

Financial Markets where Traders Neglect the Informational Content of Prices

Erik Eyster

London School of Economics

Matthew Rabin

University of California—Berkeley

Dimitri Vayanos

London School of Economics

August 25, 2013

Abstract We present a model of a financial market where some traders are “cursed” when choosing how much to invest in a risky asset, failing to take into account what prices convey about others’ private information. In contrast to rational-expectations equilibrium (REE), the model predicts extensive trade, which can increase in the presence of more private information. The price responds more to public information and less to private information than in REE, causing momentum in asset returns. Also in contrast to REE, cursed traders with more precise private information can be worse off than traders with less precise information. We contrast our results to other models of departures from REE and show that trading volume among cursed agents converges to infinity when the number of agents becomes large, while natural forms of overconfidence predict that volume should remain bounded.

Acknowledgments We thank Nick Barberis, Xavier Gabaix, Tristan Gagnon-Bartsch, Josh Schwartzstein, Andrei Shleifer, seminar participants at Columbia, Humboldt, NYU Stern, Wharton, and participants at the Workshop in Bounded Rationality at the Paris School of Economics for helpful comments. We also thank Tristan Gagnon-Bartsch and Tarso Mori Madeira for research assistance.

1 Introduction

People might rationally trade financial assets for a variety of non-speculative motives, such as portfolio rebalancing and liquidity. But ever since Milgrom and Stokey (1982), researchers have understood that common knowledge of rationality combined with a common prior precludes purely speculative trade. In most people’s estimation, the volume of trade in financial markets greatly exceeds what can be plausibly explained by models using rational-expectations equilibrium (REE).¹ Researchers have sought to explain this excessive volume by relaxing the common-prior assumption. Harrison and Kreps (1978) show how non-common priors about an asset’s payoff generate volume in a dynamic model where risk-neutral traders cannot sell the asset short. Scheinkman and Xiong (2003) use their framework to explore traders who are “overconfident”: all signals about the payoff are observed by all traders, yet certain traders overestimate the information content of certain signals.² In these complete-information models, trade derives from traders’ agreeing to disagree. A second approach incorporates overconfidence into incomplete-information models by assuming that privately informed traders agree to disagree because they are overconfident about the precision of their private information. Daniel, Hirshleifer and Subrahmanyam (1998, 2001) and Odean (1998), for example, show how such overconfidence can increase trading volume.³

Models of agreeing to disagree depict traders who recognize their disagreements in beliefs and

¹For example, according to French’s (2008) presidential address to the American Finance Association, the capitalized cost of trading exceeds 10% of market capitalization and turnover in 2007 was 215%, creating a puzzle that “[f]rom the perspective of the negative-sum game, it is hard to understand why equity investors pay to turn their aggregate portfolio over more than two times in 2007” (page 1552).

²Hong, Sheinkman and Xiong (2006) model overconfidence similarly, allowing also for heterogenous priors, in a model where the number of shares of a risky asset increases over time due to the expiry of lock-up clauses.

³Other models of trade deriving from differences in beliefs include Varian (1985), where traders have different subjective priors, DeLong, Shleifer, Summers, Waldmann (1990), where symmetrically informed traders disagree because some of them (“noise traders”) misperceive next-period prices for exogenous reasons, and Harris and Raviv (1993) and Kandel and Pearson (1995), where traders disagree about the informativeness of public signals. Hong and Stein (2007) provide an overview of this literature.

trade based on them. This paper takes a different tack: people trade because they neglect disagreements in beliefs. This approach may seem retrograde, moving the theory of asset markets back to before the rational-expectations revolution, but it builds on evidence and modeling outside the context of financial markets that people do not sufficiently attend to the information content of others' behavior—even in the absence of intrinsic disagreements. We present a simple and tractable model of markets where some or all traders, when choosing their demands, do not attend to the informational content of prices or others' trades. We draw out several implications that follow from this simple assumption, and contrast the model to fully rational models as well as to existing alternatives. The most important implication is also the most basic: trading volume is higher than in REE. Other predictions follow as well. The price responds more to public information and less to private information than in REE, making changes in asset prices predictable from public information. In contrast to REE, trading volume can increase in the precision of traders' private information. Also in contrast to REE, traders with more precise private information can be worse off than traders with less precise information. We contrast our predictions to those of models based on agreeing to disagree, and specifically to overconfidence. Most notably, whereas our model predicts that the per-trader volume of trade grows with the number of agents in the market, we show that when traders are overconfident but don't neglect disagreements, per-trader volume declines to zero.

Ours is not the first paper to investigate the possibility that some market participants fail to invert prices. Hong and Stein (1999) assume that some or all traders are “newswatchers” who trade based on news or signals they observe without inverting price to infer news that they haven't yet heard. They show how prices move predictably when information diffuses gradually through the market, similar to our result, but do not explore the other implications we focus on in this paper.

Section 2 outlines the basic model upon which our approach builds. Based on evidence from strategic situations, Eyster and Rabin (2005) define *cursed equilibrium* in Bayesian games by the requirement that every player correctly predicts the behavior of others, but fails to fully attend to its informational content. Cursed equilibrium is meant to capture the intuitive psychology behind the “winner's curse” in common-values auctions, as well as related phenomena in other strategic

settings.⁴ Section 2 then illustrates the workings of cursed equilibrium in a simple zero-sum game of speculative trade. Cursed equilibrium predicts that agents should trade in that example. As we point out in Section 6, this prediction is supported by direct experimental evidence, but is hard to generate under alternative approaches such as overconfidence, agreeing to disagree, and non-common priors.

Section 3 introduces our formal set-up, based on Grossman (1976), Hellwig (1980) and Diamond and Verrechia (1981). We consider a market in which traders can exchange a risky for a riskless asset over one period. Traders observe public and private signals about the risky asset's payoff, and receive random endowments correlated with that payoff. We define *cursed-expectations equilibrium (CEE)* by the requirement that some traders do not fully extract information from asset prices. CEE transposes the concept of cursed equilibrium from strategic games to price-taking competitive settings. As an application of a more general equilibrium concept, it has the methodological benefit of not having been designed specifically to explain the particular financial-market puzzles that we explore. For tractability, we assume that traders have constant-absolute-risk-aversion (CARA) preferences, and that each either fully extracts or entirely fails to extract information from prices.

Section 4 analyzes the model without random endowments. As in Grossman (1976), there is a unique linear REE with the classical prediction of no trade, and a price that aggregates efficiently all public and private signals. We next solve for CEE when all traders are cursed. Although each cursed trader relies too much upon his own private signal when estimating the asset payoff, because other traders fail to appreciate how that signal influences the price, private signals enter the price with a smaller weight than in REE. Conversely, the public signal enters the price with a larger weight because each trader relies on it more than in REE. These two effects make returns a predictable function of observables: future return depends positively on past return and negatively on the public

⁴Cursedness explains the voluminous evidence on over-bidding in common-values auctions, reviewed in Kagel and Levin (2002), better than Bayesian Nash equilibrium does. Additional evidence consistent with cursedness comes from settings ranging from social learning (Weizsäcker (2010)), voting (Esponda and Vespa (2013)), and trade in positive-sum (Samuelson and Bazerman (1985), Holt and Sherman (1994)) and zero-sum (Carrillo and Palfrey (2011)) environments.

signal in a bivariate regression, and it depends positively on past return in a univariate regression. The positive coefficient on past return accords with the empirical evidence on momentum.⁵

We show additionally that traders with more precise private signals trade more than those with less precise ones, but can be worse off because cursedness causes them to trade too aggressively. The total volume of trade approaches infinity as the number of agents becomes large, and is hump-shaped in the average precision of private signals. Intuitively, there is little private information when either signals are very imprecise—everybody knows very little—or when signals are very precise—everybody is fully informed.

We complete Section 4 by solving for CEE when some traders are rational, focusing, for tractability, on the case where rational traders observe no private signals. Rational traders exploit the under-reaction of price to cursed traders' private signals by engaging in momentum trading, buying when the price goes up and selling when it goes down. This attenuates the price under-reaction to private signals. We show that one consequence of this result is that cursed traders with more precise private signals are worse off than those with less precise signals under a larger set of parameter values.

Section 5 analyzes the model with random endowments. As in Hellwig (1980) and Diamond and Verrechia (1981), trade happens even in REE because the correlation between endowments and the asset payoff generates a hedging motive. We show that REE trading volume is inverse hump-shaped in the precision of private signals—the exact opposite result than when traders are cursed. Intuitively, adverse selection (Akerlof (1970), Hirshleifer (1971)) reduces volume when there are private signals, but disappears when everybody knows little due to imprecise signals or is fully informed because of very precise signals.

Section 6 contrasts our approach to others in the literature, such as overconfidence, agreeing to disagree, and non-common priors. We discuss reasons for concern about the ubiquitous assumption that traders exaggerate the quality of their private information, so that they are overconfident at the time of trade.⁶ But we concentrate mostly on contrasting the implications of overconfidence and

⁵See Jegadeesh and Titman (1993), and Jegadeesh and Titman (2011) for a recent survey.

⁶This form of overconfidence is not exactly equivalent to people's sensation that they are more skilled

cursedness. We embed in our setting a form of overconfidence that most closely resembles Odean (1998), where traders are rational except that they overestimate the precision of their own private signal. We follow Odean in assuming that traders understand the mapping between the price and other traders' private information—but they agree to disagree about the meaning of that information. We show that overconfidence leads to prices that depend too much on private information and too little on public information relative to REE—the exact opposite of our findings with cursed traders. Odean also derives results under an additional assumption that traders underestimate the precision of other traders' signals. This assumption is a cousin of sorts to cursedness, and traders who downplay the informativeness of others' signals exhibit similar behavior to cursed ones. We replicate Odean's results in our setting, showing that traders who are overconfident or dismissive of others' signals trade too much.

More interesting is the contrast in the extent of over-trading as the number of agents becomes large. Whereas the total volume of trade from cursedness converges to infinity with the number of traders, overconfident volume converges to a finite constant regardless of whether the overconfident also undervalue others' signals. Intuitively, while each trader thinks he knows more than he does, he understands that the total amount of “valid” information reflected in the price in a large market swamps his own information. Hence, the same no-trade logic that prevails in REE prevails also in large markets of overconfident traders.⁷

We also show, however, that in a large market of *cursed* overconfident traders, per-trader volume remains significant. In this sense, cursedness and overconfidence work as complements, and cursedness helps vindicate the basic intuition from the literature that overconfidence can be a significant source of trading volume.

than they are, as in the work of Malmendier and Tate (2005) on CEOs. Instead, it corresponds to people thinking “my private signals are better than they are,” which might result from people thinking they are better than others at reading information, making it akin to ego-related overconfidence.

⁷Our finding that the per-trader volume of overconfident trade vanishes in large markets would also hold if all signals in the model were made public, which resembles the form of overconfidence assumed in Scheinkman and Xiong (2003).

We conclude in Section 7. We discuss some of the limits of our model, especially the challenges in extending cursedness to multi-period settings. We also discuss how cursedness may interact with other biases. In particular—as per the case of overconfidence discussed in Section 6—cursedness may often serve as an “enabler” of various cognitive and other types of errors traders seem subject to: many errors matter significantly for prices and volume only if and *only if* traders are cursed.

2 Cursed Equilibrium

In this section, we summarize Eyster and Rabin’s (2005) concept of *cursed equilibrium*, before adapting it to price-taking settings in Section 3, in a new concept called *cursed-expectations equilibrium*. Cursed equilibrium is defined in finite Bayesian games of the form

$$(\{A_i\}_{i=1,\dots,N}, \{T_i\}_{i=0,\dots,N}, p, \{u_i\}_{i=1,\dots,N}).$$

For each player $i = 1, \dots, N$, A_i is a finite set of available actions and T_i is a finite set of types, including one, T_0 , for nature. We denote the set of action profiles by $A \equiv \prod_{i=1,\dots,N} A_i$ and the set of type profiles by $T \equiv \prod_{i=0,\dots,N} T_i$. We assume that all players share the common prior probability distribution p over T . Player i ’s utility function is $u_i : A \times T \rightarrow \mathbb{R}$.

A strategy for player i , $\sigma_i : T_i \rightarrow \Delta A_i$, specifies a probability distribution over actions for each type. We denote by $\sigma_i(a_i|t_i)$ the probability that type t_i plays action a_i when he follows strategy σ_i . We denote the set of action profiles for players other than i by $A_{-i} \equiv \prod_{j \neq 0,i} A_j$, and the set of type profiles for nature and players other than i by $T_{-i} \equiv \prod_{j \neq i} T_j$. We denote by a_{-i} and t_{-i} generic elements of these sets. We denote by $\sigma_{-i}(a_{-i}|t_{-i})$ the probability that types t_{-i} play action profile a_{-i} when they follow strategy $\sigma_{-i} \equiv \{\sigma_j\}_{j \neq 0,i}$. Finally, we denote by $p(t_{-i}|t_i)$ the distribution of player i ’s beliefs about other players’ types conditional on his own type t_i . The standard solution concept for these games is Bayesian Nash equilibrium.

Definition 1 *A strategy profile σ is a Bayesian Nash equilibrium if for each player i , each type $t_i \in T_i$, and each a_i^* such that $\sigma_i(a_i^*|t_i) > 0$:*

$$a_i^* \in \arg \max_{a_i \in A_i} \sum_{t_{-i}} p(t_{-i}|t_i) \left(\sum_{a_{-i}} \sigma_{-i}(a_{-i}|t_{-i}) u_i(a_i, a_{-i}; t_i, t_{-i}) \right). \quad (1)$$

To define cursed equilibrium, we compute for each type of each player the average strategy of other players, averaged over the other players' types. For type t_i of player i we define

$$\bar{\sigma}_{-i}(a_{-i}|t_i) \equiv \sum_{t_{-i} \in T_{-i}} p_i(t_{-i}|t_i) \cdot \sigma_{-i}(a_{-i}|t_{-i}).$$

This is the marginal probability that other players play action profile a_{-i} , and is derived by averaging over type profiles t_{-i} the probabilities $\sigma_{-i}(a_{-i}|t_{-i})$ that other players play a_{-i} conditional on t_{-i} . We associate to each player i a cursedness parameter $\chi_i \in [0, 1]$.

