# Culture, Caution, and Trust

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**Abstract**

Trust is an important determinant of economic development. Understanding its origins is therefore critical. We develop a principal-agent model with heterogeneous players to determine the aggregate amount of trustworthiness and trust in a society. People are distributed according to their preference toward *caution*, which we model as loss aversion. The first two moments of the distribution across principals and agents – along with institutional quality – are critical to the process by which trustworthiness and trust are formed. A direct effect suggests that more caution leads to less societal trust. An indirect effect of greater caution, working through trustworthiness, leads to *more* trust. Paradoxically, the net effect is almost always positive. The results are similar when we use expected utility theory, but social preferences like betrayal aversion may temper the results.

## 1 Introduction

People who trust leave themselves vulnerable to losses. It would seem to follow that more cautious people trust less. Even if that were true, does it follow that more cautious *societies* trust less? Our answer is: rarely. Because more cautious societies are also more trustworthy, they almost surely trust *more* - not less. The precise relationship between caution and trust depends on the *dispersion* of caution relative to key institutional parameters, but the relationship is almost always positive. Our model can account for the fact that the United States is

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less trusting than Japan, even though Japan is more cautious, and why in Persian Gulf States, there is very little trust despite high trustworthiness.

We begin with a definition of *caution*. There are two main ways that *individual* caution has been modeled: expected utility theory and prospect theory.[1] In the former, a more cautious person is one with greater *risk aversion*; in the latter, caution is reflected in a person's *loss aversion*. Conceptually, either may be used, but in what follows, we adopt loss aversion because it makes it possible to find closed-form solutions to key constructs and simplifies the exposition.[2]

This leads to the next issue: how do we model *societal* caution? We assume that individuals in a society are distributed by their caution – their loss aversion – according to a well-defined density function. We think of the first two moments of the distribution within a country – the mean $\mu$ and the variance $\sigma^2$ – as reflecting fundamental facets of culture. For example, Japanese culture is considered to be very cautious (high $\mu$) and homogeneous (low $\sigma$). US culture is thought to be the opposite – entrepreneurial (low $\mu$) and diverse or heterogeneous (high $\sigma$).[3]

It is well-documented in the experimental and field research that there is considerable heterogeneity in willingness to trust and in risk attitudes across individuals within a country (Andreoni and Miller, 2002; Harrison et al., 2007; Schechter, 2007, Bohnet et al., 2008, Abdellaoui et al., 2008). Even in groups of college students, responses are very different, suggesting that $\sigma^2$ is not close to zero. As noted below, there is also considerable heterogeneity across countries.

To analyze how the mean and variance of caution in a society determine trust, we rely on a simple game between a principal and an agent. Principals extend trust and agents respond by being trustworthy or not. We first assume that principals and agents *within a country* are drawn from the same distribution of loss aversion. In this case, we find that when cultural

[1] The term is due to Kahneman and Tversky (1979), but they note many antecedents, like Allais (1953) and Markowitz (1952).

[2] We show how the model works under expected utility theory in Section 6.2 and Appendix B.

[3] We will define cultural homogeneity and heterogeneity by the variance of the distribution of loss aversion. We assume that amongst cultures that are more diverse along ethnic or religious dimensions, attitudes toward losses will be less widely shared than in more ethnically or religiously homogeneous cultures.

heterogeneity in attitudes toward losses $\sigma$ is the same *across countries*, more cautious (higher $\mu$) societies almost always show *greater* trust, not less. This happens because the more cautious country is also more trustworthy. What is interesting is that this indirect effect of raising the chance that trust will be met with honesty outweighs the direct effect of caution on trust. It is more difficult to generalize about the effect of diversity. If average caution $\mu$ is the same in two countries, the more homogeneous society trusts more *if and only if* $\mu$ *is relatively high*.

We also consider what happens when principals and agents are instead drawn from different distributions within a country. For example, principals would be more cautious than agents if they are subject to *betrayal aversion* as proposed by Bohnet and Zeckhauser (2004) and Bohnet et al. (2008) – the notion that losses due to dishonesty are worse than those from nature. If the distribution of loss aversion for principals is completely independent of the distribution for agents, then we get a more conventional result: when principals become more cautious and agents do not change, there is *less* trust.

Our work is most closely related to the experimental literature on trust. Much of the work by experimentalists has been designed to discover how much of the trust decision is rational. Do people really calculate the expected return from trusting, incorporating their personal risk attitude and the likelihood of the agent's being trustworthy? Do social preferences such as kindness, altruism, warm glow, or the fear of betrayal also play a role? Although very little is settled, there is evidence that trust does depend, at least in part, on players' expectation of trustworthiness (Ashraf et al., 2006). There is also evidence that trustworthiness is influenced by fear of punishment (Karlan, 2005).[4] These two elements are central to our game.

Findings from several recent cross-country experiments dealing with trust point to a role for culture. In a framework similar to ours, Bohnet et al. (2010) document differences in reference points for levels of trustworthiness. They claim this might explain why citizens of the Gulf region are so much less trusting than their U.S. and European counterparts. Bohnet et al. (2008) find evidence of betrayal aversion and trust differences across six countries – Brazil, China, Oman, Switzerland, Turkey, and the United States. Buchan and Croson (2004)

[4]Trustworthiness may also be affected by notions of fairness (Rabin, 1993; Fehr and Schmidt, 1999).

examine cross-country differences in trust and trustworthiness and find significant differences between the U.S. and China. Henrich et al. (2001) conduct ultimatum games around the world for fifteen different groups and find that behaviors differ across cultures. They conjecture that social institutions and norms about cultural fairness are responsible for the differences. Glaeser et al. (2000) also find a cultural component to the level of trust. Hofstede and Hofstede (2010) document differences in attitudes toward uncertainty around the world. The Japanese, they find, are extremely cautious, with an uncertainty avoidance index of 90. By comparison, the score for the United States is 46. There is ample evidence that cultural differences matter in game situations.[5]

The paper is organized as follows. In Section 2, we set out the trust game played by principals and agents. In Section 3, we solve the game for equilibrium trustworthiness and trust and show how they depend on the parameters of the distribution of loss aversion as well as the quality of institutions. In Section 4, we provide a comparative statics analysis of how changes in the mean, variance, and institutional quality affect trustworthiness and trust. In Section 5, we conduct numerical analyses. In Section 6, we address how betrayal aversion affects our results, and indicate how the results would change if we used expected utility theory instead. In Section 7, we offer some concluding comments.

