some proxies for the expected degree of stability or changefulness of the economic and social environment in each country. In general, expectations are likely to reflect a country's experience of changefulness or stability in the past, but also forward-looking influences. For this reason, wherever possible, we collected data on the relevant variables, discussed below, over the period 1985-2013, since our

[24]See, e.g., Bengtsson, Persson and Willenhag (2005).

data on self-confidence is a cross-section for the year 2000. Thus past experience is captured by the period 1985-1999, while realized values for the period 2001-2013 proxy for forward-looking influences on expectations. Using the full period (1985-2013) can also be motivated in the light of our discussion of multiple equilibria with endogenous π in section 4.3.

We consider several possible proxies. The first is the average unemployment rate. This is a widely reported economic indicator, likely to influence many people's expectations: a low average rate of unemployment suggests a more stable environment, in which individuals are less likely to lose their current job. We calculate a long-term average (annual) unemployment rate, denoted by U. Second, we looked for a proxy that could capture a broad set of influences on people's expectations of stability or changefulness, distinct from unemployment. We found an indicator, the Global Peace Index (GPI, see footnote 8), which reflects the importance of both internal (e.g. violence, crime) and external (e.g. war) conflict: this causes disruption and change, often confronting individuals with the need to decide whether to invest in new projects and new relationships. We denote this conflict indicator as C, also calculated as the annual average for the period for which data is available. The GPI has only been collected since 2008: we therefore rely on realized values of the GPI being sufficiently good proxies for prior expectations. While this makes C a potentially less satisfactory proxy than U in this respect, the two variables capture different aspects of stability and changefulness: it is therefore important to consider both. Moreover, both variables have the advantage that they would not normally be thought of as having a positive influence on self-confidence: if anything, intuition would suggest that higher rates of unemployment, crime and violence would be associated with higher average self-confidence. Thus finding a positive relationship would seem intuitively surprising - but entirely consistent with our model. We construct a simple indicator of expected changefulness, denoted by $CHANGE$, which is just the product $U * C$. Finally, we looked for other variables that might be expected to influence self-confidence at the country level, to use as controls and thereby alleviate as much as possible any omitted variable bias. We calculate long-term average (annual) real GDP per capita, denoted GDP, and an indicator of a country's education level, denoted EDU[25]. Both these variables might have a positive influence on average self-confidence. In addition, we include a set of continent-level dummies, to capture a variety of other influences on self-confidence, including any long-run historical and cultural factors beyond the scope of our model.

Schmitt and Allick compute a "Metatraitedness Index" for each country, measuring the extent to which respondents answered the different items in the Scale consistently. They identify countries with a value of this index below 1.4 as having a low degree of consistency. We therefore focus on the countries with a Metatraitedness Index above 1.4.[26] Table 2 shows the countries used in our analysis, and gives for each country the mean self-competence score (MSC), the

[25] We use mean years of schooling over the period 1998-2000.

[26] This excludes the following countries from our sample: Bangladesh, Bolivia, Botswana, the Democratic Republic of the Congo, Ethiopia, Malaysia, Mexico, Romania, Tanzania, and Zimbabwe (see Schmitt and Allick (2005), pp.628-9).

Table 2:

COUNTRY	MSC	CHANGE	U	C
Argentina	16.74	0.233	0.128	1.817
Australia	16.84	0.098	0.069	1.435
Austria	16.04	0.08	0.063	1.267
Belgium	15.74	0.157	0.115	1.363
Brazil	16.19	0.146	0.071	2.058
Canada	16.07	0.11	0.083	1.328
Chile	17.42	0.13	0.083	1.565
Croatia	16.93	0.329	0.201	1.638
Cyprus	16.83	0.078	0.044	1.784
Czech Rep.	15.41	0.106	0.076	1.399
Estonia	16.76	0.174	0.102	1.712
Finland	16.87	0.125	0.096	1.295
France	16.08	0.17	0.095	1.798
Germany	16.41	0.12	0.084	1.433
Greece	16.81	0.207	0.109	1.897
India	16.09	0.104	0.04	2.607
Indonesia	15.66	0.111	0.059	1.88
Israel	17.5	0.233	0.081	2.864
Italy	16.51	0.165	0.099	1.668
Japan	13.33	0.049	0.037	1.328
Latvia	15.68	0.176	0.1	1.766
Lebanon	16.34	0.199	0.077	2.57
Lithuania	16.15	0.16	0.092	1.745
Morocco	15.54	0.242	0.13	1.868
Netherlands	16.69	0.094	0.061	1.555
New Zealand	16.58	0.089	0.072	1.226
Peru	17.49	0.169	0.079	2.136
Philippines	16.02	0.219	0.09	2.43
Poland	16.36	0.211	0.135	1.566
Portugal	16.33	0.109	0.077	1.421
Slovakia	15.83	0.229	0.148	1.542
Slovenia	17.13	0.155	0.114	1.358
South Korea	15.9	0.06	0.034	1.788
Spain	16.69	0.264	0.167	1.581
Switzerland	14.3	0.033	0.026	1.284
Turkey	17.09	0.218	0.09	2.426
United Kingdom	16.36	0.118	0.068	1.748
United States	17.21	0.134	0.061	2.173