Definition 2 *A strategy profile σ is a cursed equilibrium if for each player i , each type $t_i \in T_i$, and each a_i^* such that $\sigma_i(a_i^*|t_i) > 0$:*

$$a_i^* \in \arg \max_{a_i \in A_i} \sum_{t_{-i}} p(t_{-i}|t_i) \left(\sum_{a_{-i}} (1 - \chi_i) \sigma_{-i}(a_{-i}|t_{-i}) u_i(a_i, a_{-i}; t_i, t_{-i}) + \chi_i \bar{\sigma}_{-i}(a_{-i}|t_i) u_i(a_i, a_{-i}; t_i, t_{-i}) \right). \quad (2)$$

Player i best-responds to beliefs that with probability $1 - \chi_i$ the other players' actions depend on their types (the probability of action profile a_{-i} in (2) is conditional on type profile t_{-i}) and with probability χ_i actions do not depend on types (the probability of a_{-i} in (2) is the marginal). When $\chi_i = 0$, player i is rational, and his objective is as in Bayesian Nash equilibrium (Eq. (1)). When $\chi_i = 1$, player i is fully cursed, and neglects entirely the relationship between the other players' actions and their types. Note that while cursed players fail to map actions to types, they assess correctly the probability distribution of other players' actions. We refer to a player with cursedness parameter χ as a χ -cursed player.⁸

⁸Although the formalization of cursed equilibrium looks as if players believe that their opponents foolishly under-utilize available information, Eyster and Rabin (2005, pp. 1629) motivate cursedness very differently: players do not have a theory that others are misusing information. Rather, when thinking through their own strategies, players fail to attend to the informational content of others' behavior. This distinct motivation matches our emphasis in Section 6 and elsewhere in this paper on how our approach contrasts with disagreement models in the finance literature where people recognize and embrace their differences in beliefs.

To see the logic of cursed equilibrium, and to provide initial intuitions for our analysis below, we consider the following game. A seller has an asset that he knows to be worth s to himself and a potential buyer, but the buyer does not know s . Instead, the buyer has beliefs that s is the realization of the random variable S with support $[0, 1]$ and cumulative distribution function F . The buyer makes the seller a take-it-or-leave-it offer for the asset.

Regardless of his beliefs about the buyer's strategy, the seller maximizes utility by accepting p if and only if $s \leq p$. In a Bayesian Nash equilibrium, the buyer understands this, and so chooses p to maximize $F(p) \times (E[S|S \leq p] - p)$. Because $E[S|S \leq p] < p$ for each $p > 0$, the buyer's optimal offer is $p^* = 0$. This illustrates Milgrom and Stokey's (1982) celebrated result on the absence of speculative trade between rational agents.

Given the seller's strategy, a χ -cursed buyer believes that a seller with $s \leq p$ accepts with probability $(1 - \chi) \times 1 + \chi \times F(p)$, the χ -weighted average of that type of seller's actual probability ($= 1$ for $s \leq p$) of accepting, and the average probability of accepting among all types of seller. Similarly, the buyer believes that a seller with $s > p$ accepts with probability $(1 - \chi) \times 0 + \chi \times F(p)$. Consequently, the buyer believes that the average type of seller who accepts p is $(1 - \chi)E[S|S \leq p] + \chi E[S]$. The buyer thus chooses p to maximize $F(p) \times ((1 - \chi) \times E[S|S \leq p] + \chi \times E[S] - p)$. Since $E[S] > 0$, the buyer's optimal offer is $p^* > 0$. Moreover, since the buyer's objective function is supermodular in (p, χ) for $p \in [0, E[S]]$, Topkis's Theorem implies that p^* increases in χ . In summary, cursedness produces trade in no-trade settings, and the more cursed the buyer, the higher the volume of trade is.

3 Model, Equilibrium Concept, and Equilibrium Conditions

In this section, we begin by defining cursed-expectations equilibrium in a general version of our model, before making more specific assumptions on traders' cursedness parameters, the distribution of their information, and their utility functions, which allow us to derive analytically tractable, linear equilibria. There are two periods, 1 and 2, and two assets that pay off in terms of a consumption good in Period 2. One asset is riskless and pays off one unit of the consumption good with certainty. The other asset is risky and pays $d = \bar{d} + \epsilon + \zeta$ units, where \bar{d} is a constant and

(ϵ, ζ) are random variables with mean zero. We use the riskless asset as the numeraire, and denote by p the price of the risky asset in Period 1. Our choice of numeraire implies that the price of the risky asset in Period 2 is d and the riskless rate is zero. We assume that the risky asset is in zero supply.

There are N traders who can exchange the two assets in Period 1. Trader $i = 1, \dots, N$ observes the private signal

$$s_i = \epsilon + \eta_i, \tag{3}$$

as well as the public signal

$$s = \epsilon + \eta, \tag{4}$$

which is also observed by all other traders. The random variables $(\{\eta_i\}_{i=1, \dots, N}, \eta)$ have mean zero. The signals are observed in Period 1. They provide information about the component ϵ of the risky asset's payoff but not about ζ .

Trader i starts with a zero endowment of the riskless and the risky assets, and receives an endowment $z_i d$ of the consumption good in Period 2. We refer to z_i as the endowment shock, and assume that it is observed in Period 1 and has mean zero. Through its correlation with d , the endowment generates a hedging motive to trade. When, for example, $z_i > 0$, trader i is exposed to the risk that d will be low and wishes to hedge by selling the risky asset. We assume that the variables $(\epsilon, \zeta, \{\eta_i\}_{i=1, \dots, N}, \eta, \{z_i\}_{i=1, \dots, N})$ are mutually independent.

The budget constraint of trader i is

$$W_i = x_i(d - p) + z_i d, \tag{5}$$

where x_i denotes the number of shares of the risky asset held by the trader in Period 1. We impose no portfolio constraints, e.g., on short sales or leverage, and assume that x_i can take any value in \mathbb{R} .

Traders maximize expected utility of consumption in Period 2. We denote by $u_i(W_i)$ the utility of trader i . If the trader is rational, he maximizes the expected utility

$$E[u_i(x_i(d - p) + z_i d) | \{s_i, s, z_i, p\}],$$

where we use (5) to substitute for W_i . A rational trader conditions his estimate of the asset payoff d on his private signal, the public signal, the endowment shock, and the price. To derive the objective of a cursed trader, we adapt the analysis of Section 2 to our price-taking setting. From the point of view of trader i , the actions of other traders are summarized in the price p , which trader i observes. Therefore, there is no need to compute the average actions of other traders as is done in Section 2. We focus instead on trader i 's posterior distribution conditional on the price. Recall from Section 2 that a χ_i -cursed player i best-responds to beliefs that with probability $1 - \chi_i$ the other players' actions depend on their types and with probability χ_i actions do not depend on types. Therefore, player i 's posterior beliefs conditional on observing action profile a_{-i} are the average of the true posteriors with weight $1 - \chi_i$ (since player i treats actions by other players as informative about types with probability $1 - \chi_i$) and the beliefs before observing a_{-i} with weight χ_i (since player i treats actions as uninformative with probability χ_i). We adapt this result, proven as Lemma 1 of Eyster and Rabin (2005), in our setting by replacing a_{-i} with the price p . If trader i is χ_i -cursed, he maximizes the expected utility

$$(1 - \chi_i)\mathbb{E}[u_i(x_i(d - p) + z_i d) | \{s_i, s, z_i, p\}] + \chi_i \mathbb{E}[u_i(x_i(d - p) + z_i d) | \{s_i, s, z_i\}],$$

which is an average of the rational expected utility with weight $1 - \chi_i$ and the expected utility not conditioned on price with weight χ_i .

Our definition of cursed-expectations equilibrium combines utility maximization under cursed expectations with market clearing. As in the case of REE, the equilibrium involves a price function p that depends on all the random variables in the model. These are the private signals $\{s_i\}_{i=1, \dots, N}$, the public signal s , and the endowment shocks $\{z_i\}_{i=1, \dots, N}$.

Definition 3 *A price function $p(\{s_i\}_{i=1, \dots, N}, s, \{z_i\}_{i=1, \dots, N})$ and demand functions $\{x_i(s_i, s, z_i, p)\}_{i=1, \dots, N}$ are a cursed-expectations-equilibrium (CEE) if:*

(i) (**Optimization**) *For each trader $i = 1, \dots, N$, and each (s_i, s, z_i, p) ,*

$$x_i \in \arg \max_x \{ (1 - \chi_i)\mathbb{E}[u_i(x(d - p) + z_i d) | \{s_i, s, z_i, p\}] + \chi_i \mathbb{E}[u_i(x(d - p) + z_i d) | \{s_i, s, z_i\}] \}, \tag{6}$$

(ii) (**Market Clearing**) For each $(\{s_i\}_{i=1,\dots,N}, s, \{z_i\}_{i=1,\dots,N})$,

$$\sum_{i=1}^N x_i = 0. \quad (7)$$

We next specialize our analysis by making three assumptions, which allow us to derive tractable linear equilibria. First, the variables $(\epsilon, \zeta, \{\eta_i\}_{i=1,\dots,N}, \eta, \{z_i\}_{i=1,\dots,N})$ follow normal distributions, with variances denoted by $(\sigma_\epsilon^2, \sigma_\zeta^2, \{\sigma_{\eta_i}^2\}_{i=1,\dots,N}, \sigma_\eta^2, \{\sigma_{z_i}^2\}_{i=1,\dots,N})$ and precisions, i.e., the inverses of the variances, denoted by $(\tau_\epsilon, \tau_\zeta, \{\tau_{\eta_i}\}_{i=1,\dots,N}, \tau_\eta, \{\tau_{z_i}\}_{i=1,\dots,N})$. Second, traders have negative exponential, or constant absolute risk aversion (CARA), utility functions: $u_i(W_i) = -\exp(-\alpha_i W_i)$, where α_i is the coefficient of absolute risk aversion. Third, traders can either be rational ($\chi_i = 0$) or fully cursed ($\chi_i = 1$). The third assumption keeps the analysis tractable because when $\chi_i \in (0, 1)$ expected utility involves a weighted average of exponential functions of normally distributed variables, whose maximization does not yield a closed-form solution.

A linear CEE price function has the form

$$p = \bar{d} + \sum_{i=1}^N A_i s_i + A s - \sum_{i=1}^N B_i z_i, \quad (8)$$

for coefficients $(\{A_i\}_{i=1,\dots,N}, A, \{B_i\}_{i=1,\dots,N})$. For CARA utility and $\chi_i \in \{0, 1\}$, we can write trader i 's objective in (6) as

$$\begin{aligned} & -\mathbf{E}[\exp[-\alpha_i(x_i(d-p) + z_i d)] | I_i] \\ & = -\exp\left[-\alpha_i\left(x_i(\mathbf{E}(d|I_i) - p) + z_i \mathbf{E}(d|I_i) - \frac{1}{2}\alpha_i(x_i + z_i)^2 \text{Var}(d|I_i)\right)\right], \end{aligned} \quad (9)$$

where the information set I_i is equal to $\{s_i, s, z_i, p\}$ if $\chi_i = 0$ and to $\{s_i, s, z_i\}$ if $\chi_i = 1$. The second step in (9) follows because all variables are normally distributed. The first-order condition yields the demand

$$x_i = \frac{\mathbf{E}(d|I_i) - p}{\alpha_i \text{Var}(d|I_i)} - z_i. \quad (10)$$

Combining (10) with the market-clearing condition (7), we derive conditions in Proposition 1 so that (8) is an equilibrium price. Proposition 1 does not show existence or uniqueness of

$(\{A_i\}_{i=1,\dots,N}, A, \{B_i\}_{i=1,\dots,N})$ satisfying these conditions, both of which are instead demonstrated in the special cases studied in subsequent sections.⁹

To state Proposition 1, we introduce some notation. From the perspective of a rational trader i , the price (8) includes information on (s_i, s, z_i) , which the trader knows, and on $(\{s_i\}_{j \neq i}, \{z_i\}_{j \neq i})$, which he does not. The latter information is summarized in the signal

$$\frac{\sum_{j \neq i} A_j s_j - \sum_{j \neq i} B_j z_j}{\sum_{j \neq i} A_j}, \quad (11)$$

which the trader can extract from the price. Using (3) and (4), we can write this signal as $\epsilon + \theta_i$, where

$$\theta_i \equiv \frac{\sum_{j \neq i} A_j \eta_j - \sum_{j \neq i} B_j z_j}{\sum_{j \neq i} A_j}. \quad (12)$$

We denote the variance of θ_i by $\sigma_{\theta_i}^2$ and its precision by τ_{θ_i} . We set

$$\mathcal{T} \equiv \sum_{i \in C} \frac{\tau_\epsilon + \tau_{\eta_i} + \tau_\eta}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} + \sum_{i \in R} \frac{\tau_\epsilon + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_i}}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_i})},$$

where R denotes the set of rational traders and C that of cursed traders.

Proposition 1 *The price (8) is an equilibrium price if and only if $(\{A_i\}_{i=1,\dots,N}, A, \{B_i\}_{i=1,\dots,N})$ satisfy the conditions*

$$\frac{\tau_{\eta_i}}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} = A_i \left[\mathcal{T} - \sum_{j \in R} \frac{\tau_{\theta_j}}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_j}) \sum_{k \neq j} A_k} \right], \quad (13)$$

$$B_i = A_i \alpha_i \frac{\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta}{\tau_\zeta \tau_{\eta_i}}, \quad (14)$$

for $i \in C$;

$$\frac{\tau_{\eta_i}}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_i})} = A_i \left[\mathcal{T} - \sum_{j \in R \setminus \{i\}} \frac{\tau_{\theta_j}}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_j}) \sum_{k \neq j} A_k} \right], \quad (15)$$

$$B_i = A_i \alpha_i \frac{\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_i}}{\tau_\zeta \tau_{\eta_i}}, \quad (16)$$

⁹A broader issue related to uniqueness is whether equilibria with non-linear price functions exist. Since cursed traders' demand functions are independent of the price function, this issue is easier to address than in REE. We can show that the linear CEE derived in Section 4.2 is unique among all possible equilibria.

for $i \in R$; and

$$\sum_{i \in C} \frac{\tau_\eta}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} + \sum_{i \in R} \frac{\tau_\eta}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_i})} = A\mathcal{T}. \quad (17)$$

4 No Endowment Shocks

This section analyzes the model in the case where there are no endowment shocks. This case is derived by setting the variances $\{\sigma_{z_i}^2\}_{i=1,\dots,N}$ of endowment shocks equal to zero. The shocks are then equal to their mean, which is zero. Without endowment shocks, traders lack a hedging motive to trade, and trade can occur only because of the private signals. The price (8) takes the form

$$p = \bar{d} + \sum_{i=1}^N A_i s_i + A s. \quad (18)$$

4.1 All Traders Rational

We begin with the benchmark case where all traders are rational. Proposition 2 shows that the coefficients $(\{A_i\}_{i=1,\dots,N}, A)$ in the price (18), which are characterized by the conditions in Proposition 1, are uniquely determined.