## 2 The Game

There are two types of players: a principal (or trustor) and an agent (trustee). The former decides whether or not to initiate a contract to transact, and the latter decides whether or not to honor the contract. Honoring the contract is the same as being trustworthy. The principal can always work alone and earn an income of 1. A successfully completed transaction between the principal and agent yields an income of $1 + y$ for each of them. If the agent cheats, she transfers the sum $\alpha$ from the principal to herself. Thus, in the event of cheating, the principal

[5] There is also a literature that looks at culture and economic performance. See, for example, Tabellini (2008a), Guiso et al. (2006) and Buchan (2009). The earliest literature sought to link economic growth to trust and other forms of social capital. See, for example, Knack and Keefer (1997), La Porta et al. (1997), Temple and Johnson (1998), Hall and Jones (1999), Acemoglu et al. (2001), and Zak and Knack (2001).

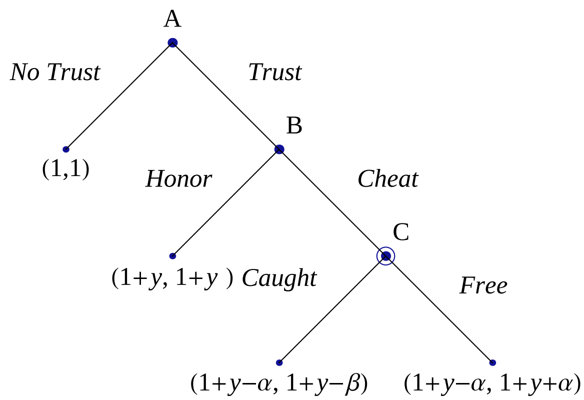


Figure 1: Game Structure

gets $1 + y - \alpha$. For simplicity, we do not allow cheating to cause a deadweight loss, so that $2+2y$ is produced whether there is cheating or not. We also assume that:

$$y < \alpha < 1 + y \tag{1}$$

so that every principal prefers working alone to being cheated.

The payoff to the agent, if she decides to cheat, depends on whether or not she is caught. If she is not, she receives $1 + y + \alpha$. If she is caught, she is penalized and receives $1 + y + \alpha - \phi$, where $\phi$ is the penalty. Define:

$$\beta \equiv \phi - \alpha \tag{2}$$

Here, we assume:

$$0 < \beta < 1 + y \tag{3}$$

to ensure that getting caught is worse than being honest and that, even when caught, income is positive.

The game is illustrated in Figure 1 where the principal's and agent's incomes are given at the end of each stem. We solve the game backwards, in the usual way, first analyzing the decision of the agent. The game is one of random matching, so the principal has aggregate information but knows nothing specific about the agent with whom she transacts. There are three important features of the model:

1. The probability that an agent will get caught cheating is exogenous, depends on the institutions of the country, and is the same for all agents;

2. In their decisions, both principals and agents demonstrate loss aversion;

3. Individuals within a country differ with respect to the intensity of their loss aversion.

The first assumption means that causality is one way: institutional differences influence trustworthiness and trust, but trustworthiness and trust do not influence institutions.[6] Both principals and agents make decisions under uncertainty – our second assumption – according to a simple version of prospect theory. In our version, utility is piecewise linear in income: the slope of the utility function *below* current income exceeds the slope above it.[7] The last assumption provides the nature of heterogeneity across players in the model and allows us to index individuals according to their level of loss aversion and to index countries by their population means and variances of loss aversion.

# 3 Solution

We begin with the agent's decision. In our game, agents take a gamble whenever they decide to cheat. We assume that the country's institutional structure determines the probability $Q$ that they will get caught and experience loss. Our key assumption is that Agent $i$ receives the following expected utility from cheating:

$$E(U)_i^a = (1 - Q)(1 + y + \alpha) + Q(1 + y - z_i\beta) \tag{4}$$

[6] On the evolution and persistence of institutions and their relation to economic performance and trust, see Bohnet et al. (2001), Tabellini (2008b), Rajan and Zingales (2006) and Breuer and McDermott (2008).

[7] In the original prospect theory (Kahneman and Tversky, 1979) this is also the case, but the utility function is convex for gains, and concave for losses. In their experiments, Abdellaoui et al. (2008) find that linearity is a good approximation, especially for losses. See also Rabin and Thaler (2001) for comparison with expected utility theory. In their experiments, Bohnet et al. (2010) use a variant of prospect theory due to Köszegi and Rabin (2006). Many of the papers in Camerer et al., eds (2004) find evidence of pronounced loss aversion in decision-making.

where $z_i$ measures the intensity of Agent $i$'s *loss aversion.* For all agents, income gains translate directly into equivalent gains in utility, but agents have stronger aversion towards losses. We assume that $z_i > 1$, indicating that losses to income are weighted more heavily than gains in calculating utility.

How can we tell if an agent is trustworthy? We first find the critical value of loss aversion $z_c$ by setting equation (4) equal to the sure payoff of $1 + y$ which yields:

$$z_c = \left(\frac{1-Q}{Q}\right)\frac{\alpha}{\beta} \tag{5}$$

Any agent $i$ for whom $z_i \geq z_c$ will *not* cheat. Agents for whom $z_i < z_c$ will cheat. The reasoning is straightforward. Agent $i$'s *net* expected utility from *cheating* is $N_i^a = E(U)_i^a - (1+y) = (1-Q)\alpha - Qz_i\beta$. This is strictly decreasing in $z_i$ and equals zero at $z_c$. Hence, if $z_i > z_c$, then $N_i^a < 0$, and agent $i$ will not cheat. Agents for whom $z_i < z_c$ will cheat, since $N_i^a > 0$. An agent with $z_i = z_c$, is indifferent, and we assume she does not cheat.

The construct $z_c$ has a straightforward interpretation: it is the ratio of the expected gain to getting away with cheating to the expected penalty from getting caught. It is the *relative expected benefit* from cheating, and anyone whose personal loss aversion exceeds that expectation will behave honestly.