Source: for U, IMF; for C, Institute for Economics and Peace

two proxies U and C, and the indicator $CHANGE$ of expected changefulness. According to this indicator, the three most "stable" countries in the sample are: Switzerland (0.033), Japan (0.049), and South Korea (0.06). The three least "stable" countries are: Croatia (0.329), Spain (0.264), and Morocco (0.242). This suggests that the indicator does capture part of the notion of "stability" in our model - albeit very imperfectly. It is interesting therefore to examine its relationship with average self-confidence.

Table 3: Regression Results: Cross-Country Evidence (1985-2013)

	Dependent Variable is Mean Self-competence					
	(1)	(2)	(3)	(4)	(5)	(6)
CHANGE	4.92**		5.16**		4.44**	
	(1.92)		(2.29)		(1.92)	
U		7.42**		5.04		6.03*
		(3.39)		(3.90)		(3.53)
C		0.68**		1.36***		0.85**
		(0.30)		(0.39)		(0.40)
GDP			$-7.83e-6$	$-2.97e-6$	$3.76e-6$	$4.84e-6$
			$(1.34e-5)$	$(1.24e-5)$	$(1.16e-5)$	$(1.15e-5)$
EDU			$2.97e-5$	0.01	0.02	0.24
			(0.06)	(0.05)	(0.05)	(0.05)
Asia			-0.39	−1.10**	0.11	-0.33
			(0.35)	(0.44)	(0.32)	(0.49)
N. America			0.60	0.21	0.38	0.21
			(0.58)	(0.54)	(0.48)	(0.48)
S. America			0.43	0.18	0.67*	0.52
			(0.46)	(0.44)	(0.38)	(0.41)
Africa			−1.39*	−1.43*	-1.1	−1.15*
			(0.81)	(0.73)	(0.68)	(0.66)
Oceania			0.88	0.84	0.71	0.72
			(0.78)	(0.70)	(0.65)	(0.63)
Adj R-squared	0.13	0.16	0.18	0.33	0.12	0.16
No of obs	38	38	38	38	37	37

Note: * significant at the 10 % level, ** significant at the 5 % level , *** significant at the 1% level

Tables 3 and 4 present regressions with MSC as the dependent variable, the first using available data for the period 1985-2013, the second data available for 1985-2000.[27] Consider first Table 3. Column 1 examines the relationship between the mean self-competence score

[27]With the exceptions noted earlier, namely that the GPI is only available from 2008, while the education control, mean years of schooling, is the average for 1998-2000.

MSC and our indicator $CHANGE$; column 2 the relationship with each of the components U and C; columns 3 and 4 do the same as the first two columns but including all the controls. We do find our predicted positive relationship with $CHANGE$, and with each of the components U and C. The positive relationship between average self-confidence and our indicator $CHANGE$ is highly significant and robust to the inclusion of all the controls. *Thus more "dynamic" (changeful) countries have significantly higher average self-confidence.* To what extent is this result due to the presence of Japan in the sample? We investigate this question by estimating the same specifications as in Columns 3 and 4 without Japan. The results for the set of 37 remaining countries are shown in columns 5 and 6. Our main findings are clearly robust to the exclusion of Japan: the relationship between self-confidence and "dynamism" ($CHANGE$) remains positive and significant.

As a further robustness check, Table 4 presents results analogous to those in Table 3, for the period 1985-2000. These results confirm our main findings.

6 Conclusions

Comparisons across cultures provide a very valuable opportunity for understanding how economics and psychology interact. In this paper, we have focused on self-confidence, which has received considerable attention in the psychology literature but far less attention in the economics literature. We have developed a model that can shed light on the observed variation in overconfidence across countries, and also across individuals within countries. The model helps to understand when and why overconfidence may emerge as a motivational mechanism. It also identifies some important costs associated with the use of this mechanism in equilibrium: reliance on overconfidence means that in equilibrium the incentives to exert improvement effort may be reduced for the individuals who could benefit most from such effort, and similarly for investment in new projects.