Proposition 2 *Suppose that there are no endowment shocks and all traders are rational. The price (18) is an equilibrium price if and only if*

$$A_i = \frac{\tau_{\eta_i}}{\tau_\epsilon + \sum_{j=1}^N \tau_{\eta_j} + \tau_\eta}, \quad (19)$$

$$A = \frac{\tau_\eta}{\tau_\epsilon + \sum_{j=1}^N \tau_{\eta_j} + \tau_\eta}. \quad (20)$$

There is no trade in equilibrium.

That there is no trade in equilibrium is a manifestation in the context of our model of the no-trade theorem of Milgrom and Stokey (1982). Since traders start with zero endowments in the risky asset and receive no endowment shocks, no-trade is a Pareto-efficient allocation and hence the unique equilibrium outcome.

The coefficients $(\{A_i\}_{i=1,\dots,N}, A)$ with which the private and the public signals enter into the price are proportional to these signals' precisions. Therefore, the price aggregates all the signals efficiently, as in Grossman (1976). The price equals the expected value of the asset payoff d conditional upon all of the signals in the market (see Lemma A.1 in the Appendix).

4.2 All Traders Cursed

We next turn to the case where all traders are cursed. Proposition 3 shows that the coefficients $(\{A_i\}_{i=1,\dots,N}, A)$ in the price (18) are uniquely determined.

Proposition 3 *Suppose that there are no endowment shocks and all traders are cursed. The price (18) is an equilibrium price if and only if*

$$A_i = \frac{\frac{\tau_{\eta_i}}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)}}{\sum_{j=1}^N \frac{\tau_\epsilon + \tau_{\eta_j} + \tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)}}, \quad (21)$$

$$A = \frac{\sum_{j=1}^N \frac{\tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)}}{\sum_{j=1}^N \frac{\tau_\epsilon + \tau_{\eta_j} + \tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)}}. \quad (22)$$

Unlike in the case where all traders are rational, the coefficients $(\{A_i\}_{i=1,\dots,N}, A)$ are not proportional to the precisions of the corresponding signals. Therefore, the price does not aggregate the signals efficiently. Proposition 4 compares the coefficients $(\{A_i\}_{i=1,\dots,N}, A)$ in the rational and cursed cases.

Proposition 4 *Suppose that there are no endowment shocks and all traders are cursed. Compared to the case where all traders are rational:*

- (i) *The coefficient A with which the public signal enters into the price is larger.*
- (ii) *The sum across traders of the coefficients $\{A_i\}_{i=1,\dots,N}$ with which private signals enter into the price is smaller. The coefficient A_i for any given trader i can be larger or smaller.*
- (iii) *The ratio A_i/A is smaller.*

In both the rational and the cursed case, the price is a weighted average of traders' conditional expectations of the asset payoff d . This follows by substituting the demands $\{x_i\}_{i=1,\dots,N}$ given by (10), for $\{z_i\}_{i=1,\dots,N} = 0$, into the market-clearing condition (7) and solving for p :

$$p = \frac{\sum_{i=1}^N \frac{E(d|I_i)}{\alpha_i \text{Var}(d|I_i)}}{\sum_{i=1}^N \frac{1}{\alpha_i \text{Var}(d|I_i)}}. \quad (23)$$

Trader i 's conditional expectation receives weight $\frac{1}{\sum_{j=1}^N \frac{1}{\alpha_j \text{Var}(d|I_j)}}$ in the weighted average. This weight is larger for traders who are less risk averse or observe more precise signals because they trade more aggressively on any given discrepancy between the price and their conditional expectation. In the rational case, all traders have the same conditional expectation because they learn from the price, which aggregates all the signals efficiently. Therefore, the price is also equal to that conditional expectation. In the cursed case, conditional expectations differ because traders do not learn other traders' signals from the price.

Since cursed traders form conditional expectations using fewer signals than rational traders, they attach larger weight to each signal they use. The public signal thus receives larger weight in each trader's conditional expectation than in the rational case, and hence enters the price with a larger coefficient (Result (i) of Proposition 4). The private signal of any given trader i receives larger weight in that trader's conditional expectation but zero weight in all other traders' expectation. When trader i 's risk aversion is low, the first effect dominates and that signal enters the price with a larger coefficient than in the rational case. The second effect dominates, however, when the coefficients are averaged across traders (Result (ii)). Note that when traders are symmetric, the coefficient corresponding to each trader equals the average coefficient, and hence is smaller than in the rational case. Finally, trader i gives the correct weight to his private signal relative to the public signal. Because, however, other traders give zero weight to trader i 's private signal but positive weight to the public signal, the price in the cursed case underweights the former signal relative to the latter (Result (iii)).

Since private signals are unlikely to be observable to the empiricist, Proposition 4 does not by itself identify observable consequences of cursedness. However, the results of Proposition 4 do have observable implications for the predictability of asset returns. We define the return of the

risky asset between Periods 1 and 2 as the difference between the asset payoff d and the price p . We examine whether this return can be predicted using information available in Period 1, i.e., whether including such information improves the accuracy of a return forecast. When all traders are rational, the return is not predictable based on past information because p is the expectation of d conditional on all the signals available in Period 1.

Proposition 5 *Suppose that there are no endowment shocks and all traders are cursed. The linear regression*

$$d - p = \gamma_1(p - \bar{d}) + \gamma_2 s + \nu \tag{24}$$

yields coefficients $\gamma_1 > 0$ and $\gamma_2 < 0$. Both coefficients are zero when all traders are rational.

The regression (24) predicts the asset return between Periods 1 and 2 using the public signal s and the difference between the price p and the unconditional expectation \bar{d} of the asset payoff. The difference $p - \bar{d}$ can be interpreted as the return between a Period 0, in which no signals are observed and the asset trades at \bar{d} , and Period 1. Hence, the regression measures the extent to which past return and the public signal predict future return. Since the price p is influenced by the private and the public signals, and the regression (24) controls for the latter, the coefficient γ_1 measures the effect of the private signals.

Because (γ_1, γ_2) are non-zero, the return between Periods 1 and 2 is predictable. Holding the public signal constant, high private signals in Period 1 predict a price rise in Period 2 ($\gamma_1 > 0$). Holding instead the private signals constant, a high public signal in Period 1 predicts a price drop ($\gamma_2 < 0$). The price thus under-reacts to the private signals and over-reacts to the public signal. The under-reaction is consistent with Result (ii) of Proposition 4 that the average coefficient with which the private signals enter into the price is smaller in the cursed than in the rational case. The over-reaction is consistent with Result (i) that the coefficient with which the public signal enters into the price is larger in the cursed than in the rational case.

We next predict the asset return between Periods 1 and 2 using only the public signal or only the return between Periods 0 and 1. The coefficient γ in each of these univariate regressions combines the effects of γ_1 and γ_2 . Since γ_1 and γ_2 have opposite signs, the sign of γ is a priori ambiguous.

Proposition 6 *Suppose that there are no endowment shocks and all traders are cursed. The linear regressions*

$$d - p = \gamma s + \nu, \tag{25}$$

$$d - p = \gamma(p - \bar{d}) + \nu, \tag{26}$$

yield coefficients $\gamma = 0$ and $\gamma > 0$, respectively. Both coefficients are zero when all traders are rational.

Since $\gamma = 0$ in the regression (25), the return between Periods 1 and 2 cannot be predicted using the public signal alone, even when traders are cursed. This stems from the fact that cursed traders process correctly the limited set of signals that they observe, and the public signal belongs to that set. The law of iterative expectations thus implies that when a trader’s conditional expectation of the asset payoff d is “conditioned down” on the public signal s , it must equal the expectation of d conditional on s . Since the price p equals a weighted average of traders’ conditional expectations of d (Eq. (23)), the expectation of p conditional on s equals that of d conditional on s , and so $d - p$ cannot be predicted by s .

The return between Periods 1 and 2 can be predicted based on the return between Periods 0 and 1 only. Since $\gamma > 0$, a high return between Periods 0 and 1 predicts a price rise in Period 2, which means that returns exhibit momentum. Since the price in Period 2 is equal to the asset’s payoff, momentum in our model reflects price under-reaction to information. This under-reaction is driven by the price response to the private signals. Because the price under-reacts to information, the return between Periods 0 and 1 has lower variance than when traders are rational. Variance averaged across the return between Periods 0 and 1 and that between Periods 1 and 2 is also lower.

Corollary 1 *Suppose that there are no endowment shocks and all traders are cursed. Compared to the case where all traders are rational, the variance of the return between Periods 0 and 1 is lower, and so is the variance averaged across the return between Periods 0 and 1 and that between Periods 1 and 2.*

The positive coefficient on past return in the regression (26) is consistent with the empirical evidence on return momentum (Jegadeesh and Titman (1993)). The zero coefficient on the public

signal in the regression (25), however, appears at odds with the evidence on post-earnings drift (Bernard and Thomas (1989)). Indeed, according to that evidence, earnings announcements work their way into stock prices slowly, implying a positive coefficient. One way to reconcile our analysis with the evidence is to assume that some traders cannot observe and process announcements immediately. An announcement would then would be formally equivalent to a private signal observed by a subset of traders, and the coefficient in (25) would be positive.

We next explore the implications of cursedness for trading volume. Since cursed traders do not learn others' signals from the price, they trade with each other even without endowment shocks. We define the trading volume generated by trader i as the absolute value of the quantity x_i that the trader trades in equilibrium. Proposition 7 computes expected trading volume in two special cases, and examines how it depends on the precision of private signals.

Proposition 7 *Suppose that there are no endowment shocks and all traders are cursed.*

- (i) *When all traders have the same risk-aversion coefficient α and observe private signals with the same precision $\tau_{\eta c}$, the expected volume that each generates is*

$$\sqrt{\frac{2(N-1)\tau_{\eta c}}{\pi N}} \frac{\tau_{\zeta}}{\alpha(\tau_{\epsilon} + \tau_{\zeta} + \tau_{\eta c} + \tau_{\eta})}. \quad (27)$$

Volume increases in the number of traders N . It is hump-shaped in the common precision $\tau_{\eta c}$ of private signals, with the hump located at $\tau_{\eta c} = \tau_{\epsilon} + \tau_{\zeta} + \tau_{\eta}$.

- (ii) *When all traders have the same risk-aversion coefficient α and the shock ζ has zero variance, the expected trading volume generated by trader i is*

$$\sqrt{\frac{2}{\pi N}} \frac{\sqrt{(\tau_{\epsilon} + \tau_{\eta})^2[\tau_{\eta c} + (N-2)\tau_{\eta_i}] + (\tau_{\epsilon} + \tau_{\eta}) [N\tau_{\eta c}^2 + (N-2)\tau_{\eta_i}^2] + (N\tau_{\eta c} - \tau_{\eta_i})\tau_{\eta c}\tau_{\eta_i}}}{\alpha(\tau_{\epsilon} + \tau_{\eta c} + \tau_{\eta})}}, \quad (28)$$

where $\tau_{\eta c}$ denotes the average precision of private signals. Trader i generates more volume than trader j if and only if he observes a more precise private signal ($\tau_{\eta_i} > \tau_{\eta_j}$).

The intuition why volume is hump-shaped in the precision of private signals when traders are symmetric (Case (i) of Proposition 7) is as follows. Under symmetry, the quantity that a trader

trades in equilibrium is equal to the difference between his conditional expectation of the asset payoff and the average conditional expectation of all traders, adjusted by his risk aversion and conditional variance. The difference in conditional expectations is zero when private signals have zero precision because traders then do not use them and share the same conditional expectation. It is also zero when private signals have infinite precision because they must then reveal the same information. For intermediate values of precision the dispersion in conditional expectations is positive, making volume hump-shaped in the common precision $\tau_{\eta c}$ of private signals.

Adjusting by risk aversion and conditional variance preserves the hump-shaped pattern. The hump is located at a larger value of $\tau_{\eta c}$, and so the adjustment causes trading volume to be increasing in $\tau_{\eta c}$ over a larger interval. This is because an increase in signal precision reduces traders' conditional variances, hence making traders less uncertain and more eager to trade.

Case (ii) of Proposition 7 allows signal precision to differ across traders. Traders' conditional expectations can then differ both because of the private signals and because each trader weights the public signal differently when forming his expectation. For analytical simplicity we eliminate the shock ζ about which traders cannot learn by setting its variance to zero. For $\sigma_\zeta^2 = 0$, the hump in trading volume in Case (i) occurs for $\tau_{\eta c} = \infty$, and so volume is always increasing in $\tau_{\eta c}$. Proposition 7 shows that the same comparison applies in the cross section: traders who observe more precise signals generate more volume than those observing less precise signals.

When traders are symmetric, the per-trader volume increases in market size as measured by the number N of traders. This is because the weight that each trader's private signal receives in the trader's conditional expectation is independent of N while the weight that it receives in the price converges to zero when N becomes large. Hence, each trader's beliefs become more discordant with price as N increases. Since per-trader volume increases in N , total volume converges to infinity when N becomes large: cursedness produces large volume in large markets.

We finally compute traders' expected utilities and examine how they depend on the precision of private signals. We evaluate expected utility in the ex-ante sense, before signals are observed (Period 0). We also focus on the true expected utilities, i.e., compute the expectation under the true joint distribution of the signals and the price, rather than the distribution perceived by cursed

traders.