Now that we have an answer to individual behavior on cheating, we ask what proportion of the population will behave trustworthily? To answer this question, we will need to make assumptions about the distribution of loss aversion across individuals. We assume that the population of agents is distributed according to personal loss aversion $z$ *uniformly* on the closed interval $[a, b]$:

$$z \sim U(\mu, \sigma^2) \tag{6}$$

where $\mu = \frac{a+b}{2}$ and $\sigma^2 = (b-a)^2/12$ . The cumulative distribution function (CDF) for the uniform distribution is:

$$D(z) = \frac{z-a}{b-a} \tag{7}$$

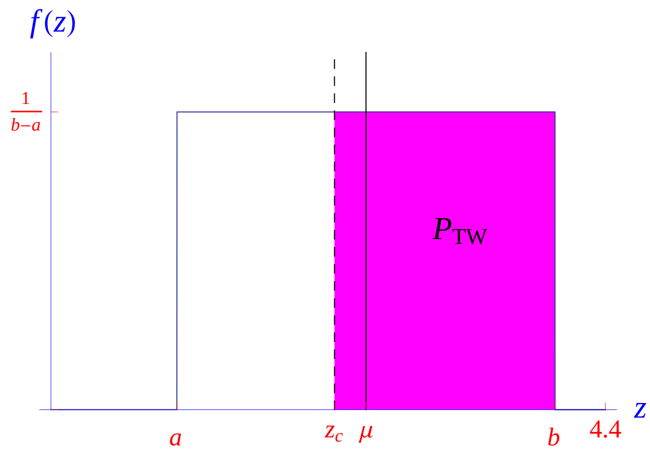


Figure 2: The Distribution of Loss Aversion

for $a \leq z \leq b$. To find the *equilibrium proportion of agents that act trustworthily*, which we label $P_{TW}$, we subtract the CDF in (7) from 1 and set $z$ equal to $z_c$. This yields:

$$P_{TW} = \frac{b - z_c}{b - a} \tag{8}$$

where $z_c$ is given in (5).

It is useful for what follows to express $P_{TW}$ in terms of the mean $\mu$ and standard deviation $\sigma$ of the distribution of loss aversion. Since $a = \mu - \sigma\sqrt{3}$ and $b = \mu + \sigma\sqrt{3}$ we obtain the following expression:

$$P_{TW} = \begin{cases} 0 & if \quad z_c > \mu + \sigma\sqrt{3} \\ \frac{1}{2} - \frac{(z_c - \mu)}{\sigma\sqrt{12}} & otherwise \\ 1 & if \quad z_c < \mu - \sigma\sqrt{3} \end{cases} \tag{9}$$

If the cut-off $z_c$ (our institutionally-determined parameter) just happens to equal the mean $\mu$, then exactly half of the population will be trustworthy. If $z_c < \mu$, then trustworthiness is greater than one half; and conversely for $z_c > \mu$.

We illustrate with Figure 2, which shows a country's $z$ density $f(z)$ and the cut-off $z_c < \mu$. Equilibrium trustworthiness is represented by the area under the PDF to the right of $z_c$, which is greater than a half.

We now turn to the problem faced by the representative principal. He decides to trust only if the expected utility of initiating a transaction exceeds the certain value of the work-alone option, which is 1. The expected utility of trusting by Principal $i$ is:

$$E(U)_i^p = P_{TW}\,(1+y) + (1-P_{TW})\,(1+y-z_i\alpha) \tag{10}$$

where, again, we weight the loss by $z_i$. Given our restrictions on $\alpha$ and $y$ in (1), we see that for $P_{TW}=0$, our condition means $E\,(U)_i^p < 1$ for all $z_i$ so that a principal will never trust if she observes that no one is trustworthy. Likewise, if $P_{TW}=1$, all principals will trust.

It has long been recognized that trust depends on the perception of general trustworthiness. For example, Sapienza et al. (2007) note that there are two aspects of trust: beliefs about "others trustworthiness" – which is captured by $P_{TW}$ – and individual preferences – which in our case are manifest in attitudes toward losses $z_i$. Equation (10) makes these two aspects explicit.

We assume that principals are randomly matched with agents and only have information about the population. Principals are assumed to know the proportion of agents who do not cheat, $P_{TW}$, but do not know anything about the individual agent with whom they are transacting.

The principal's decision is made by setting (10) equal to 1 (the value of the sure, work-alone option) and solving for $z$ to get:

$$z_p = \frac{1}{(1-P_{TW})\,\omega} \tag{11}$$

where $P_{TW}$ is given in (9) and $\omega \equiv \frac{\alpha}{y} > 1$ is the *relative cost* to the principal of being cheated. The object $\omega$ is the other institutional variable besides $z_c$.

Trust only occurs if the individual is not too cautious. Any principal $i$ for whom $z_i > z_p$ will *not* trust. Principals for whom $z_i \leq z_p$ will trust. Our reasoning is like that above. Principal $i$'s *net* expected utility from *trusting* is $N_i^p = E\,(U)_i^p - 1 = y - (1-P_{TW})\,z_i\alpha$. This is strictly decreasing in $z_i$ and equals zero at $z_p$. Hence, if $z_i > z_p$, then $N_i^p < 0$, and principal $i$ will not trust. Agents for whom $z_i < z_p$ will trust, since $N_i^p > 0$. A principal with $z_i = z_p$, is indifferent, and we assume she trusts. As would be expected, individuals who are very cautious – have high loss aversion – are not willing to trust.

We assume that principals share the same distribution of caution as agents, so that we can use the same cumulative distribution (7). Plug $z_p$ into (7) to get the *equilibrium proportion of principals who trust*:

$$P_T = \frac{z_p - a}{b - a} \tag{12}$$

Using the expressions for the mean and standard deviation yield:

$$P_T = \begin{cases} 0 & if \quad z_p < \mu - \sigma\sqrt{3} \\ \frac{1}{2} + \frac{(z_p - \mu)}{\sigma\sqrt{12}} & otherwise \\ 1 & if \quad z_p > \mu + \sigma\sqrt{3} \end{cases} \tag{13}$$

Only when the mean value of loss aversion $\mu$ is less than the cut-off value $z_p$ does trust exceed one half of the population.[8]

# 4 Comparative Statics

Trustworthiness and trust depend on both *institutional* and *cultural* factors. In the context of our model, the former are given by $z_c$ and $\omega$, and the latter by $\mu$ and $\sigma$. In this section we show how both factors affect $P_{TW}$ and $P_T$.

## 4.1 Institutional Factors

There are four primitive parameters in the model: the probability of punishment $Q$, income $y$, the transfer in the case of cheating $\alpha$, and the net fine if caught $\beta \equiv \phi - \alpha$. We have already

[8] If the distribution of loss aversion within a country were normal instead of uniform, our results would be qualitatively the same, but there would be no simple expressions for trustworthines $P_{TW}$ or trust $P_T$. One reason to prefer the uniform to the normal, aside from simplicity, is that loss aversion should have a lower bound of 1. The normal distribution always contains some mass below 1.

collected these parameters into two objects: an agent's expected relative benefit of cheating $z_c = \frac{1-Q}{Q}\left(\frac{\alpha}{\beta}\right)$ and a principal's relative loss from being cheated $\omega \equiv \frac{\alpha}{y}$. These reflect the quality of a country's institutions. A large value of $z_c$ reflects poor institutions, either because the chance of being caught $Q$ is low, or because the relative income gain from cheating $(\alpha/\beta)$ is high. Institutional quality is also inversely related to $\omega$, which reflects the share of any transaction appropriated by dishonest agents.