We have presented some initial evidence on the cross-country and cross-sectional implications of the analysis: there is much scope for future work on this. More broadly, we see this paper as contributing to a very promising research agenda, which will shed light on endogenized economic and psychological differences across and within cultures.

7 Appendix

7.1 Proof of Proposition 1

Proof. Note that the sign of X_1 depends on whether $\phi^*(\theta^{\max} - \theta^*)$ is greater or smaller than $\phi_L(\theta^{\max} - \theta_L)$. While $r^* \in [q, 1]$ in our analysis, note that $\phi^*(\theta^{\max} - \theta^*) = \phi_L(\theta^{\max} - \theta_L)$ when r^* takes the value zero. Moreover, $\phi^*(\theta^{\max} - \theta^*)$ is strictly concave in r^*, as

$$\frac{d^2\phi^*(\theta^{\max} - \theta^*)}{dr^{*2}} = -2\left(\theta_H - \theta_L\right)\left(\phi_H - \phi_L\right) < 0.$$

Therefore, we have three cases to consider.

Table 4: Regression Results: Cross-Country Evidence (1985-2000)

	Dependent Variable is Mean Self-competence					
	(1)	(2)	(3)	(4)	(5)	(6)
CHANGE	4.25**		5.09**		4.36**	
	(1.70)		(1.87)		(1.58)	
U		6.75**		5.92*		6.16**
		(2.86)		(2.92)		(2.66)
C		0.70**		1.42***		0.95**
		(0.30)		(0.37)		(0.38)
GDP			$-12.8e-6$	$-4.92e-6$	$-4.14e-7$	$1.78e-6$
			$(1.26e-5)$	$(1.14e-5)$	$(1.11e-5)$	$(1.07e-5)$
EDU			$4.89e-3$	5.64e-3	0.02	0.02
			(0.06)	(0.05)	(0.05)	(0.05)
Asia			-0.37	-1.06^{**}	0.10	-0.4
			(0.33)	(0.39)	(0.31)	(0.44)
N. America			0.69	0.27	0.45	0.25
			(0.55)	(0.50)	(0.47)	(0.46)
S. America			0.46	0.22	0.67*	0.50
			(0.43)	(0.40)	(0.37)	(0.38)
Africa			-1.77^{**}	-1.68^{**}	-1.46^{**}	-1.45^{**}
			(0.79)	(0.69)	(0.67)	(0.63)
Oceania			0.72	0.86*	0.59	0.7
			(0.54)	(0.48)	(0.45)	(0.44)
Adj R-squared	0.12	0.18	0.24	0.42	0.18	0.25
No of obs	38	38	38	38	37	37

Note: * significant at the 10 % level, ** significant at the 5 % level, *** significant at the 1 % level

(1) $\min\left\{\phi_H(\theta^{\max}-\theta_H),\bar{\phi}(\theta^{\max}-\bar{\theta})\right\}>\phi_L(\theta^{\max}-\theta_L)$:

In this case, we have $X_1<0$, and $X(r^*,\pi)>0$ for all r^*. Thus, there is a unique PBE with $h^*=0$.

(2) $\phi_L(\theta^{\max}-\theta_L)>\bar{\phi}(\theta^{\max}-\bar{\theta})>\phi_H(\theta^{\max}-\theta_H)$:

In this case, we have $X_1>0$ for all r^*.

It is clear that $X(r^*,\pi)$ is continuous and decreasing in π for all $r^*\in[q,1]$ as X_1 and X_2 are both positive. Further, we have that $X(r^*,1)<0$ and $X(r^*,0)>0$ for all r^*. Thus there is a unique $\pi^*(r^*)$ such that $X(r^*,\pi^*(r^*))=0$, and $X(r^*,\pi)>0$ for all $\pi<\pi^*(r^*)$, and $X(r^*,\pi)<0$ for all $\pi>\pi^*(r^*)$ for all r^*.