Proposition 8 *Suppose that there are no endowment shocks, all traders are cursed and have the same risk-aversion coefficient α , and the shock ζ has zero variance. The expected utility of trader i is*

$$-\frac{1}{\sqrt{1 + \frac{(\tau_\epsilon + \tau_\eta)^2 [N\tau_{\eta_i} - (2N-1)\tau_{\eta_c}] - (\tau_\epsilon + \tau_\eta) [N(2N-1)\tau_{\eta_c}^2 - 2N(N+1)\tau_{\eta_c}\tau_{\eta_i} + (N-2)\tau_{\eta_i}^2] - (N\tau_{\eta_c} - \tau_{\eta_i})\tau_{\eta_c}\tau_{\eta_i}}{N(\tau_\epsilon + \tau_{\eta_c} + \tau_\eta)^2(\tau_\epsilon + N\tau_{\eta_c} + \tau_\eta)}}, \quad (29)$$

where τ_{η_c} denotes the average precision of private signals. A trader i who observes a more precise signal than a trader j ($\tau_{\eta_i} > \tau_{\eta_j}$) has higher expected utility if

$$(\tau_\epsilon + \tau_\eta)^2 + 2(N+1)(\tau_\epsilon + \tau_\eta)\tau_{\eta_c} - \tau_{\eta_c}^2 > 0. \quad (30)$$

When (30) fails, there exist $\tau_{\eta_i} > \tau_{\eta_j}$ such that trader i has lower expected utility than trader j .

Proposition 8 shows that cursed traders who observe more precise signals can be worse off relative to those observing less precise signals. This is not a manifestation of the standard result that asymmetric information makes traders worse off by destroying trading opportunities (Akerlof (1970), Hirshleifer (1971)). Indeed, the standard result compares expected utilities when traders are uninformed to those when some traders become informed and equilibrium prices change. Proposition 8 compares instead expected utilities of two traders who differ in the precision of their information, are present in the market at the same time, and face the same equilibrium price.

To explain how signal precision affects expected utility, we consider a trader who observes a completely uninformative private signal. Because the trader does not learn from the price, he falls victim to trading against others' private signals, e.g., buys when others observe negative signals. If the trader observes instead an informative signal, less of that trading occurs because his signal is better aligned with others' signals, e.g., is more likely to be negative when others' signals are negative. At the same time, a new effect appears: because the trader does not learn from the price, he trades overly aggressively on his signal and becomes exposed to excessive risk. When the second effect dominates, traders with more precise signals are worse off relative to those with less precise signals.

According to (30), the second effect dominates when the average precision $\tau_{\eta c}$ of private signals is high, but the first effect dominates when the number N of traders is large. Intuitively, when precision is high, signals are essentially identical and information is symmetric. As a consequence, returns are not predictable (the regression coefficients in Propositions 5 and 6 are zero) and trading against others' signals does not generate a loss. Hence, the first effect disappears. When instead the market is large, returns remain predictable. Indeed, even though the price aggregates a large number of signals and provides highly precise information, cursed traders neglect that information and rely only on their own signals.

4.3 Rational and Cursed Traders

We next introduce rational traders in a market where all traders are cursed, and study how this modifies the properties derived in Section 4.2. For simplicity, we assume that the rational traders receive no private signals. Thus, the price (18) takes the form

$$p = \bar{d} + \sum_{i \in C} A_i s_i + A s, \quad (31)$$

which allows rational traders to back out a weighted average of cursed traders' signals from price. Proposition 9 shows that the coefficients $(\{A_i\}_{i \in C}, A)$ are uniquely determined.

Proposition 9 *Suppose that there are no endowment shocks, there are cursed and rational traders, and rational traders receive no private signals. The price (31) is an equilibrium price if and only if*

$$A_i = \frac{\left[1 + \frac{\sum_{j \in R} \frac{\tau_\theta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_\eta + \tau_\theta)}}{\sum_{j \in C} \frac{\tau_{\eta_j}}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)}} \right] \frac{\tau_{\eta_i}}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)}}{\sum_{j \in C} \frac{\tau_\epsilon + \tau_{\eta_j} + \tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)} + \sum_{j \in R} \frac{\tau_\epsilon + \tau_\eta + \tau_\theta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_\eta + \tau_\theta)}}, \quad (32)$$

$$A = \frac{\sum_{j \in C} \frac{\tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)} + \sum_{j \in R} \frac{\tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_\eta + \tau_\theta)}}{\sum_{j \in C} \frac{\tau_\epsilon + \tau_{\eta_j} + \tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)} + \sum_{j \in R} \frac{\tau_\epsilon + \tau_\eta + \tau_\theta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_\eta + \tau_\theta)}}, \quad (33)$$

where

$$\tau_\theta \equiv \frac{\left[\sum_{j \in C} \frac{\tau_{\eta_j}}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)} \right]^2}{\sum_{j \in C} \frac{\tau_{\eta_j}}{\alpha_j^2(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)^2}}. \quad (34)$$

The coefficients $\{A_i\}_{i \in C}$ are proportional to their counterparts in the case where all traders are cursed. Since in that case the price does not aggregate the private signals efficiently, aggregation remains inefficient even in the presence of rational traders. Rational traders merely alter the weight with which the public signal and the inefficient aggregate of the cursed traders' private signals enter into the price. Proposition 10 characterizes these effects.

Proposition 10 *Suppose that there are no endowment shocks, there are cursed and rational traders, and rational traders receive no private signals.*

- (i) The coefficient A_i with which the private signal of a cursed trader $i \in C$ enters into the price is larger than in the rational traders' absence.*
- (ii) The coefficient A with which the public signal enters into the price is smaller than in the rational traders' absence.*
- (iii) An increase in the private signal of any cursed trader, holding other signals constant, raises the quantity that rational traders buy in equilibrium. An increase in the public signal, holding other signals constant, lowers that quantity.*

The intuition for Proposition 10 is that rational traders exploit the predictability of asset returns caused by cursedness. When all traders are cursed, the public signal enters into the price with a larger weight than when all traders are rational (Result (i) of Proposition 4) and is negatively correlated with the asset's future return holding the price constant (Proposition 5). Therefore, rational traders sell the asset when the public signal is high, and this lowers the weight with which that signal enters into the price. Conversely, private signals receive a lower average weight when all traders are cursed than when they are rational (Result (ii) of Proposition 4) and this causes the price to be positively correlated with the asset's future return holding the public signal constant (Proposition 5). Therefore, rational traders buy the asset when cursed traders' private signals are high, and this raises the weight with which these signals enter into the price. Rational traders act as momentum traders, buying when the price is high and selling when it is low.

The presence of rational traders strengthens the result of Section 4.2 that cursed traders who observe more precise signals can be worse off relative to those observing less precise signals. Propo-

sition 11 shows that this result holds for a larger set of parameter values than in Proposition 8.

Proposition 11 *Suppose that there are no endowment shocks, there are N_c cursed and N_r rational traders with the same risk-aversion coefficient α , rational traders receive no private signals, and the shock ζ has zero variance. A cursed trader i who observes a more precise signal than a cursed trader j ($\tau_{\eta_i} > \tau_{\eta_j}$) has higher expected utility if*

$$(\tau_\epsilon + \tau_\eta)^2 + 2(N_c + 1)(\tau_\epsilon + \tau_\eta)\tau_{\eta_c} - \tau_{\eta_c}^2 - 2(\tau_\epsilon + \tau_\eta)(\tau_\epsilon + N_c\tau_{\eta_c} + \tau_\eta)\tau_{\eta_c}(2\mu - \tau_{\eta_c}\mu^2) > 0, \quad (35)$$

where τ_{η_c} denotes the average precision of cursed traders' private signals and

$$\mu \equiv \frac{N_r(N_c - 1)}{N_c(\tau_\epsilon + \tau_{\eta_c} + \tau_\eta) + N_r(\tau_\epsilon + N_c\tau_{\eta_c} + \tau_\eta)}. \quad (36)$$

If (35) is violated, then there exist $\tau_{\eta_i} > \tau_{\eta_j}$ such that trader i has lower expected utility than trader j . The term $2\mu - \tau_{\eta_c}\mu^2$ is positive, and hence (35) is satisfied for smaller set of parameter values than (30) when $N_c = N$.

Recall from Section 4 that an increase in signal precision has two effects on the expected utility of a cursed trader. The positive effect is that the trader takes smaller positions when trading against others' signals. The negative effect is that he trades overly aggressively on his own signal and becomes exposed to excessive risk. In the presence of rational traders, return predictability is smaller, and so is the loss from trading against others' signals. Thus, the positive effect of an increase in signal precision is weaker.

When the number of traders becomes large, holding constant the ratio of rational to cursed traders, (35) becomes $(\tau_\epsilon + \tau_\eta)^2 - \tau_{\eta_c}^2 > 0$ and can fail to hold. Thus, unlike in Section 4, cursed traders with more precise signals are not always better off than those with less precise signals, in large markets. This is because the addition of a large number of rational traders causes return predictability to disappear.

5 Endowment Shocks

In this section we introduce endowment shocks. Our main reason to do this is to perform comparative statics of trading volume when all traders are rational. Such comparative statics are not possible when there are no endowment shocks because volume is then equal to zero. We only consider the case where all traders are rational; by continuity, comparative statics of volume when all traders are cursed are as in Proposition 7, provided that endowment shocks are small. For simplicity, we assume that rational traders are symmetric in terms of risk aversion, signal precision, and endowment shock precision. Thus, the price (18) takes the form

$$p = \bar{d} + A_c \sum_{i=1}^N s_i + As - B_c \sum_{i=1}^N z_i. \quad (37)$$

Proposition 9 shows that the coefficients (A_c, A, B_c) are uniquely determined.

Proposition 12 *Suppose that all traders are rational, have the same risk-aversion coefficient α , observe private signals with the same precision $\tau_{\eta c}$, and receive endowment shocks with the same precision τ_{zc} . The price (37) is an equilibrium price if and only if*

$$A_c = \frac{\tau_{\eta c} + \frac{(N-1)\tau_{\eta c}\tau_{zc}}{\tau_{zc} + \frac{B_c^2}{A_c^2}\tau_{\eta c}}}{N \left(\tau_{\epsilon} + \tau_{\eta c} + \tau_{\eta} + \frac{(N-1)\tau_{\eta c}\tau_{zc}}{\tau_{zc} + \frac{B_c^2}{A_c^2}\tau_{\eta c}} \right)}, \quad (38)$$

$$A = \frac{\tau_{\eta}}{\tau_{\epsilon} + \tau_{\eta c} + \tau_{\eta} + \frac{(N-1)\tau_{\eta c}\tau_{zc}}{\tau_{zc} + \frac{B_c^2}{A_c^2}\tau_{\eta c}}}, \quad (39)$$

and $\frac{B_c}{A_c} > 0$ is the unique solution to the cubic equation

$$\left(\tau_{zc} + \frac{B_c^2}{A_c^2}\tau_{\eta c} \right) \left(\frac{B_c}{A_c}\tau_{\eta c} - \alpha(\tau_{\eta} + \tau_{\zeta} + \tau_{\eta c} + \tau_{\eta}) \right) - \alpha(N-1)\tau_{\eta c}\tau_{zc} = 0. \quad (40)$$

When $\tau_{zc} = \infty$, the coefficients A_c on the private signals and A on the public signal coincide with their counterparts in Proposition 2, derived in the case where all traders are rational and there are no endowment shocks. This is because endowment shocks are equal to zero when $\tau_{zc} = \infty$. When instead $\tau_{zc} = 0$, A_c and A coincide with their counterparts in Proposition 3, derived in the

case where all traders are cursed and there are no endowment shocks. This is because endowment shocks have infinite variance when $\tau_{zc} = 0$, and hence the price has infinite noise and provides no information to rational traders. For $0 < \tau_{zc} < \infty$, A_c and A lie between the two extremes.

Proposition 13 *Suppose that all traders are rational, have the same risk-aversion coefficient α , observe private signals with the same precision $\tau_{\eta c}$, and receive endowment shocks with the same precision τ_{zc} . The expected volume that each trader generates is*

$$\sqrt{\frac{2(N-1)\frac{B_c^2}{A_c^2}\tau_{\eta c}}{\pi N\tau_{zc}\left(\tau_{zc} + \frac{B_c^2}{A_c^2}\tau_{\eta c}\right)}}. \quad (41)$$

Volume increases in the number of traders N and is inverse hump-shaped in the common precision $\tau_{\eta c}$ of private signals.

The result of Proposition 13 that volume with rational traders is inverse hump-shaped in the precision of private signals is in sharp contrast to the result of Proposition 7 that volume with cursed traders is hump-shaped. The intuition for the inverse hump-shaped pattern is as follows. Starting from the case where precision is zero, an increase in precision reduces volume because it introduces adverse selection (Akerlof (1970), Hirshleifer (1971)). Adverse selection disappears again when precision is infinite because traders' signals are identical.

When the shock ζ about which traders cannot learn has zero variance, the hump in volume occurs for $\tau_{\eta c} = \infty$, and so volume is always decreasing in $\tau_{\eta c}$. Intuitively, when precision is infinite traders know the asset payoff perfectly. Therefore, while there is no adverse selection, there are also no gains from risk-sharing. Notice that when ζ has zero variance, the corresponding hump with cursed traders also occurs for $\tau_{\eta c} = \infty$, and so volume is always increasing in $\tau_{\eta c}$.

6 Overconfidence and Agreeing to Disagree

Researchers have proposed models for speculative trade based on the idea that traders hold different views of the world, about which they “agree to disagree.” This is modeled as non-common priors on the distribution of asset payoffs, or as common priors but disagreement over the information that different signals convey about payoffs. Models of overconfidence give empirical content

to non-common priors by specifying a particular relationship between belief heterogeneity and the correct interpretation of signals—allowing empirical predictions such as that people who interpret signals more modestly have more accurate beliefs, and that in general people hold overly strong beliefs relative to the true underlying uncertainty. Although this research is based explicitly on prevailing wisdom about overconfidence in psychology, some caution is in order. Despite identifiable circumstances in which people over-infer from information, in other identifiable circumstances people systematically under-infer. For instance, people over-infer from small samples. But they under-infer from large ones.¹⁰ Without a stronger sense of the nature of the private information depicted by these models, it is unclear whether overconfidence is as compelling a general phenomenon as has been portrayed in the literature.