Using (9), we see that an increase in $z_c$ has the following impact:

$$\frac{dP_{TW}}{dz_c} = -\frac{1}{\sigma\sqrt{12}} < 0 \tag{14}$$

and using (9), (11), and (13):

$$\frac{dP_T}{dz_c} = \frac{\partial P_T}{\partial z_p}\frac{\partial z_p}{\partial P_{TW}}\frac{\partial P_{TW}}{\partial z_c} = \frac{-1}{12\sigma^2\omega\left(1-P_{TW}\right)^2} < 0 \tag{15}$$

From (11) and (13), an increase in $\omega$ has the following effects:

$$\frac{dP_{TW}}{d\omega} = 0 \tag{16}$$

$$\frac{dP_T}{d\omega} = \frac{\partial P_T}{\partial z_p}\frac{\partial z_p}{\partial \omega} = \frac{-z_p}{\omega\sigma\sqrt{12}} < 0 \tag{17}$$

As we expect, in countries where institutions are weaker both trustworthiness and trust will be lower. The effect on $P_{TW}$ and $P_T$, however, is *smaller* in culturally diverse societies; that is, where $\sigma$ is high. More diverse societies can withstand larger downside shocks to institutional quality before trust collapses. On the other hand, in more homogeneous societies, very small improvements in institutions can lead to a much larger potential increase in $P_{TW}$ and $P_T$.

## 4.2 Cultural Factors

In this section, we derive our main results: the effects of the cultural factors $\mu$ and $\sigma$ on $P_{TW}$ and $P_T$. We begin with trustworthiness.

#### 4.2.1 Trustworthiness

As we see by differentiating (9) in its interior, the effect of a higher mean $\mu$ on $P_{TW}$ is the same as the effect of $z_c$ but with opposite sign:

$$\frac{dP_{TW}}{d\mu} = \frac{1}{\sigma\sqrt{12}} > 0 \tag{18}$$

As intuition would suggest, a rise in the average level of caution in a society, *holding $\sigma$ constant*, will lead to a rise in trustworthiness. Greater caution inhibits cheating and trustworthiness rises. As was true with changes in $z_c$, the effect is smaller the more diverse the society.

The effect of a change in $\sigma$ on trustworthiness can also be found by differentiating (9):

$$\frac{dP_{TW}}{d\sigma} = \frac{z_c - \mu}{12\sigma^2} \gtreqless 0 \tag{19}$$

More diverse (high-$\sigma$) societies are more trustworthy *only* if they are relatively less cautious: $\frac{dP_{TW}}{d\sigma} > 0$ iff $\mu < z_c$. A mean-preserving increase in $\sigma$ redistributes agents away from the mean to the tails. Only when $\mu = z_c$ are the gains and losses by agent type symmetric. In the case where $\mu < z_c$, the loss of trustworthy agents from the middle (i.e. agents who now play dishonest) is smaller than the gain at the tail. So, there is a net gain of trustworthy types. Figure 2 makes this clear.

#### 4.2.2 Trust

We now examine the effects of $\mu$ and $\sigma$ on trust. Our primary interest is in the effect of the population mean of caution $\mu$ on trust. Average caution $\mu$ works directly on trust in (13), but also works indirectly through $z_p$ and $P_{TW}$:

$$\frac{dP_T}{d\mu} = \frac{\partial P_T}{\partial \mu} + \frac{\partial P_T}{\partial z_p}\frac{\partial z_p}{\partial P_{TW}}\frac{\partial P_{TW}}{\partial \mu} \tag{20}$$

The direct effect is negative – higher average loss aversion means society trusts less out of caution. The indirect effect, however, is positive because more caution leads to more trustworthiness, which leads to more trust. Working out the expression yields:

$$\frac{dP_T}{d\mu} = \frac{1}{\sigma\sqrt{12}} \left( -1 + \frac{1}{\sigma\sqrt{12}\,(1 - P_{TW})^2\,\omega} \right) \gtreqless 0 \tag{21}$$

where $P_{TW}$ is given by (9) and depends on $\mu$, $\sigma$, and $z_c$.

We solve the inequality in (21) as an expression for $P_{TW}$ to find the condition for which the derivative $dP_T/d\mu$ is positive:

$$P_{TW} > 1 - \sqrt{\frac{1}{\sigma\omega\sqrt{12}}} = 1 - \sqrt{\frac{1}{(b-a)\,\omega}} \tag{22}$$

For example, if the range of loss aversion in society was $b - a = 3$ and we assume that $\omega = 1.25$, then $P_{TW}$ would have to exceed 43% for the derivative to be positive. In the next section, we use numerical methods to show that this condition is likely to be satisfied.

Last, we consider the effect of societal cultural heterogeneity $\sigma$ on trust. The total effect is given by:

$$\frac{dP_T}{d\sigma} = \frac{1}{12\sigma^2} \left[ \mu - z_p + \frac{z_c - \mu}{\sigma\sqrt{12}\,(1 - P_{TW})^2\,\omega} \right] \gtreqless 0 \tag{23}$$

In this case, we find the impact of cultural diversity on trust to be ambiguous. The direct effect is ambiguous and depends on the sign of $\mu - z_p$. The indirect effect is also ambiguous and more complex. Numerical analysis will prove useful to understanding the effect of dispersion in loss aversion on trust.

## 5 Numerical Analysis

At this point, it becomes useful to introduce numerical examples to help reinforce the unambiguous comparative statics results and to try to resolve any of the ambiguities related to $P_{TW}$ and $P_T$.

Table 1: Calibration

| Variables | | | |
|---|---|---|---|
| | *Baseline* | *Minimum* | *Maximum* |
| Set Values | | | |
| $\mu$ | 2.5 | 1.1 | 4.0 |
| $a$ | 1.0 | 1.0 | 1.0 |
| $z_c$ | 2.25 | 1.6 | 3.4 |
| $\omega$ | 1.25 | 1.1 | 1.5 |
| Implied Values | | | |
| $b$ | 4.0 | 1.2 | 7.0 |
| $\sigma$ | .866 | .1 | 1.73 |

### 5.1 Understanding Trustworthiness

We begin with a baseline calibration where we assume that average loss aversion is $\mu = 2.5$. This number emerged in early field studies and is widely quoted in the literature.[9] We adopt the standard loss aversion assumption that the least loss averse person has a $z = 1$, which is the lower bound on the uniform distribution for $z$ and is given by $a$. Given a uniform distribution, these assumptions mean that the most loss averse person has $z = 4$, which is the upper bound on the distribution, $b$. This gives the range for $z$ and implies a standard deviation $\sigma = .866$. We also assume that the baseline expected relative gain from cheating is $z_c = 2.25$: cheating is expected to return over twice as much as honesty in terms of utility, but less than the average of loss aversion. This is the case represented in Figure 2, and it determines a baseline value of $P_{TW} = 58\%$. Although it has no bearing on $P_{TW}$, we set $\omega = 1.25$ in the baseline case.[10] The baseline numbers are presented in the first column of Table 1.