By the implicit function theorem, we have that

$$\begin{aligned}\frac{d\pi^*}{d\theta^*}&=-\frac{\frac{dX(r^*,\pi)}{d\theta^*}}{\frac{dX(r^*,\pi)}{d\pi}}\\&=\frac{(1-\pi)\beta\delta V^2(\delta\theta_L-\beta\delta\theta^*)f-\pi\beta\delta\phi^*W^2[\delta\phi(\theta^{\max}-\theta_L)-\beta\delta\phi^*(\theta^{\max}-\theta^*)]g}{\int_{\beta\delta\phi^*(\theta^{\max}-\theta^*)W}^{\beta\delta\phi(\theta^{\max}-\theta_L)W}\{\delta\phi_L(\theta^{\max}-\theta_L)W-k\}dG(k)+\int_{\beta\delta\theta_LV}^{\beta\delta\theta^*V}\{\delta\theta_LV-c\}dF(c)}\end{aligned}$$

where the denominator is always positive. Notice that the sign of the numerator is ambiguous. Thus, our proof here is not a straightforward extension of the proof of Proposition 2 in Bénabou and Tirole (2002).

There are three cases to consider.

(I) For π sufficiently small, the numerator is positive. Since the numerator is decreasing in θ^*, formally, we have $\frac{d\pi^*}{d\theta^*}>0$ for

$$\pi<\pi_1\equiv\frac{V^2(\theta_L-\beta\theta_H)f}{V^2(\theta_L-\beta\theta_H)f+\phi_HW^2[\phi_L(\theta^{\max}-\theta_L)-\beta\phi_H(\theta^{\max}-\theta_H))]g}.$$

For values of π satisfying this condition, $\pi^*(r^*)$ is increasing in r^*, since θ^* is increasing in r^*.

Since

$$\begin{aligned}&X(q,\pi^*(q))\\&=-\pi^*(q)\int_{\beta\delta\bar{\phi}(\theta^{\max}-\bar{\theta})W}^{\beta\delta\phi_L(\theta^{\max}-\theta_L)W}\{\delta\phi_L(\theta^{\max}-\theta_L)W-k\}dG(k)+(1-\pi^*(q))\int_{\beta\delta\theta_LV}^{\beta\delta\bar{\theta}V}\{\delta\theta_LV-c\}dF(c)\\&=0,\end{aligned}$$

we have

$$\pi^*(q)=\frac{\int_{\beta\delta\theta_LV}^{\beta\delta\bar{\theta}V}\{\delta\theta_LV-c\}dF(c)}{\int_{\beta\delta\bar{\phi}(\theta^{\max}-\bar{\theta})W}^{\beta\delta\phi_L(\theta^{\max}-\theta_L)W}\{\delta\phi_L(\theta^{\max}-\theta_L)W-k\}dG(k)+\int_{\beta\delta\theta_LV}^{\beta\delta\bar{\theta}V}\{\delta\theta_LV-c\}dF(c)}.$$

Similarly, we have

$$\pi^*(1)=\frac{\int_{\beta\delta\theta_LV}^{\beta\delta\theta_HV}\{\delta\theta_LV-c\}dF(c)}{\int_{\beta\delta\phi_H(\theta^{\max}-\theta_H)W}^{\beta\delta\phi_L(\theta^{\max}-\theta_L)W}\{\delta\phi(\theta^{\max}-\theta_L)W-k\}dG(k)+\int_{\beta\delta\theta_LV}^{\beta\delta\theta_HV}\{\delta\theta_LV-c\}dF(c)}.$$

It is straightforward to verify that both $\pi^*(q)$ and $\pi^*(1)$ are greater than π_1. Thus we must have $X(r^*, \pi) > 0$ for all r^*. Therefore, there is a unique PBE with $h^* = 0$.

(II) The numerator is negative for π sufficiently large. Since the numerator is decreasing in θ^*, formally, we have $\frac{d\pi^*}{d\theta^*} < 0$ for

$$\pi > \pi_2 \equiv \frac{V^2\left(\theta_L - \beta\overline{\theta}\right) f}{V^2\left(\theta_L - \beta\overline{\theta}\right) f + \bar{\phi} W^2[\phi_L(\theta^{\max} - \theta_L) - \beta\bar{\phi}(\theta^{\max} - \overline{\theta}))]g}$$

where $\pi_2 > \pi_1$.

For values of π satisfying this condition, $\pi^*(r^*)$ is decreasing in r^*, since θ^* is increasing in r^*. Moreover, it is straightforward to verify that $\pi^*(q) > \pi_2$.

We therefore have the following results when $\pi > \pi_2$.

(i) If $\pi > \max\{\pi^*(q), \pi^*(1)\}$, $X(r^*, \pi) < 0$ for all r^*. Therefore, there is a unique PBE with $h^* = 1$.