Cursedness may provide an important alternative to overconfidence and agreeing-to-disagree for explaining excess trading volume and other market phenomena. It also gives a fundamentally different account of the epistemology of trade. Cursed trade derives from people’s neglect of disagreement. We believe that a substantial amount of trade is due to such neglect of disagreement rather than people believing that they understand things better than their trading partners. Indeed, in many cases where people seemingly trade based on private information, it is variously implausible or incoherent to assume that they do so from any sense that they understand things better than others. Consider again the example from Section 2. Whereas cursed equilibrium generates trade, other departures from Bayesian Nash equilibrium do not. Overconfidence cannot explain trade, because the seller has a dominant strategy and the buyer lacks private information whose precision to exaggerate. Moreover, since the no-equilibrium-trade prediction does not depend upon the distribution F , the buyer believing F different than it is cannot explain trade. Agreeing-to-disagree can only explain trade if, when the asset is worth s , either the buyer or seller believes that it is not, which makes little sense. Carrillo and Palfrey (2011) present lab evidence on subject behavior in a variant of the example of Section 2 where the buyer also has private information; alternative explanations are similarly hard to fathom in their experiment, and the authors conclude that both

¹⁰See, e.g., Griffin and Tversky (1992), and references and meta-analyses in Benjamin, Rabin, and Raymond (2013).

seller and buyer behavior is explained pretty well by cursed equilibrium.¹¹

To compare cursedness to overconfidence in settings where overconfidence is more compelling, we introduce overconfidence in our model following Odean (1998). We specialize our model to symmetric traders, as assumed in Odean: traders have common risk preferences and receive private signals with common precision $\tau_{\eta c}$. Following Odean, we capture overconfidence by assuming that each trader incorrectly perceives the precision of his own signal to be $\kappa \times \tau_{\eta c}$, for $\kappa \geq 1$ (and $\kappa = 1$ embedding REE in our analysis below), but correctly perceives the precision of all other traders' signals to be $\tau_{\eta c}$. Moreover, this belief system is common knowledge: it is common knowledge that each trader thinks he is better informed than all other traders think he is. Also, we follow Odean by allowing traders to err in a second, conceptually distinct way, namely by underestimating the information content in others' private signals, which we call *contemptuousness*. Each trader incorrectly perceives the precision of all other traders' signals to be $\gamma \times \tau_{\eta c}$, for $\gamma \in [0, 1]$ (and $\gamma = 1$, together with $\kappa = 1$, embedding REE in our analysis below). This too is common knowledge.

Under the parameter values $\kappa = 1$ and $\gamma = 0$, i.e., no overconfidence and extreme contemptuousness, behavior is the same as under full cursedness ($\chi = 1$). This is because a trader who fails to infer another's signal from the price behaves identically to one who fully infers that signal but erroneously assumes that it has zero precision. In the rest of this section we identify contemptuousness with $\gamma > 0$, i.e., traders do not view others' signals as completely worthless, and show that

¹¹Agreeing-to-disagree may be more plausible and prevalent in financial markets, where it is easy to imagine that some traders appreciate that others disagree with them but nonetheless bet on themselves. Indeed, Wall Street may be populated by individuals who believe that they are smarter than others. Other active traders, however, seem far less likely to think that they can outsmart the market. For example, small investors presumably know that much of the smart money on Wall Street has better information than their own. Indeed, we strongly suspect that most of them would hire as experts and advisors the same group of people they are implicitly trading against! Of course, they might believe that most of those whom they trade against are “dumb money”—investors similar to, yet less smart than, themselves. We hypothesize that if small investors paid full attention to the likely identity of those on the other side of their trades, they would trade far less; that is, they fail to think through the logic of disagreement rather than agree to disagree with prevalent market opinions.

overconfident or contemptuous traders behave very differently than cursed ones. This applies both to full cursedness ($\chi = 1$), as we show in Propositions 14 and 15, and to $\chi < 1$.

Proposition 14 derives the equilibrium of our model of overconfidence. Because of symmetry, we look for a price of the form

$$p = \bar{d} + A_c \sum_{i=1}^N s_i + As. \quad (42)$$

Proposition 14 *Suppose that there are no endowment shocks and that each trader observes a private signal with precision $\tau_{\eta c}$, which he misperceives to be $\kappa \times \tau_{\eta c}$ for $\kappa \geq 1$, and also misperceives every other trader's signal to have precision $\gamma \times \tau_{\eta c}$ for $\gamma \in (0, 1]$. When all traders have the same risk-aversion coefficient α , the price (42) is an equilibrium price if and only if*

$$A_c = \frac{\frac{1}{N}[(N-1)\gamma + \kappa]\tau_{\eta c}}{\tau_\epsilon + [(N-1)\gamma + \kappa]\tau_{\eta c} + \tau_\eta}, \quad (43)$$

$$A = \frac{\tau_\eta}{\tau_\epsilon + [(N-1)\gamma + \kappa]\tau_{\eta c} + \tau_\eta}. \quad (44)$$

Compared to the case where all traders are cursed (Proposition 3), the coefficient A_c on the private signals is larger and the coefficient A on the public signal is smaller.

Fixing the contemptuousness parameter γ , more overconfidence (larger κ) causes traders to attach larger weight to their own private signals and smaller weight to the public signal when forming conditional expectations. This causes A_c to increase and A to decrease. Fixing instead the overconfidence parameter κ , more contemptuousness (smaller γ) causes traders to attach smaller weight to other traders' private signals (as revealed by price) and larger weight to the public signal when forming conditional expectations. This causes A_c to decrease and A to increase. Contemptuousness thus moves A_c and A from their REE values in the same direction as cursedness does, while overconfidence moves them in the opposite direction. In either case the price depends less on the public signal and more on the private signals than under full cursedness ($\chi = 1$) since the latter is observationally equivalent to no overconfidence ($\kappa = 1$) and extreme contemptuousness ($\gamma = 0$). Proposition 15 shows that overconfidence and contemptuousness yield dramatically different predictions than cursedness about trading volume.

Proposition 15 *Suppose that there are no endowment shocks and that each trader observes a private signal with precision $\tau_{\eta c}$, which he misperceives to be $\kappa \times \tau_{\eta c}$ for $\kappa \geq 1$, and also misperceives every other trader's signal to have precision $\gamma \times \tau_{\eta c}$ for $\gamma \in (0, 1]$. When all traders have the same risk-aversion coefficient α , the expected volume that each generates is*

$$\sqrt{\frac{2(N-1)\tau_{\eta c}}{\pi N} \frac{(\kappa - \gamma)\tau_{\zeta}}{\alpha [\tau_{\epsilon} + \tau_{\zeta} + [(N-1)\gamma + \kappa]\tau_{\eta c} + \tau_{\eta}]}}. \quad (45)$$

Volume declines to zero as the number N of traders grows large.

Overconfident or contemptuous traders can trade for two reasons: first, each thinks that the price overweights all other traders' signals; second, each thinks that the price underweights her own signal. Since each trader inverts the price to perfectly infer the average signal of all other traders, the price would not change if all private signals were made public. If all signals were public, then each trader's expectation of the asset payoff d would be a weighted average of her own signal, the average signal of other traders, and what we call the public signal s . For any $\kappa \geq 1$ and $\gamma \in (0, 1]$, as N grows large, each trader puts arbitrarily more weight on the average signal of other traders than on her own signal. Hence, the difference between any two traders' expectations of d converges to zero, and so does per-trader volume.¹² Comparing Propositions 7 and 15 reveals a key difference between cursedness and overconfidence or contemptuousness. When traders are cursed, per-trader volume grows as the market becomes large. When instead traders are overconfident or contemptuous, per-trader volume vanishes in the limit. Indeed, it declines so quickly that total volume aggregated across all traders converges not to infinity, as with cursed traders, but to a finite constant.¹³

Overconfident per-trader volume disappears in our model because each trader, no matter how overconfident, believes that the information conveyed by price about all other traders' signals trumps her own private signal in a sufficiently large market. This would not happen if traders

¹²The fact that equilibrium prices do not depend upon whether signals are public or private suggests that per-trader volume would be negligible in large markets even in complete-information models of overconfidence (e.g., Sheinkman and Xiong (2003)) if traders are risk averse.

¹³Formally, N times the expected volume of each trader converges to $\sqrt{\frac{2\tau_{\eta c}}{\pi} \frac{(\kappa - \gamma)\tau_{\zeta}}{\alpha \gamma \tau_{\eta c}}}$ when N goes to infinity.

believed that their private information conveyed something non-negligible beyond the information conveyed by a large-market price. Odean (1998) implicitly makes this assumption by assuming that the N traders in the market observe $M < N$ signals in such a way that $\frac{N}{M} > 1$ observe each signal. He computes volume when $\gamma = 1$ and $N \rightarrow \infty$, but holds M fixed. Whatever the value of M , each signal conveys non-negligible information beyond that conveyed by all other signals.

Propositions 14 and 15 contrast overconfidence and contemptuousness to full cursedness ($\chi = 1$). We expect, however, that the volume comparison carries through to general χ . Indeed, the price in a large market virtually reveals ϵ , leading a χ -cursed trader to form conditional expectations approximately equal to $(1 - \chi)(\bar{d} + \epsilon) + \chi E[d|\{s_i, s, z_i\}]$. Thus, differences in beliefs among χ -cursed traders persist in large markets, and total volume converges to infinity. This suggests that any $\chi \in (0, 1)$ would generate more trade than any $\gamma \in (0, 1]$ in a sufficiently large market.

We conclude with the observation that overconfidence *does* have substantial effects when traders *are* cursed. Proposition 16 derives volume when traders are overconfident and cursed. As in the case where traders are cursed but not overconfident, per-trader volume grows when the market becomes large and hence total volume converges to infinity. The additional effect of overconfidence is to increase per-trader volume even in the large-market limit. Overconfidence thus has an effect only when traders are cursed, and it amplifies the effect of cursedness. In this sense, overconfidence and cursedness work as complements. Intuitively, when traders fail to infer information from prices, overconfidence magnifies differences in their beliefs, which produces more trade.

Proposition 16 *Suppose that there are no endowment shocks and all traders are cursed. When all traders have the same risk-aversion coefficient α and observe private signals with the same precision $\tau_{\eta c}$ that they misperceive as $\kappa \times \tau_{\eta c}$ for $\kappa \geq 1$, the expected volume that each generates is*

$$\sqrt{\frac{2(N-1)\tau_{\eta c}}{\pi N} \frac{\kappa\tau_{\zeta}}{\alpha(\tau_{\epsilon} + \tau_{\zeta} + \kappa\tau_{\eta c} + \tau_{\eta})}}. \quad (46)$$

Volume increases in the number of traders N and in the overconfidence parameter κ .

7 Discussion and Conclusion

In this paper, we propose a market equilibrium definition, *cursed expectations equilibrium (CEE)*, for traders who are cursed and fail to fully infer information from prices. We compare CEE to REE and find that although each cursed trader puts more weight on his own private signal than would a rational trader, because traders neglect that the price encodes other traders' information, CEE prices depend less on private signals and more on public signals than REE prices. We show that this creates a predictable pattern in prices: prices are expected to rise following a rise in the current price. Consequently, rational traders without any private information of their own employ momentum strategies, buying after price rises and selling after price drops. We show that cursed traders may be worse off with better private information because they trade too aggressively on that information. More private information in the market may increase the volume of trade, in contrast to markets with rational traders. We contrast cursed trade to overconfidence-based trade, showing that cursed volume per trader grows with the size of the market, whereas overconfidence-based per-trader volume declines to zero. Cursedness, however, can enhance overconfidence-based trade.

How can we extend cursed-expectations equilibrium to dynamic settings? In a cursed equilibrium, agents understand the relationship between their opponents' actions across periods. Consequently, if the private signal that agent i receives in period t feeds into both p_t and p_{t+1} , then cursed agents will forecast p_{t+1} more accurately from p_t than befits the motivation behind cursedness. Indeed, a shortcoming of cursed equilibrium emphasized by Eyster and Rabin (2005) in their conclusion is that it captures failures of contingent thinking about the relationship between private information and action, but not those about the relationship between action and action. Extending the logic of CEE to multiple periods probably requires relaxing the assumption that agents correctly perceive the correlation among actions. One approach might resemble that of Eyster and Piccione (2013), who model a dynamic market where agents trade based on potentially incomplete models of the relationship between next period's price and current, publicly available economic variables. Each trader uses a theory comprised of some subset of these variables and forecasts next period's expected price correctly conditional upon all included variables. One major

conceptual difference of their approach from CEE is that it offers no guidance as to which theories traders are likely to employ.¹⁴ Nevertheless, it might be marriageable to CEE by having a cursed trader i forecast the next-period price p_{t+1} conditional upon the current price p_t , his current (accumulated) private signal, $s_{i,t}$, and the current (accumulated) public signal s_t , excluding all lagged prices, as $E[p_{t+1}|\{s_{i,t}, s_t\}]$. With only two periods, and $p_2 = d$, this formulation delivers CEE in our model. With more periods, it preserves the feature of our model that in every period traders fully appreciate the relationship that next period’s price has to their signals.

A dynamic model may also highlight the role of a second shortcoming in inference from market prices that might affect traders. Eyster and Rabin (2010) develop the concept of “best response trailing naive inference”: to the extent that agents *do* infer some private information from earlier actions (or prices), they may neglect how others infer information from actions. Models embedding this joint tendency to underappreciate the information about others’ beliefs contained in market prices, with the tendency to underappreciate how those beliefs do not reflect independent information, may provide ways of understanding the co-existence of under-inference as emphasized in this paper with unwarranted swings in group beliefs that also appear to be a hallmark of financial beliefs. In a narrower sense, combining the two errors may help better understand dynamics of market prices. In a dynamic market, agents in period $t + 2$ may fail to appreciate how those in period $t + 1$ infer private information from prices in period t . Suppose that the price is high in both periods t and $t + 1$. If some agents in period $t + 2$ neglect that some of the positive information contained in the period $t + 1$ price is in fact information agents gleaned from the high period t price, then they will overestimate the positive information in the high prices, and push the price up further. This additional type of error in inference may then produce medium-run over-reaction to private information to accompany the short-run under-reaction that underlies our current result on momentum.

¹⁴Rabin (2013) advocates the methodological advantages of “portable extensions of existing models” such as cursed equilibrium. Just as CEE identifies directional departures from REE in the static model of this paper, a dynamic extension is likely to make directional predictions that are merely accommodated by the framework of Eyster and Piccione (2013).