In Figure 3 we show iso-$P_{TW}$ lines in $(\mu, \sigma)$ space. This figure which is based on (9) and Table 1 allows us to compare countries' trustworthiness based on their culture as given by $\mu$ and $\sigma$. We let $\mu$ vary between 1.1 and 4.0. We allow $\sigma$ to vary in the range:

$$.1 \leq \sigma \leq \frac{\mu - 1}{\sqrt{3}} \tag{24}$$

[9] See Tversky and Kahneman (1992) and Rabin and Thaler (2001) among many others.

[10] To get the values for $z_c$ and $\omega$, we assume that: $y = 2$, $\alpha = 2.5$, $\phi = 4.0$, and $Q = .42553$. These values only enter the model via $z_c$ and $\omega$, so we will not consider them separately in what follows.

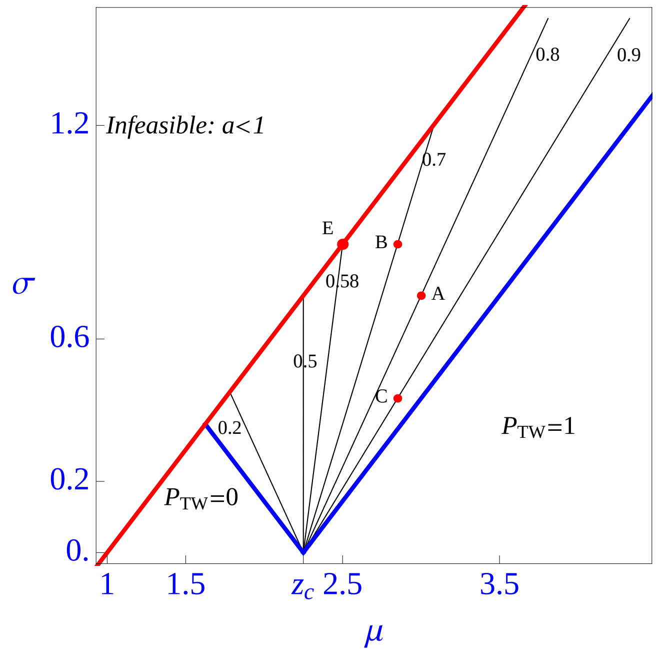


Figure 3: Contours of Trustworthiness

The upper bound on $\sigma$ is necessary to ensure that $z_i > 1$, which means that $a = \mu - \sigma\sqrt{3} \geq 1$. We call this the *feasibility condition.* The thick, upper solid line in Figure 3 is the boundary above which $a < 1$ and so is not feasible.

Table 1 shows the range of values that we use throughout the paper. We restrict $z_c$ to the interval [1.6, 3.4] because this guarantees that $P_{TW}$ lies in the interval [.20, .80] when $\mu$ and $\sigma$ have their baseline values. The range of $\omega$, which must exceed 1, is assumed to be $[1.1, 1.5]$. At most, principals lose 50% more than normal output if they are cheated.

Figure 3 is split into four regions. In addition to feasibility, we also show the two corner cases of Equation (9) – where $P_{TW} = 0$ and $P_{TW} = 1$ – also separated by thick solid lines. The baseline case is shown here at Point E. Within the interior feasible region, trustworthiness always rises with $\mu$ (given $\sigma$) as we know from (18). Moving horizontally, we cross contours of increasing trustworthiness. As established in (19), we see that the effect of greater diversity $\sigma$ is ambiguous: it raises trustworthiness only if $\mu < z_c$. However, the level of trustworthiness never rises above half when this is true.

One lesson from our work is that average caution alone is not sufficient to predict trustworthiness. This is because the combined effect on $P_{TW}$ depends on (18) and (19). Consider three points A, B, and C representing three different countries. We see that country B is *less* cautious than A and exhibits less trustworthiness (0.7 vs. 0.8). Country C has the same mean level of caution as country B, yet C exhibits *more* trustworthiness than A (0.9 vs. 0.8) even though C is on average less cautious. While outcomes like these are possible, the steepness of the contours makes it unlikely for $\mu$ and $P_{TW}$ to be negatively related.

The pattern shown in Figure 3 is general. It does depend on the calibrated variable $z_c = 2.25$, but if $z_c$ were to rise (a weakening of institutions), the only effect would be to shift the lines to the right in proportion. A weakening of institutions would be associated with lower levels of trustworthiness for every $\mu$. The other institutional variable $\omega$ has no effect on the figure. As we will see, the effect of caution on trustworthiness is important to understanding patterns related to caution and trust.

## 5.2 Understanding Trust

Our comparative statics on trust showed ambiguity pertaining to the effect of greater average caution and greater diversity on trust. Numerical analyses can help establish the plausibility of our claim that a rise in caution is likely to generate *more* trust, not less. To do so, we examine maps of iso-$P_T$ curves in ($\mu$, $\sigma$) space. Figures 4 and 5 are drawn for the baseline pair $z_c = 2.25$ and $\omega = 1.25$. In Figure 4, we divide the space into six regions defined by five boundary loci. Three of the boundaries are the same as in Figure 3: they divide the space by infeasibility ($a < 1$) and the extreme values of $P_{TW}$. The two new boundary loci carve the space into regions where $P_T$ is 0, or 1, or in its interior.[11]

Region A is where $P_{TW} = P_T = 0$. In Region D, the other extreme, we have $P_{TW} = P_T = 1$. Interestingly, there is an area (Region B) where some fraction of the population is trustworthy ($0 < P_{TW} < 1$) but not sufficiently to generate any trust ($P_T = 0$). In Region C people have

[11] These loci were derived from the first and third lines of Equation (13). The first of these defines the boundary where $P_T = 0$ (when expressed as an equality). We must use (9) in (11) and then in (13), and then use the quadratic formula to solve for $\sigma$. There are two solutions, and for a range of $\mu$ both are positive, which we observe along the eastern edge of the $P_T = 0$ boundary. This boundary locus crosses the $\mu$-axis at $z_c$. The locus where $P_T = 1$ is tangent to the locus where $P_T = 0$ at the point $(z_c, 0)$.