(ii) If $\pi < \min\{\pi^*(q), \pi^*(1)\}$, we have that $X(r^*, \pi) > 0$ for all r^*. Therefore, there is a unique PBE with $h^* = 0$.

(iii) If $\min\{\pi^*(q), \pi^*(1)\} < \pi < \max\{\pi^*(q), \pi^*(1)\}$, since $\pi^*(r^*)$ is a decreasing function, the inverse function $r^*(\pi)$ is also decreasing. Thus $X(r^*, \pi)$ has the same sign of $r^*(\pi) - r^*$, implying that there are two PBEs: (a) $r^* = 1$ $(h^* = 1)$ with $r^* > r^*(\pi)$, and (b) $r^* = q$ $(h^* = 0)$ with $r^* < r^*(\pi)$.

(III) For intermediate values of $\pi \in [\pi_1, \pi_2]$, there is a threshold value $\theta(\pi)$ such that when $\theta^* < \theta(\pi)$, $\frac{d\pi^*}{d\theta^*} > 0$,and when $\theta^* > \theta(\pi)$, $\frac{d\pi^*}{d\theta^*} < 0$. Thus $\pi^*(r^*)$ increases in r^* as long as r^* is smaller than some cutoff value $\overline{r}$ and decreases thereafter.

We therefore have the following results when $\pi \in [\pi_1, \pi_2]$.

(i) If $\pi < \min\{\pi^*(q), \pi^*(1)\}$, we have that $X(r^*, \pi) > 0$ for all r^*. Therefore, there is a unique PBE with $h^* = 0$.

(ii) If $\min\{\pi^*(q), \pi^*(1)\} < \pi < \max\{\pi^*(q), \pi^*(1)\}$, there are two PBEs: (a) $r^* = 1$ $(h^* = 1)$, and (b) $r^* = q$ $(h^* = 0)$.

We now let $\pi_H \equiv \max\{\pi^*(q), \pi^*(1)\}$, and $\pi_L \equiv \min\{\pi^*(q), \pi^*(1)\}$.

(3) $\bar{\phi}(\theta^{\max} - \bar{\theta}) > \phi_L(\theta^{\max} - \theta_L) > \phi_H(\theta^{\max} - \theta_H)$:

When $r^* = q$, we have $X_1 < 0$, and $X(q, \pi) > 0$. Thus, there is a PBE with $h^* = 0$.

When $r^* = 1$, we have $X_1 > 0$. Let $\pi_M \equiv \pi^*(1)$ be the threshold value such that for $\pi_M > \pi$, $X(1, \pi) > 0$ and for $\pi_M < \pi$, $X(1, \pi) < 0$. Thus, there is a second PBE with $h^* = 1$ when $\pi > \pi_M$. ■

7.2 Online survey

The survey was conducted on a WeChat platform in China, using the following format:

7.2.1 Questionnaire

Before you begin to answer the questions in the survey, please take a look at the following instructions:

Thanks for your participation in the online survey which is organized by the Department of Economics in the Hong Kong University of Science and Technology and Shenzhen Quantum Cloud Technology Company. As part of the survey, you will have the opportunity to participate in a picture-based test which focuses on logical reasoning and numerical ability. It does not require any prior knowledge or preparation.

The test will consist of 1 picture question: you can take up to 60 seconds to answer the question. We will also ask you a few general questions before and after the test.

A The first part

Q1 Introduction

(1) I'm willing to continue the survey; (2) I am not interested in it, end the survey.

Q2. What is your age?_ _ _ _ _

Q3. What is your gender?

(1) Male (2) Female

Q4. Are you:

(1) single (2) married (3) divorced or separated (4) widowed

Q5. What's your education?

(1) No formal schooling (2) Preliminary school (3) Junior high school

(4) Senior high school or equivalent technical high school

—— if you chose the above choices, turn to question Q6

(5) Polytechnic college (6) University and above

—— if you choose (5) or (6), turn to question Q7

Q6. How often do you use logical reasoning ability in your daily work and life?

(1) Use very frequently (2) Use sometimes (3) Rarely use (4) No need at all

Q7. What's your major for your highest degree?

(1) science major (e.g. mathematics, physics, chemistry and biology)

(2) engineering major (e.g. computer science, electronics, mechanism engineering, environment engineering)

(3) business major (e.g. economics, finance, marketing, accounting)

(4) social science major (e.g. psychology, sociology, political science, law and journalism)

(5) human science major (e.g. literature, history, philosophy and foreign language)

(6) others, please specify

(7) medical major (e.g. clinical medicine; clinical pharmacology)

Q8. What's you occupation?