In Section 6, we showed the necessity in some settings of cursedness to “enable” overconfidence to explain appreciable per-trader volume of trade. We conclude by speculating how cursedness may similarly enable the study of various other biases in asset markets. Researchers have recently proposed that a number of statistical errors may be relevant for financial decisions, including over-inference from small samples (see Rabin (2002) and Rabin and Vayanos (2010)) and non-belief in the law of large numbers (see Benjamin, Rabin, and Raymond (2013)). Predicting the consequences of these and other biases for markets where traders extract information from prices requires additional assumptions about traders’ theories of one another’s errors. Yet relatively little is known about how people reason about others’ errors. In its extreme, cursedness provides a simple assumption about what people think of others’ errors: they don’t think about them at all. If models of errors are instead closed by assuming that people do agree to disagree about the meaning of private signals, then, much like with overconfidence in Section 6, we suspect that the per-trader volume of trade will be small in information-rich settings where each trader values the sum total of others’ private information far more heavily than her own private signal. Finally, whereas we have assumed throughout the paper that private signals convey true information about the value of the risky asset, it might instead be the case that traders share a common misperception of the meaningfulness of signals. Indeed, much of “private information”, especially that held by unsophisticated investors, may in fact be irrelevant. Otherwise rational traders who agree to *agree* on the information content of such private signals would, of course, not generate high volume of trade. Asymmetries in beliefs created by these false private signals would, however, produce cursed trade.

References

- [1] Akerlof, G. 1970, “The Market for ‘Lemons’: Quality Uncertainty and the Market Mechanism”, *Quarterly Journal of Economics* 84(3): 488-500.
- [2] Benjamin, D., Rabin, M. and C. Raymond 2013, “A Model of Non-Belief in the Law of Large Numbers”, Mimeo.
- [3] Bernard, V. and J. Thomas 1989, “Post-Earnings-Announcement Drift: Delayed Price Response or Risk Premium?”, *Journal of Accounting Research* 27(Suppl):1-36.
- [4] Carrillo, J. and T. Palfrey 2011, “No Trade”, *Games and Economic Behavior* 71(1): 66-87.
- [5] Daniel, K.; Hirshleifer, D. and A. Subrahmanyam 1998, “Investor Psychology and Security Market under- and Overreactions”, *Journal of Finance* 53(6): 1839-1885.
- [6] Daniel, K.; Hirshleifer, D. and A. Subrahmanyam 2001, “Overconfidence, Arbitrage, and Equilibrium Asset Pricing”, *Journal of Finance* 56(3): 921-965.
- [7] DeLong, J., Shleifer, A., Summers, L. and R. Waldmann 1990, “Noise Trader Risk in Financial Markets”, *Journal of Political Economy* 98: 703-738.
- [8] Diamond D. and R. Verrecchia 1981, “Information Aggregation in a Noisy Rational Expectations Equilibrium”, *Journal of Financial Economics* 9: 221-235.
- [9] Esponda, I. and E. Vespa 2013, “Hypothetical Thinking and Information Extraction: Strategic Voting in the Laboratory”, Mimeo, NYU Stern.
- [10] Eyster, E. and M. Piccione 2013, “An Approach to Asset-Pricing Under Incomplete and Diverse Perceptions”, *Econometrica* 81(4): 1483-1506.
- [11] Eyster, E. and M. Rabin 2005, “Cursed Equilibrium”, *Econometrica* 73(5): 1623-1672.
- [12] Eyster, E. and M. Rabin 2010, “Naïve Herding in Rich-Information Settings”, *American Economic Journal: Microeconomics* 2: 221-43.

- [13] French, K. 2008, “Presidential Address: The Cost of Active Investing”, *Journal of Finance* 63(4): 1537-1573.
- [14] Griffin, D. and A. Tversky 1992, “The Weighing of Evidence and the Determinants of Confidence”, *Cognitive Psychology* 24(3): 411-435.
- [15] Grossman, S. 1976, “On the Efficiency of Competitive Stock Markets when Traders Have Diverse Information”, *Journal of Finance* 31: 573-585.
- [16] Harris, M. and A. Raviv 1993, “Difference of Opinion Make a Horse Race”, *Review of Financial Studies* 6: 473-506.
- [17] Harrison, J. M. and D. Kreps 1978, “Speculative Investor Behavior in a Stock Market with Heterogenous Expectations”, *Quarterly Journal of Economics* 93(2): 323-336.
- [18] Hellwig, M. 1980, “On the Aggregation of Information in Competitive Markets”, *Journal of Economic Theory* 22: 477-498.
- [19] Hirshleifer, J. 1971, “The Private and Social Value of Information and the Reward to Inventive Activity”, *American Economic Review* 61(4): 561-574.
- [20] Holt, C. and R. Sherman 1994, “The Loser’s Curse”, *American Economic Review* 84(3): 642-652.
- [21] Hong, H. J. Scheinkman and W. Xiong 2006. “Asset Float and Speculative Bubbles”, *Journal of Finance*, American Finance Association 61: 1073-1117.
- [22] Hong, H. and J. Stein 1999, “A Unified Theory of Underreaction, Momentum Trading and Overreaction in Asset Markets”, *Journal of Finance* 54(6): 2143-2184.
- [23] Hong, H. and J. Stein 2007, “Disagreement and the Stock Market”, *Journal of Economic Perspectives* 21(2): 109-128.
- [24] Jegadeesh, N. and S. Titman 1993, “Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency”, *Journal of Finance* 48: 65-91.

- [25] Jegadeesh, N. and S. Titman 2011, “Momentum”, *Annual Review of Financial Economics* 3: 493-509.
- [26] Kagel, J. and D. Levin 2002, *Common Value Auctions and the Winner’s Curse*, Princeton University Press.
- [27] Kandel, E. and N. Pearson 1995, “Differential Interpretation of Public Signals and Trade in Speculative Markets”, *Journal of Political Economy* 103: 831-72.
- [28] Malmendier, U. and G. Tate 2008, “Who Makes Acquisitions? CEO Overconfidence and the Market’s Reaction”, *Journal of Financial Economics* 89(1): 20-43.
- [29] Milgrom, P. and N. Stokey 1982, “Information, Trade and Common Knowledge”, *Journal of Economic Theory* 26(1): 17-27.
- [30] Morris, S. 1996, “Speculative Investor Behavior and Learning”, *Quarterly Journal of Economics* 111: 1111-1133.
- [31] Odean, T. 1998, “Volume, Volatility, and Price when all Traders Are Above Average”, *Journal of Finance* 53(6): 1887-1934.
- [32] Rabin, M. 2002, “Inference by Believers in the Law of Small Numbers”, *Quarterly Journal of Economics* 117(3): 775-816.
- [33] Rabin, M. 2013, “An Approach to Incorporating Psychology into Economics,” *American Economic Review (Papers & Proceedings)* 103(3): 617-22.
- [34] Rabin, M. and D. Vayanos 2010, “The Gambler’s and Hot-Hand Fallacies: Theory and Applications,” *Review of Economic Studies* 77: 730-778.
- [35] Samuelson, W. and Bazerman, M. 1985, “The Winner’s Curse in Bilateral Negotiations.” In *Research in Experimental Economics, vol. 3*, Vernon L. Smith, ed., Greenwich, CT: JAI Press.
- [36] Scheinkman, J. and W. Xiong 2003, “Overconfidence and Speculative Bubbles”, *Journal of Political Economy* 111(6): 1183-1219.

- [37] Varian, H. 1989, "Divergence of Opinion in Complete Markets: A Note", *Journal of Finance* 40: 309-317.
- [38] Weizsäcker, G. 2010, "Do We Follow Others when We Should? A Simple Test of Rational Expectations" *American Economic Review* 100: 2340-2360.

APPENDIX—Proofs

We first prove the following lemma, which we use for proving Proposition 1.

Lemma A.1 *Suppose that the variables $(x, \{y_i\}_{i=1,\dots,K})$ are normal, independent, with mean zero and precisions $(\tau_x, \{\tau_{y_i}\}_{i=1,\dots,K})$. Then, the distribution of x conditional on $\{x+y_i\}_{i=1,\dots,K}$ is normal with mean*

$$\mathbb{E}(x | \{x+y_i\}_{i=1,\dots,K}) = \sum_{i=1}^K \frac{\tau_{y_i}}{\tau_x + \sum_{j=1}^K \tau_{y_j}} (x+y_i) \quad (\text{A.1})$$

and precision

$$\tau(x | \{x+y_i\}_{i=1,\dots,K}) = \tau_x + \sum_{i=1}^K \tau_{y_i}. \quad (\text{A.2})$$

Proof. The conditional mean and variance can be computed from the regression

$$x = \sum_{i=1}^K \beta_i (x+y_i) + e,$$

where $\{\beta_i\}_{i=1,\dots,K}$ are the regression coefficients and e is the error term. Taking covariances of both sides with $x+y_i$ and noting that $(x, \{y_i\}_{i=1,\dots,K}, e)$ are independent, we find

$$\begin{aligned} \text{Cov}(x, x+y_i) &= \sum_{j=1}^N \beta_j \text{Cov}(x+y_j, x+y_i) \\ &\Rightarrow \frac{1}{\tau_x} = \beta_i \left(\frac{1}{\tau_x} + \frac{1}{\tau_{y_i}} \right) + \sum_{j \neq i} \beta_j \frac{1}{\tau_x} \\ &\Rightarrow \beta_i = \frac{\tau_{y_i}}{\tau_x} \left(1 - \sum_{j=1}^N \beta_j \right). \end{aligned} \quad (\text{A.3})$$

Summing (A.3) across i and solving for $\sum_{j=1}^N \beta_j$, we find

$$\sum_{j=1}^N \beta_j = \frac{\sum_{j=1}^N \tau_{y_j}}{\tau_x + \sum_{j=1}^N \tau_{y_j}}. \quad (\text{A.4})$$

Substituting $\sum_{j=1}^N \beta_j$ from (A.4) into (A.3), we find

$$\beta_i = \frac{\tau_{y_i}}{\tau_x + \sum_{j=1}^K \tau_{y_j}}. \quad (\text{A.5})$$

Since

$$E(x | \{x + y_i\}_{i=1, \dots, K}) = \sum_{i=1}^K \beta_i (x + y_i),$$

(A.5) implies (A.1). Taking variances of both sides and noting that $(x, \{y_i\}_{i=1, \dots, K}, e)$ are independent, we find

$$\begin{aligned} \text{Var}(x) &= \left(\sum_{i=1}^N \beta_i \right)^2 \text{Var}(x) + \sum_{i=1}^N \beta_i^2 \text{Var}(y_i) + \text{Var}(e) \\ \Rightarrow \frac{1}{\tau_e} &= \frac{1}{\tau_x} \left[1 - \left(\frac{\sum_{i=1}^N \tau_{y_i}}{\tau_x + \sum_{i=1}^N \tau_{y_i}} \right)^2 \right] - \sum_{i=1}^N \frac{1}{\tau_{y_i}} \left(\frac{\tau_{y_i}}{\tau_x + \sum_{j=1}^K \tau_{y_j}} \right)^2 \\ \Rightarrow \frac{1}{\tau_e} &= \frac{1}{\tau_x + \sum_{i=1}^N \tau_{y_i}}, \end{aligned} \tag{A.6}$$

where the second step follows from (A.4) and (A.5). Since

$$\tau(x | \{x + y_i\}_{i=1, \dots, K}) = \tau_e,$$

(A.6) implies (A.2). ■

Proof of Proposition 1. We first determine traders' demands using (10). Since $d = \bar{d} + \epsilon + \zeta$ and ζ is independent of traders' information I_i ,

$$E(d | I_i) = \bar{d} + E(\epsilon | I_i), \tag{A.7}$$

$$\text{Var}(d | I_i) = \text{Var}(\epsilon | I_i) + \text{Var}(\zeta) = \frac{1}{\tau(\epsilon | I_i)} + \frac{1}{\tau_\zeta}. \tag{A.8}$$

To compute the distribution of ϵ conditional on I_i for a cursed trader i , we use Lemma A.1 with $x = \epsilon$, $K = 2$ and $\{y_j\}_{j=1,2} = (\eta_i, \eta)$. Combining with (10), (A.7) and (A.8), we find

$$x_i = \frac{\bar{d} + \frac{\tau_{\eta_i}}{\tau_\epsilon + \tau_{\eta_i} + \tau_\eta} s_i + \frac{\tau_\eta}{\tau_\epsilon + \tau_{\eta_i} + \tau_\eta} s - p}{\alpha_i \left(\frac{1}{\tau_\epsilon + \tau_{\eta_i} + \tau_\eta} + \frac{1}{\tau_\zeta} \right)} - z_i. \tag{A.9}$$

To compute the distribution of ϵ conditional on I_i for a rational trader i , we use Lemma A.1 with $x = \epsilon$, $K = 3$ and $\{y_j\}_{j=1,2,3} = (\eta_i, \eta, \theta_i)$. Combining with (10), (A.7) and (A.8), we find

$$x_i = \frac{\bar{d} + \frac{\tau_{\eta_i}}{\tau_\epsilon + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_i}} s_i + \frac{\tau_\eta}{\tau_\epsilon + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_i}} s + \frac{\tau_{\theta_i}}{\tau_\epsilon + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_i}} (\epsilon + \theta_i) - p}{\alpha_i \left(\frac{1}{\tau_\epsilon + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_i}} + \frac{1}{\tau_\zeta} \right)} - z_i. \tag{A.10}$$

We next substitute (A.9) and (A.10) into the market-clearing condition (7), use (8) to write p in terms of $(\{s_i\}_{i=1,\dots,N}, s, \{z_i\}_{i=1,\dots,N})$, and use (11) to write $\epsilon + \theta_i$ in terms of $(\{s_i\}_{j \neq i}, \{z_i\}_{j \neq i})$. This yields an equation that is linear in $(\{s_i\}_{i=1,\dots,N}, s, \{z_i\}_{i=1,\dots,N})$. Identifying terms in s_i for $i \in C$ and $i \in R$ yields (13) and (15), respectively. Identifying terms of s yields (17). Identifying terms in z_i for $i \in C$ and $i \in R$ yields

$$1 = B_i \tau_\zeta \left[\mathcal{T} - \sum_{j \in R} \frac{\tau_{\theta_j}}{\alpha_j (\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_j}) \sum_{k \neq j} A_k} \right], \quad (\text{A.11})$$

$$1 = B_i \tau_\zeta \left[\mathcal{T} - \sum_{j \in R \setminus \{i\}} \frac{\tau_{\theta_j}}{\alpha_j (\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_j}) \sum_{k \neq j} A_k} \right], \quad (\text{A.12})$$

respectively. Combining (A.11) with (13) yields (14). Combining (A.12) with (15) yields (16). ■