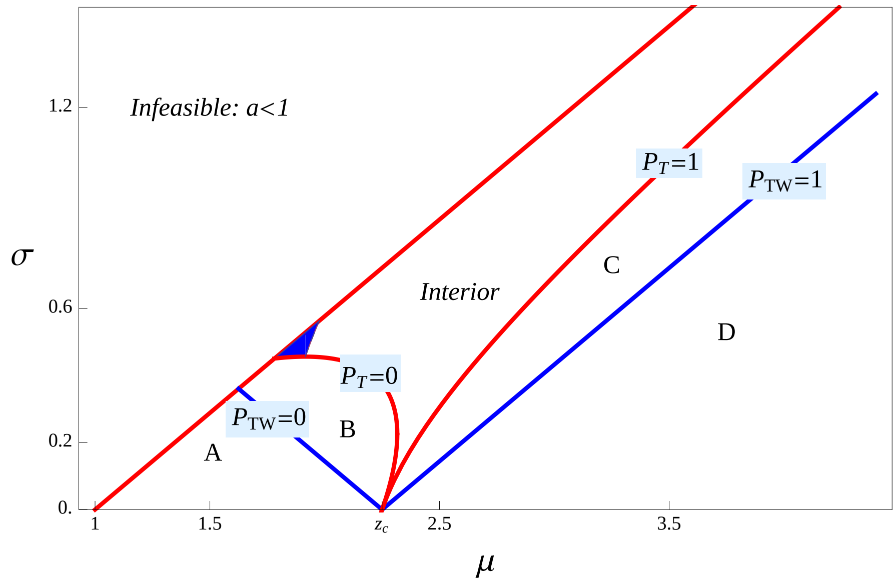


Figure 4: Regions of Trust and Trustworthiness

complete trust ($P_T = 1$) even though trustworthiness is incomplete ($P_{TW} < 1$). The upper left region is infeasible ($a < 1$). Only in the interior region do we observe positive but incomplete trust and trustworthiness: $0 < P_{TW}, P_T < 1$. The small shaded region is part of the interior and is addressed below.

Experiments conducted by Bohnet et al. (2010) find that there is a threshold of trustworthiness necessary to generate any positive trust and that it may be as high as 70% in Persian Gulf states. The existence of a threshold is consistent with our model, since in Region B of Figure 4 trust is zero in spite of positive trustworthiness. One way to explain the relatively high threshold in the Gulf is that institutions are so weak that considerable trustworthiness is necessary to generate any level of trust. Using (11) and (13), we see that in the presence of weak institutions (high $\omega$), a high level of $P_{TW}$ would be necessary to generate any trust. This requires a high $\mu$. The US, with better institutions, could have less trustworthiness (and less caution) yet achieve the same level of trust.

In Figure 5 we show a sample of iso-$P_T$ curves bounded by the extreme conditions on $P_T$ and that take into account the endogenous adjustment of $P_{TW}$ as $\mu$ and $\sigma$ vary. The contours are not linear, nor symmetric, but they have the same general shape as the iso-$P_{TW}$ lines in

Figure 3. Traversing horizontally across the contours, we see that increases in $\mu$ *raise* $P_T$. This is satisfied for most values of $(\mu, \sigma)$ in the interior region. It is possible that there exists a region where $dP_T/d\mu < 0$, but this region, if it exists, will be small. Such a region does exist in our baseline case, and is located in the vicinity of Point F in Figure 5 where the contour is very flat. It is also indicated by the shaded region in Figure 4.[12]

In the Introduction, we highlighted this paradoxical result: *for any given value of* $\sigma$*, societies with more caution* $\mu$ *generally have* more *trust.* This, as we noted before, is counterintuitve since, for *individuals*, greater caution unambiguously reduces trust. Why does this happen? In the aggregate, trust rises because trustworthiness simultaneously rises with a general cultural shift that raises $\mu$.[13] Further, we see in Figure 5 that in very homogeneous societies (where $\sigma$ is very low, e.g. 0.2 or lower) the effect of $\mu$ on trust is not only positive, it is extremely powerful. In very homogeneous societies, small changes in $\mu$ can lead to rapid and complete reversals in trust and a relatively low level of caution can produce complete trust.

Last, we can make a general observation about the effect of diversity on trust: moving vertically across contours in Figure 5, in relatively cautious (high-$\mu$) societies, greater homogeneity raises trust. The opposite is true in societies with low $\mu$; diversity raises trust, but as Figure 5 shows, not to those levels reached by more cautious societies.

In the latest wave of the World Values Survey, Japan's measured trust was $P_T = .43$ while the US had a score of $P_T = .36$. In Figure 5, points U and J might correspond to the two countries. Japan is more cautious and homogeneous, both of which work to raise trust above that of the US where caution is lower. This anecdotal evidence confirms our basic result: greater caution may correspond to higher levels of trust.

[12]We can find this region precisely with numerical methods, which we do in Appendix A. If $z_c$ is sufficiently low (good institutions) this region does not exist. For some threshold $z_c$, it does exist, and its size rises as $z_c$ rises. But even at our maximum value of $z_c = 3.4$, it is not large. An increase in $\omega$ also increases the size of this region, but the magnitude of the change is small.

[13]This may explain the empirical regularity that trust and output per capita $y$ are more strongly correlated across developed countries than developing countries. If, in these studies, the trust question is measuring *caution* instead of trust (see Miller and Mitamura, 2003), then we are really observing a relation between $\mu$ and $y$. To the extent that $P_T$ partially determines $y$, as argued in much of the literature, we would expect the correlation between $\mu$ and $y$ to be higher in rich countries (like points around J in Figure 5) than in developing ones (like point F).

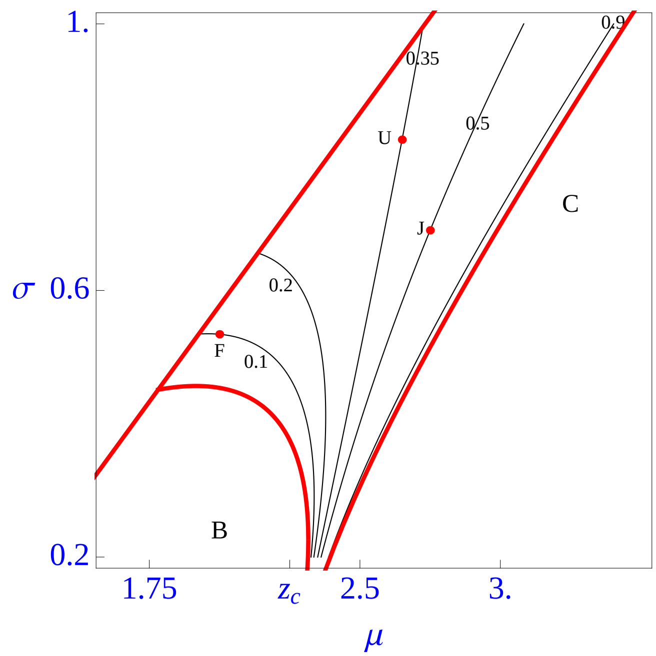


Figure 5: Contours of Trust

# 6 Extensions

We consider two extensions of our model. In the first, we assume principals and agents are now drawn from two separate distributions of loss aversion. This allows us to consider how social preferences such as betrayal aversion or warm glow altruism might affect our main results. In the second, we replace loss aversion with risk aversion and demonstrate that our basic results hold.