(1) student

—— if you chose (1), turn to question Q10

(2) civil servant; public institution /state or publicly owned enterprise employee

(5) private or foreign enterprise employee (6) housewife (7) unemployed (8) self-employed entrepreneur

(10) other, please specify (11) NGO employee (15) Rural worker

——if you chose the above choices, turn to question Q9

(9) Retired

——if you chose (9), turn to question Q11

Q9. How likely do you think it is you will change your job in the future?

(1) very unlikely (2) quite unlikely (3) neither unlikely nor likely

(4) quite likely (5) very likely

Q10. How likely do you think it is that you will transfer from your original school or original major to another school or another major?

(1) very unlikely (2) quite unlikely (3) neither unlikely nor likely

(4) quite likely (5) very likely

Q11. Where do you live?

(1) city or town (2) village

Q12. During your life, how many times have you moved to different towns or villages within China?

- - - - - -

Q13. How likely do you think it is that you will move to different cities and villages within China in the future?

(1) very unlikely (2) quite unlikely (3) neither unlikely nor likely

(4) quite likely (5) very likely

Q14. Have you ever lived outside China?

(1) Yes

(2) No——if you chose(2), turn to question Q16

Q15. How long in total have you lived outside China?

(1) less than three months (2) three months to one year (3) one year to three years (4) more than three years

Q16. How likely do you think it is that you will spend time abroad in the future?

(1) very unlikely (2) quite unlikely (3) neither unlikely nor likely

(4) quite likely (5) very likely

Q17. To what extend would you agree with the following statement: I expect a great deal of change in the way I live in the future, with many new challenges as well as opportunities

(1) Strongly disagree (2) disagree (3) neither agree nor disagree (4) agree (5) strongly agree

B The second part Picture-based test

Thanks for answering the above questions. Are you ready for the test? Just click the "start" button to begin.

[Show the question up to 60 seconds]

Q18 Introduction of test [picture]

Q19 How many squares and rectangles can you find in the above picture?

- - - - - - - - - -

C The third part

Q20 .What do you think is the probability that you got the right answer?

(1) less than 20% (2) between 20% and 40% (3) between 40% and 60% (4) between 60% and 80% (5) more than 80%

Q21. How well do you think you did relative to other WeChat users?

(1) top 20% (2) between top 40% and top 20% (3) between top 60% and top 40% (4) between top 80% and top 60% (5) bottom 20%.

Q22. Have you ever participated in a similar test before?

(1) yes (2) no

Thanks again for your participation

7.2.2 List of variables used in the analysis

The following variables were used in the regressions (the corresponding items in the questionnaire are given in brackets):

CONF Indicator of belief about likelihood of having given correct answer to test question (Q20)

RIGHT Dummy: gave correct answer to test question (Q19)

WRONGSQ Difference between actual and correct answer, squared (Q19)

EXPDYNAMICLIFE Indicator of belief about likelihood of a great deal of change in the future (Q17)

EXPABROAD Indicator of belief about likelihood of spending time abroad in the future (Q16)

EXPCHANGETOWN Indicator of belief about likelihood of moving to different towns or villages within China (Q13)

EXPJOBCHANGE Indicator of belief about likelihood of job/school/degree major change (Q9 & Q10)

TIMEABROAD Indicator for time lived outside China (Q14 & Q15)

AGE Actual age (Q2)

MALE Dummy (Q3)

EXPERIENCE Dummy: has taken a similar test before (Q22)

RURAL Dummy: lives in a village (Q11)

MARRIED Dummy (Q4)

NSINGLE Dummy for divorced, separated and widowed

PRIMARY Dummy for education level: Preliminary school (Q5)

JUNIOR Dummy for education level: Junior high school (Q5)

SENIOR Dummy for education level: Senior high school (Q5)

POLY Dummy for education level: Polytechnic (Q5)

UNI Dummy for education level: University (Q5)

STUDENT Dummy (Q8)
PRIVATE Dummy: private or foreign enterprise employee (Q8)
HOUSEWIFE Dummy (Q8)
UNEMPLOYED Dummy (Q8)
SELFEMPLOYED Dummy (Q8)
NGO Dummy: NGO employee (Q8)
PEASANT Dummy: rural worker (Q8)
OTHEROCC Dummy: other occupation (Q8)
RETIRED Dummy (Q8)

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