Proof of Proposition 2. Subtracting

$$A_i \frac{\tau_{\theta_i}}{\alpha_i (\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_i}) \sum_{j \neq i} A_j}$$

from both sides of (15), we find

$$\frac{\tau_{\eta_i}}{\alpha_i (\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_i})} - A_i \frac{\tau_{\theta_i}}{\alpha_i (\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_i}) \sum_{j \neq i} A_j} = A_i \mathcal{Z}, \quad (\text{A.13})$$

where

$$\mathcal{Z} \equiv \mathcal{T} - \sum_{j=1}^N \frac{\tau_{\theta_j}}{\alpha_j (\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_j}) \sum_{k \neq j} A_k}. \quad (\text{A.14})$$

Since $\sigma_{z_i} = 0$ for all i , (12) implies that

$$\tau_{\theta_i} = \frac{\left(\sum_{j \neq i} A_j \right)^2}{\sum_{j \neq i} \frac{A_j^2}{\tau_{\eta_j}}}. \quad (\text{A.15})$$

Substituting τ_{θ_i} from (A.15) into the left-hand side of (A.13), we can write (A.13) as

$$\begin{aligned} & \frac{\tau_{\eta_i}}{\alpha_i (\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_i}) \sum_{j \neq i} \frac{A_j^2}{\tau_{\eta_j}}} \left(\sum_{j \neq i} \frac{A_j^2}{\tau_{\eta_j}} - \frac{A_i}{\tau_{\eta_i}} \sum_{j \neq i} A_j \right) = A_i \mathcal{Z} \\ \Rightarrow & \sum_{j=1}^N \frac{A_j^2}{\tau_{\eta_j}} - \frac{A_i}{\tau_{\eta_i}} \sum_{j=1}^N A_j = \frac{\alpha_i (\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_i}) A_i \sum_{j \neq i} \frac{A_j^2}{\tau_{\eta_j}}}{\tau_{\eta_i}} \mathcal{Z}. \end{aligned} \quad (\text{A.16})$$

Multiplying (A.16) by A_i and summing over i , we find

$$0 = \sum_{i=1}^N A_i \sum_{i=1}^N \frac{A_i^2}{\tau_{\eta_i}} - \sum_{i=1}^N A_i \sum_{i=1}^N \frac{A_i^2}{\tau_{\eta_i}} = \sum_{i=1}^N \left[\frac{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta + \tau_{\theta_i}) A_i^2 \sum_{j \neq i} \frac{A_j^2}{\tau_{\eta_j}}}{\tau_{\eta_i}} \right] \mathcal{Z},$$

which implies that $\mathcal{Z} = 0$. Eq. (A.16) then implies that

$$\sum_{j=1}^N \frac{A_j^2}{\tau_{\eta_j}} - \frac{A_i}{\tau_{\eta_i}} \sum_{j=1}^N A_j = 0,$$

which in turn implies that

$$A_i = \lambda \tau_{\eta_i}, \tag{A.17}$$

for a constant λ that does not depend on i . Substituting A_i from (A.17) into (A.15), we find

$$\tau_{\theta_i} = \sum_{j \neq i} \tau_{\eta_j}. \tag{A.18}$$

Substituting (A_i, τ_{θ_i}) from (A.17) and (A.18) into (A.14), and recalling that $\mathcal{Z} = 0$, we find

$$\begin{aligned} & \left(\sum_{i=1}^N \frac{1}{\alpha_i} \right) \frac{\tau_\epsilon + \sum_{i=1}^N \tau_{\eta_i} + \tau_\eta}{\tau_\epsilon + \tau_\zeta + \sum_{i=1}^N \tau_{\eta_i} + \tau_\eta} - \frac{1}{\lambda} \left(\sum_{i=1}^N \frac{1}{\alpha_i} \right) \frac{1}{\tau_\epsilon + \tau_\zeta + \sum_{i=1}^N \tau_{\eta_i} + \tau_\eta} = 0 \\ \Rightarrow \lambda &= \frac{1}{\tau_\epsilon + \sum_{i=1}^N \tau_{\eta_i} + \tau_\eta}. \end{aligned} \tag{A.19}$$

Eqs. (A.17) and (A.19) imply (19). Eq. (20) follows similarly by substituting τ_{θ_i} from (A.18) into (17). Substituting $(\epsilon + \theta_i, p, \{A_j\}_{j=1, \dots, N}, A, \tau_{\theta_i})$ from (11), (18), (19), (20) and (A.18) into (A.10), we find that the numerator in (A.10) is zero. Since, in addition $z_i = 0$, trader i 's demand is zero for the equilibrium price. Therefore, there is no trade. ■

Proof of Proposition 3. Solving for A_i using (13) yields (21). Solving for A using (17) yields (22). ■

Proof of Proposition 4. Eqs. (20) and (22) imply that (i) holds if

$$\tau_\epsilon + \sum_{i=1}^N \tau_{\eta_i} + \tau_\eta > \frac{\sum_{i=1}^N \frac{\tau_\epsilon + \tau_{\eta_i} + \tau_\eta}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)}}{\sum_{i=1}^N \frac{1}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)}} = \sum_{i=1}^N w_i(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta), \tag{A.20}$$

where

$$w_i \equiv \frac{\frac{1}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)}}{\sum_{i=1}^N \frac{1}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)}}.$$

Since the weights $\{w_i\}_{i=1,\dots,N}$ are positive and sum to one, the right-hand side of (A.20) is smaller than

$$\tau_\epsilon + \max_{i=1,\dots,N} \tau_{\eta_i} + \tau_\eta < \tau_\epsilon + \sum_{i=1}^N \tau_{\eta_i} + \tau_\eta,$$

and so (A.20) holds.

Eqs. (19) and (21) imply that the first statement in (ii) holds if

$$\frac{\tau_\eta + \sum_{i=1}^N \tau_{\eta_i} + \tau_\eta}{\sum_{i=1}^N \tau_{\eta_i}} < \frac{\sum_{i=1}^N \frac{\tau_\epsilon + \tau_{\eta_i} + \tau_\eta}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)}}{\sum_{i=1}^N \frac{\tau_{\eta_i}}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)}} = \sum_{i=1}^N w_i \frac{\tau_\epsilon + \tau_{\eta_i} + \tau_\eta}{\tau_{\eta_i}}, \quad (\text{A.21})$$

where

$$w_i \equiv \frac{\frac{\tau_{\eta_i}}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)}}{\sum_{i=1}^N \frac{\tau_{\eta_i}}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)}}.$$

Since the weights $\{w_i\}_{i=1,\dots,N}$ are positive and sum to one, the right-hand side of (A.20) is larger than

$$\min_{i=1,\dots,N} \frac{\tau_\epsilon + \tau_{\eta_i} + \tau_\eta}{\tau_{\eta_i}} > \frac{\tau_\eta + \sum_{i=1}^N \tau_{\eta_i} + \tau_\eta}{\sum_{i=1}^N \tau_{\eta_i}},$$

and so (A.21) holds. When traders are symmetric, the first statement in (ii) implies that A_i is smaller in the cursed than in the rational case for all i . To show the second statement in (ii), it suffices to show an example where A_i is larger in the cursed than in the rational case for some i . Suppose that trader i is much less risk averse than the other traders. Eq. (21) then implies that

$$A_i \approx \frac{\tau_{\eta_i}}{\tau_\epsilon + \tau_{\eta_i} + \tau_\eta}$$

in the cursed case. This is larger than A_i in the rational case, given by (19).

Eqs. (19), (20), (21) and (22) imply that (iii) holds if

$$\frac{\tau_{\eta_i}}{\tau_\eta} \frac{\frac{1}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)}}{\sum_{i=1}^N \frac{1}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)}} < \frac{\tau_{\eta_i}}{\tau_\eta},$$

which obviously holds. ■

Proof of Proposition 5. The results for the rational case in Propositions 5 and 6 follow because Proposition 2 implies that

$$p = \mathbb{E}(d | \{s_i\}_{i=1, \dots, N}, s), \quad (\text{A.22})$$

which in turn implies that

$$\mathbb{E}(d - p | I) = \mathbb{E}[d - \mathbb{E}(d | \{s_i\}_{i=1, \dots, N}, s) | I] = \mathbb{E}(d | I) - \mathbb{E}(d | I) = 0,$$

for any information set I consisting of information revealed in Period 1. Since the expectation of $d - p$ conditional on I is zero, the coefficients $(\gamma_1, \gamma_2, \gamma)$ in the regressions in Propositions 5 and 6 are also zero.

To show the results for the cursed case, we need to compute (γ_1, γ_2) . Taking covariances of both sides of (24) with $p - \bar{d} - As$ and with s , and using (3), (4) and (18), yields respectively

$$\left(1 - \sum_{i=1}^N A_i - A\right) \sum_{i=1}^N A_i \sigma_\epsilon^2 - \sum_{i=1}^N A_i^2 \sigma_{\eta_i}^2 = \gamma_1 \left[\left(\sum_{i=1}^N A_i + A\right) \sum_{i=1}^N A_i \sigma_\epsilon^2 + \sum_{i=1}^N A_i^2 \sigma_{\eta_i}^2 \right] + \gamma_2 \sum_{i=1}^N A_i \sigma_\epsilon^2, \quad (\text{A.23})$$

$$\left(1 - \sum_{i=1}^N A_i - A\right) \sigma_\epsilon^2 - A \sigma_\eta^2 = \gamma_1 \left[\left(\sum_{i=1}^N A_i + A\right) \sigma_\epsilon^2 + A \sigma_\eta^2 \right] + \gamma_2 (\sigma_\epsilon^2 + \sigma_\eta^2). \quad (\text{A.24})$$

Eqs. (A.23) and (A.24) form a linear system in (γ_1, γ_2) . Its solution is

$$\gamma_1 = \frac{\sum_{i=1}^N A_i \left(1 - \sum_{i=1}^N A_i\right) \sigma_\epsilon^2 \sigma_\eta^2 - \sum_{i=1}^N A_i^2 \sigma_{\eta_i}^2 (\sigma_\epsilon^2 + \sigma_\eta^2)}{\left(\sum_{i=1}^N A_i\right)^2 \sigma_\epsilon^2 \sigma_\eta^2 + \sum_{i=1}^N A_i^2 \sigma_{\eta_i}^2 (\sigma_\epsilon^2 + \sigma_\eta^2)}, \quad (\text{A.25})$$

$$\gamma_2 = \frac{\sum_{i=1}^N A_i^2 \sigma_{\eta_i}^2 \sigma_\epsilon^2 - A \sum_{i=1}^N A_i \sigma_\epsilon^2 \sigma_\eta^2}{\left(\sum_{i=1}^N A_i\right)^2 \sigma_\epsilon^2 \sigma_\eta^2 + \sum_{i=1}^N A_i^2 \sigma_{\eta_i}^2 (\sigma_\epsilon^2 + \sigma_\eta^2)}. \quad (\text{A.26})$$

Substituting $(\{A_i\}_{i=1, \dots, N}, A)$ from Proposition 2 into (A.25) and (A.26), we can confirm that $\gamma_1 = \gamma_2 = 0$ in the rational case. Substituting, $(\{A_i\}_{i=1, \dots, N}, A)$ from Proposition 3 into (A.25) and

(A.26), we find that the denominator is positive and the numerator has the same sign as

$$\begin{aligned} & \sum_{i=1}^N \frac{\tau_{\eta_i}}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} \sum_{i=1}^N \frac{\tau_\epsilon + \tau_\eta}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} \sigma_\epsilon^2 \sigma_\eta^2 - \sum_{i=1}^N \frac{\tau_{\eta_i}^2 \sigma_{\eta_i}^2}{\alpha_i^2(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)^2} (\sigma_\epsilon^2 + \sigma_\eta^2) \\ &= (\sigma_\epsilon^2 + \sigma_\eta^2) \left[\sum_{i=1}^N \frac{\tau_{\eta_i}}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} \sum_{i=1}^N \frac{1}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} - \sum_{i=1}^N \frac{\tau_{\eta_i}}{\alpha_i^2(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)^2} \right] > 0, \end{aligned}$$

in the case of γ_1 , and

$$\begin{aligned} & \sum_{i=1}^N \frac{\tau_{\eta_i}^2 \sigma_{\eta_i}^2}{\alpha_i^2(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)^2} \sigma_\epsilon^2 - \sum_{i=1}^N \frac{\tau_\eta}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} \sum_{i=1}^N \frac{\tau_{\eta_i}}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} \sigma_\epsilon^2 \sigma_\eta^2 \\ &= \sigma_\epsilon^2 \left[\sum_{i=1}^N \frac{\tau_{\eta_i}}{\alpha_i^2(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)^2} - \sum_{i=1}^N \frac{1}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} \sum_{i=1}^N \frac{\tau_{\eta_i}}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} \right] < 0, \end{aligned}$$

in the case of γ_2 . ■

Proof of Proposition 6. To show the result for the cursed case for regression (25), we follow the argument sketched after the proposition. Taking expectations of both sides of (23), and noting that $\text{Var}(d|I_i)$ is a constant, we find

$$E(p|s) = \frac{\sum_{i=1}^N \frac{E[E(d|I_i)|s]}{\alpha_i \text{Var}(d|I_i)}}{\sum_{i=1}^N \frac{1}{\alpha_i \text{Var}(d|I_i)}} = \frac{\sum_{i=1}^N \frac{E(d|s)}{\alpha_i \text{Var}(d|I_i)}}{\sum_{i=1}^N \frac{1}{\alpha_i \text{Var}(d|I_i)}} = E(d|s), \quad (\text{A.27})$$

where the second step follows from the law of iterative expectations because I_i includes s . Eq. (A.27) implies that

$$E(d - p|s) = E(d|s) - E(p|s) = 0.$$

Since the expectation of $d - p$ conditional on s is zero, the coefficient γ in the regression (25) is also zero.