## 6.1 Different Distributional Assumptions

We now relax the assumption that agents and principals within a country have the same distribution of caution. Let $z_{ai}$ and $z_{pj}$ be, respectively, the loss aversion of agent $i$ and principal $j$. Furthermore, let the two variables have the joint distribution $F(z_a, z_p)$. To this point, we have assumed that agents and principals were pulled from the same distribution. Now, there are two distinct means and standard deviations – one for principals and one for agents.[14]

One way to think about why the distributions might differ is to introduce the concept of *betrayal aversion*. This idea, due to Bohnet and Zeckhauser (2004) and Bohnet et al. (2008), says that a loss from being cheated by a person is felt more acutely than an equal loss from nature. In our model, only the principal can be betrayed. The agent may get caught, but this is not a betrayal since he is playing a game against nature – the institutions of society that have a right to punish him.

With betrayal aversion, the loss aversion distribution for principals lies to the *right* of that for agents: principals have a higher $\mu$ than agents.[15] We may characterize this by:

$$\mu_p = \mu_a + \delta \tag{25}$$

where $\mu_p$ and $\mu_a$ are the means for the principals and the agents, respectively, and $\delta > 0$ is the betrayal aversion experienced by principals. Note that trustworthiness and trust are still given by (9) and (13), except that $\mu$ would now be replaced with $\mu_a$ in the former and $\mu_p$ in the latter.

A key question concerns the covariance of $z_a$ and $z_p$. If, contrary to our original assumption, they are completely *independent*, then the model is easier to solve. A change in $\mu_p$ would no longer simultaneously correspond to a change in $\mu_a$. This means that if $\mu_p$ rises, $P_{TW}$ would not change since it depends only on $\mu_a$. But, $P_T$ would decline – there would be *less trust*. This follows straight from equation (13): $z_p$ would not change since $\mu_a$ has not changed and so the higher value of $\mu_p$ unambiguously reduces $P_T$. The conventional result – more caution means less trust – would hold. Differentiating (13) with respect to $\mu_p$ gives:

$$\frac{dP_T}{d\mu_p} = \frac{-1}{\sigma\sqrt{12}} < 0 \tag{26}$$

[14]These refer to the marginal distribution functions, $f(z_a)$ and $g(z_p)$ that are derived from the joint distribution.

[15]If principals experience a *warm glow* from the act of trusting (Andreoni, 1990) this would move the distribution to the left. Inequity aversion (Fehr and Schmidt, 1999) is another non-pecuniary motive that might apply.

One problem we confront with two distributions, however, is that it is no longer clear what we mean by a "more cautious" society. Does it refer only to the principals being more cautious? The two extremes we present – where the distributions are completely dependent or completely independent – establish a broad range of possible outcomes in the relationship between caution and trust. Intermediate cases might be the most likely. In our view, there is a national, cultural component to caution so the correlation between $z_a$ and $z_p$ is likely to be strongly positive, but less than 1. High values of $\mu_p$ would tend to be accompanied by high values of $\mu_a$, so if principals became more cautious on average, so would agents. Higher caution then would be accompanied by higher trustworthiness, so trust would be more likely to rise with caution.

### 6.2 Expected Utility Theory

If we abandon the framework of loss aversion in favor of traditional expected utility theory, we replace our kinked, linear utility function with a traditional CRRA utility function. Here we discuss how the solution changes, leaving details to Appendix B.

Our results are basically unaltered. We assume the heterogeneity within countries is now over relative risk aversion $\rho_i$, not loss aversion. Due to the concavity of the utility function, we must now use numerical methods to obtain $\rho_c$, the critical value that divides the trustworthy from the dishonest. Qualitatively, $\rho_c$ depends on $Q$, $\alpha$, and $\beta$ in the same way that $z_c$ did in Section 3. Figure 3 will be largely unchanged.

Trust works in the same way as before, although we must again use numerical methods to find the critical value $\rho_p$. Using similar parameter values, we find that the iso-$P_T$ lines have the same pattern as those in Figure 5. In particular, the contours will be flatter in the region where $\mu$ and $\sigma$ are relatively low.

## 7 Conclusion

We have shown that among countries of similar cultural homogeneity, the more cautious ones will almost always trust more. This seems to go against common sense, because a cautious individual would trust *less*. It works, however, because the perception of trustworthiness is a very powerful determinant of trust, and trustworthiness also rises with culturally determined caution. The result hinges on the assumption that principals and agents are drawn from the same distribution of caution. If betrayal aversion – or any social preference – is important such that principals and agents are drawn from different distributions, the positive relation between caution and trust is weakened. Under what circumstances separate distributions make sense and their degree of independence are crucial open questions.

Empirically, our result may be difficult to demonstrate since there are few measures of caution – risk aversion or loss aversion – at the national level. Even if data were available on national averages, without data on the within-country variance, it will be difficult to detect the true relationship between caution and trust. More precise data on attitudes toward caution around the world is an important area of future research.

Trust is critical for economic development. Two policies for raising trust emerge from our work. The first policy is not new but comes with a new twist – improve institutional quality in such as way as to raise *trustworthiness*. Greater trust and higher standards of living will follow. The second policy is less obvious and is likely to be more difficult: promote shared attitudes toward more caution. In ethnically or religiously diverse countries, such policy design will likely demand much creativity. Without increasing trust, however, true economic progress will remain elusive.

# A Cases where more Caution reduces Trust

Here, we show how to find the region of the Interior in Figure 4 where $\frac{dP_T}{d\mu} < 0$. We establish that for plausible values, the region is non-existent or small relative to the region where $\frac{dP_T}{d\mu} > 0$.

Substitute (9) into (21) to obtain a quadratic expression in $\sigma$. The roots of this expression define two functions of the form $\sigma = f(\mu, z_c, \omega)$. These functions determine loci of points where (21) is satisfied with equality. In the area between the functions, the derivative is positive. Outside of it, the derivative is negative.

Figure 6 illustrates. Inside the dashed boundary $\frac{dP_T}{d\mu} > 0$. Inside the solid lines, both $0 < P_{TW} < 1$ and $P_T > 0$. Three cases are shown. In the top panel, $z_c = 1.6$, our lowest

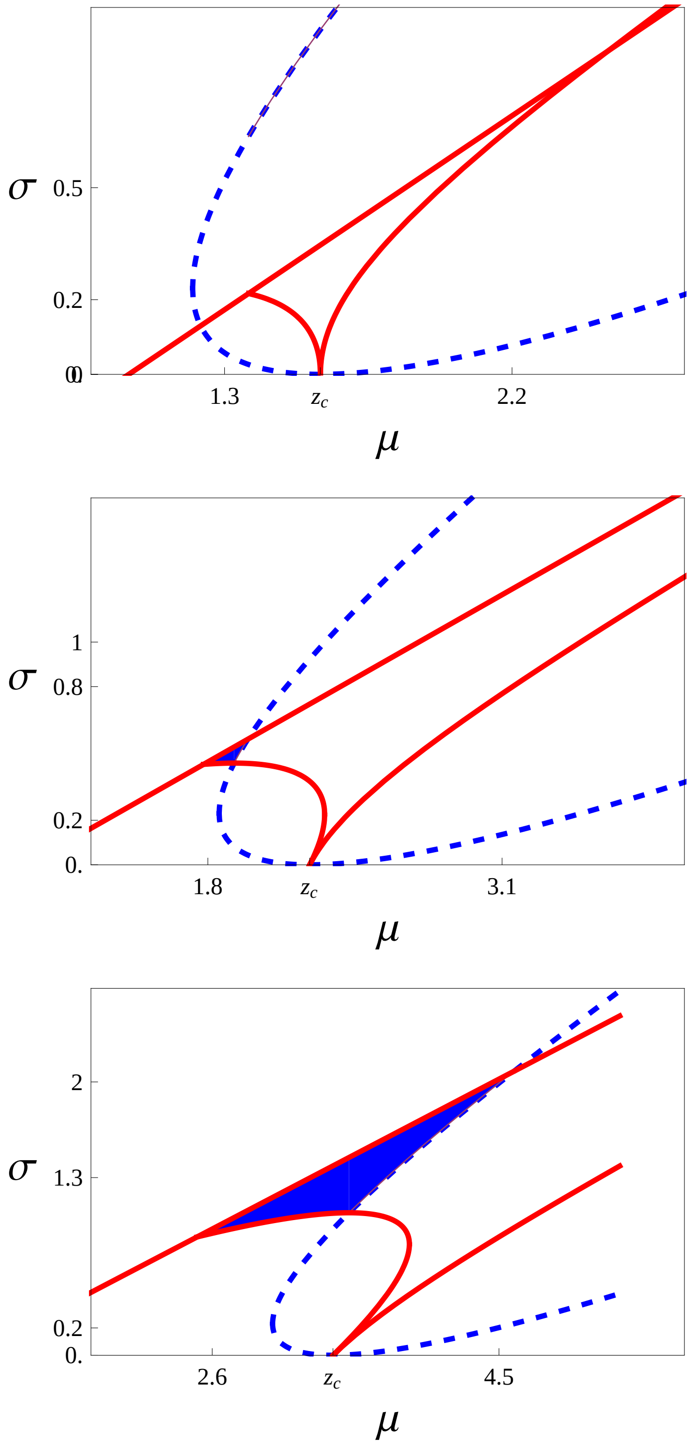


Figure 6: Region where more caution reduces trust

value, and everywhere in the interior region the derivative is positive. There is no region where $\frac{dP_T}{d\mu} < 0$. The middle panel is our baseline case where $z_c = 2.25$. Only in the small, shaded region is $\frac{dP_T}{d\mu} < 0$. In the bottom panel, $z_c = 3.4$, representing the worst institutions. The shaded region where $\frac{dP_T}{d\mu} < 0$ is larger, but it is still not large relative to the interior.

# B Expected Utility Theory

In place of linear utility, we now assume that the utility of agent $i$ is given by the standard CRRA form:

$$u(c_i, \rho_i) = \frac{{c_i}^{1-\rho_i} - 1}{1 - \rho_i} \tag{27}$$

The parameter of *relative risk aversion* $\rho_i$ differs across individuals. Any agent for whom $\rho_i = 0$ is *risk neutral* and has linear utility. People are assumed to be *risk averse* – $\rho_i > 0$.

The *net expected utility of cheating* for agent $i$ is given by:

$$N(U)_i^a = (1 - Q)\, u(1 + y + \alpha, \rho_i) + Qu(1 + y - \beta, \rho_i) - u(1 + y, \rho_i) \tag{28}$$

Agents for whom $N(U)_i^a > 0$ find it optimal to cheat. Given the values of $(Q, y, \alpha, \beta)$, for sufficiently low (possibly negative) values of $\rho_i$, we know that $N(U)_i^a$ is positive. As $\rho_i$ increases, $N(U)_i^a$ falls, and eventually crosses the $x$-axis . Where it crosses determines the critical value $\rho_c$, which is analogous to $z_c$ in (5). Any agent $i$ with $\rho_i < \rho_c$ will cheat. Those with $\rho_i \geq \rho_c$ will be honest.

There is no closed-form solution for $\rho_c$ as there was for $z_c$, so we write the implicit function

$$\rho_c = C(Q, y, \alpha, \beta) \tag{29}$$

and calculate the result for any vector of parameters. We use the Implicit Function theorem to see that $\rho_c$ rises with $\alpha$ and falls with $Q$ and $\beta$.

From this point on, the model plays out as in the main body of the paper, although all of the results are numerical or qualitative. To find $P_{TW}$, put the calculated value of $\rho_c$ into the

CDF as before. Then use the *net expected utility of trusting*:

$$N(U)_i^p = P_{TW} u(1+y, \rho_i) + (1 - P_{TW}) u(1+y-\alpha, \rho_i) - u(1, \rho_i) \tag{30}$$

to find the cut-off for principals, $\rho_p$.[16] It is the value – found numerically – that establishes $N(U)_i^p(\rho_p, \ldots) = 0$. Finally $P_T$ is found by inserting $\rho_p$ into the CDF. [17]

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[16] Note that the last term in (30) is zero under the definition of utility in (27).

[17] See Breuer and McDermott (2009) for the case of expected utility worked out in detail using the normal distribution.

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