To show the result for the cursed case for regression (26), we note that γ has the same sign as

$$\text{Cov}(d - p, p - \bar{d}) = \left(1 - \sum_{i=1}^N A_i - A \right) \left(\sum_{i=1}^N A_i + A \right) \sigma_\epsilon^2 - \sum_{i=1}^N A_i^2 \sigma_{\eta_i}^2 - A^2 \sigma_\eta^2,$$

where the equality follows from (3), (4) and (18). Substituting $(\{A_i\}_{i=1, \dots, N}, A)$ from Proposition

3, we find that $\text{Cov}(d - p, p - \bar{d})$ has the same sign as

$$\begin{aligned} & \sum_{i=1}^N \frac{\tau_\epsilon}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} \sum_{i=1}^N \frac{\tau_{\eta_i} + \tau_\eta}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} \sigma_\epsilon^2 - \sum_{i=1}^N \frac{\tau_{\eta_i}^2 \sigma_{\eta_i}^2 + \tau_\eta^2 \sigma_\eta^2}{\alpha_i^2(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)^2} \\ &= \sum_{i=1}^N \frac{1}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} \sum_{i=1}^N \frac{\tau_{\eta_i} + \tau_\eta}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} - \sum_{i=1}^N \frac{\tau_{\eta_i} + \tau_\eta}{\alpha_i^2(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)^2}, \end{aligned}$$

which is positive. ■

Proof of Corollary 1. The variance of the return $p - \bar{d}$ between Periods 0 and 1 is equal to the variance of p . The comparison between $\text{Var}(p)$ in the cursed and in the rational case will follow from the identities

$$\text{Var}[\mathbb{E}(d | \{s_i\}_{i=1, \dots, N}, s)] = \text{Var}[\mathbb{E}(d | \{s_i\}_{i=1, \dots, N}, s) - p] + 2\text{Cov}[\mathbb{E}(d | \{s_i\}_{i=1, \dots, N}, s) - p, p] + \text{Var}(p) \quad (\text{A.28})$$

and

$$\begin{aligned} \text{Cov}[\mathbb{E}(d | \{s_i\}_{i=1, \dots, N}, s) - p, p] &= \mathbb{E}[(\mathbb{E}(d | \{s_i\}_{i=1, \dots, N}, s) - p)p] - \mathbb{E}[\mathbb{E}(d | \{s_i\}_{i=1, \dots, N}, s) - p] \mathbb{E}(p) \\ &= \mathbb{E}[(\mathbb{E}(d | p) - p)p] - [\mathbb{E}(d) - \mathbb{E}(p)] \mathbb{E}(p) \\ &= \mathbb{E}[\gamma(p - \bar{d})p] \\ &= \gamma \text{Var}(p), \end{aligned} \quad (\text{A.29})$$

where the second step in (A.29) follows from applying the law of iterative expectations, and the third step follows from (26) and $\mathbb{E}(d) = \mathbb{E}(p) = \bar{d}$. When traders are cursed, (A.29) and Proposition 6 imply that the second term in the right-hand side of (A.28) is positive. Since the first term is also positive, (A.28) implies that

$$\text{Var}[\mathbb{E}(d | \{s_i\}_{i=1, \dots, N}, s)] > \text{Var}(p). \quad (\text{A.30})$$

When traders are rational, (A.30) holds as an equality because of (A.22). Therefore, $\text{Var}(p)$ is smaller when traders are cursed.

The comparison between $\text{Var}(p) + \text{Var}(d - p)$ in the cursed and in the rational case will follow similarly from the identities

$$\text{Var}(d) = \text{Var}(d - p) + 2\text{Cov}(d - p, p) + \text{Var}(p) \quad (\text{A.31})$$

and

$$\text{Cov}(d - p, p) = \text{E} [\gamma(p - \bar{d})p] = \gamma \text{Var}(p), \quad (\text{A.32})$$

where the first step in (A.32) follows from (26). Eq. (A.32) and Proposition 6 imply that the second term in the right-hand side of (A.31) is positive when traders are cursed and zero when they are rational. Since the left-hand side of (A.31) is the same when traders are cursed and when they are rational, $\text{Var}(p) + \text{Var}(d - p)$ is smaller when they are cursed. ■

Proof of Proposition 7. Substituting p from (18) into (A.9) and using $z_i = 0$, we can write the quantity that trader i trades in equilibrium as

$$x_i = \frac{\tau_\zeta(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} \left(\sum_{j=1}^N a_{ij}s_j + a_i s \right), \quad (\text{A.33})$$

where

$$a_{ii} \equiv \frac{\tau_{\eta_i}}{\tau_\epsilon + \tau_{\eta_i} + \tau_\eta} - A_i, \quad (\text{A.34})$$

$$a_{ij} \equiv -A_j \quad \text{for } j \neq i, \quad (\text{A.35})$$

$$a_i \equiv \frac{\tau_\eta}{\tau_\epsilon + \tau_{\eta_i} + \tau_\eta} - A. \quad (\text{A.36})$$

Using (3) and (4), we can write (A.33) as

$$x_i = \frac{\tau_\zeta(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} \left[\left(\sum_{j=1}^N a_{ij} + a_i \right) \epsilon + \sum_{j=1}^N a_{ij}\eta_j + a_i\eta \right]. \quad (\text{A.37})$$

Since x_i is normal,

$$\begin{aligned} E(|x_i|) &= \sqrt{\frac{2\text{Var}(x_i)}{\pi}} \\ &= \sqrt{\frac{2}{\pi}} \frac{\tau_\zeta(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} \sqrt{\left(\sum_{j=1}^N a_{ij} + a_i \right)^2 \sigma_\epsilon^2 + \sum_{j=1}^N a_{ij}^2 \sigma_{\eta_j}^2 + a_i^2 \sigma_\eta^2}, \end{aligned} \quad (\text{A.38})$$

where the second step follows from (A.37).

When $\alpha_i = \alpha$ and $\tau_{\eta_i} = \tau_{\eta c}$ for all i , Proposition 3 implies that

$$A_i = \frac{\tau_{\eta c}}{N(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)} \quad \text{for all } i,$$

$$A = \frac{\tau_\eta}{\tau_\epsilon + \tau_{\eta c} + \tau_\eta}.$$

Substituting into (A.34)-(A.36), we find

$$a_{ii} = \frac{(N-1)\tau_{\eta c}}{N(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)},$$

$$a_{ij} = -\frac{\tau_{\eta c}}{N(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)} \quad \text{for } j \neq i,$$

$$a_i = 0,$$

$$\sum_{j=1}^N a_{ij} + a_i = 0.$$

Substituting into (A.38), we find (27). The comparative statics follow by differentiating (27) with respect to N and $\tau_{\eta c}$.

When $\alpha_i = \alpha$ for all i and $\sigma_\zeta^2 = 0$, Proposition 3 implies that

$$A_i = \frac{\tau_{\eta_i}}{N(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)} \quad \text{for all } i, \tag{A.39}$$

$$A = \frac{\tau_\eta}{\tau_\epsilon + \tau_{\eta c} + \tau_\eta}. \tag{A.40}$$

(These values can be derived as a limit when τ_ζ goes to ∞ .) Substituting into (A.34)-(A.36), we find

$$a_{ii} = \frac{[(N-1)(\tau_\epsilon + \tau_\eta) + N\tau_{\eta c} - \tau_{\eta_i}]\tau_{\eta_i}}{N(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)}, \tag{A.41}$$

$$a_{ij} = -\frac{\tau_{\eta_j}}{N(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)} \quad \text{for } j \neq i, \tag{A.42}$$

$$a_i = \frac{(\tau_{\eta c} - \tau_{\eta_i})\tau_\eta}{(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)}, \tag{A.43}$$

$$\sum_{j=1}^N a_{ij} + a_i = \frac{(\tau_{\eta_i} - \tau_{\eta c})\tau_\epsilon}{(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)}. \tag{A.44}$$

Substituting into (A.38), and using again $\alpha_i = \alpha$ for all i and $\sigma_\zeta^2 = 0$, we find

$$E(|x_i|) = \sqrt{\frac{2}{\pi}} \sqrt{\frac{(\tau_{\eta_i} - \tau_{\eta c})^2 \tau_\epsilon^2 \sigma_\epsilon^2 + \frac{[(N-1)(\tau_\epsilon + \tau_\eta) + N\tau_{\eta c} - \tau_{\eta_i}]^2 \tau_{\eta_i}^2}{N^2} \sigma_{\eta_i}^2 + \sum_{j \neq i} \frac{(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)^2 \tau_{\eta_j}^2}{N^2} \sigma_{\eta_j}^2 + (\tau_{\eta c} - \tau_{\eta_i})^2 \tau_\eta^2 \sigma_\eta^2}{\alpha(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)}}.$$

(A.45)

Since the variance is the inverse of the precision, we can write (A.45) as

$$\begin{aligned}
E(|x_i|) &= \sqrt{\frac{2}{\pi}} \frac{\sqrt{(\tau_{\eta_i} - \tau_{\eta_c})^2 \tau_\epsilon + \frac{[(N-1)(\tau_\epsilon + \tau_\eta) + N\tau_{\eta_c} - \tau_{\eta_i}]^2 \tau_{\eta_i}}{N^2} + \sum_{j \neq i} \frac{(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)^2 \tau_{\eta_j}}{N^2} + (\tau_{\eta_c} - \tau_{\eta_i})^2 \tau_\eta}}{\alpha(\tau_\epsilon + \tau_{\eta_c} + \tau_\eta)}} \\
&= \sqrt{\frac{2}{\pi}} \frac{\sqrt{(\tau_{\eta_i} - \tau_{\eta_c})^2 (\tau_\epsilon + \tau_\eta) + \frac{[(N-1)(\tau_\epsilon + \tau_\eta) + N\tau_{\eta_c} - \tau_{\eta_i}]^2 \tau_{\eta_i}}{N^2} + \frac{(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)^2 (N\tau_{\eta_c} - \tau_{\eta_i})}{N^2}}}{\alpha(\tau_\epsilon + \tau_{\eta_c} + \tau_\eta)}},
\end{aligned} \tag{A.46}$$

where the second step follows from the definition of τ_{η_c} . Eq. (28) follows from (A.46) by separating quadratic, linear and constant terms in $\tau_\epsilon + \tau_\eta$. Trader i generates more volume than trader j if and only if the difference between the term inside the squared root in (28) and the corresponding term for j is positive. The difference is

$$[(N-2)(\tau_\epsilon + \tau_\eta)^2 + (N-2)(\tau_\epsilon + \tau_\eta)(\tau_{\eta_i} + \tau_{\eta_j}) + (N\tau_{\eta_c} - \tau_{\eta_i} - \tau_{\eta_j})\tau_{\eta_c}](\tau_{\eta_i} - \tau_{\eta_j}).$$

Since

$$N\tau_{\eta_c} - \tau_{\eta_i} - \tau_{\eta_j} = \sum_{k=1}^N \tau_{\eta_k} - \tau_{\eta_i} - \tau_{\eta_j} = \sum_{k \neq i, j} \tau_{\eta_k} > 0,$$

the difference is positive if and only if $\tau_{\eta_i} > \tau_{\eta_j}$. ■

We next prove two lemmas, which we then use to prove Proposition 8.

Lemma A.2 *Let x be an $n \times 1$ normal vector with mean zero and covariance matrix Σ , Z_A a scalar, Z_B an $n \times 1$ vector, Z_C an $n \times n$ symmetric matrix, I the $n \times n$ identity matrix, v' the transpose of a vector v , and $|M|$ the determinant of a matrix M . Then,*

$$E_x \exp \left\{ -\alpha \left[Z_A + Z_B' x + \frac{1}{2} x' Z_C x \right] \right\} = \exp \left\{ -\alpha \left[Z_A - \frac{1}{2} \alpha Z_B' \Sigma (I + \alpha Z_C \Sigma)^{-1} Z_B \right] \right\} \frac{1}{\sqrt{|I + \alpha Z_C \Sigma|}}. \tag{A.47}$$

Proof. When $Z_C = 0$, (A.47) gives the moment-generating function of the normal distribution. We can always assume $Z_C = 0$ by also assuming that x is a normal vector with mean 0 and covariance matrix $\Sigma(I + \alpha Z_C \Sigma)^{-1}$. ■

Lemma A.3 *Suppose that the $n \times n$ matrix Z_C is equal to $Z_{C_1}Z'_{C_2}$ for $n \times 1$ vectors (Z_{C_1}, Z_{C_2}) , and the symmetric $n \times n$ matrix Σ is positive definite. Then,*

$$|I + \alpha Z_C \Sigma| = 1 + \alpha Z'_{C_1} \Sigma Z_{C_2}. \quad (\text{A.48})$$

Proof. Since Σ is positive definite, it has a positive-definite square root. We denote that matrix by $\Sigma^{\frac{1}{2}}$ and its inverse by $\Sigma^{-\frac{1}{2}}$. We can write the determinant in (A.48) as

$$\begin{aligned} |I + \alpha Z_C \Sigma| &= \left| \left(\Sigma^{-\frac{1}{2}} + \alpha Z_C \Sigma^{\frac{1}{2}} \right) \Sigma^{\frac{1}{2}} \right| \\ &= \left| \Sigma^{\frac{1}{2}} \left(\Sigma^{-\frac{1}{2}} + \alpha Z_C \Sigma^{\frac{1}{2}} \right) \right| \\ &= \left| I + \alpha \Sigma^{\frac{1}{2}} Z_C \Sigma^{\frac{1}{2}} \right|, \end{aligned} \quad (\text{A.49})$$

where the second step follows because the determinant is commutative. We next compute

$$\Delta \equiv \left| \Sigma^{\frac{1}{2}} Z_C \Sigma^{\frac{1}{2}} \left(I + \alpha \Sigma^{\frac{1}{2}} Z_C \Sigma^{\frac{1}{2}} \right) \right|$$

in two different ways. First,

$$\begin{aligned} \Delta &= \left| \Sigma^{\frac{1}{2}} Z_C \Sigma^{\frac{1}{2}} \right| \left| I + \alpha \Sigma^{\frac{1}{2}} Z_C \Sigma^{\frac{1}{2}} \right| \\ &= \left| \Sigma^{\frac{1}{2}} Z_{C_1} Z'_{C_2} \Sigma^{\frac{1}{2}} \right| \left| I + \alpha \Sigma^{\frac{1}{2}} Z_C \Sigma^{\frac{1}{2}} \right| \\ &= \left| Z'_{C_2} \Sigma^{\frac{1}{2}} \Sigma^{\frac{1}{2}} Z_{C_1} \right| \left| I + \alpha \Sigma^{\frac{1}{2}} Z_C \Sigma^{\frac{1}{2}} \right| \\ &= Z'_{C_2} \Sigma Z_{C_1} \left| I + \alpha \Sigma^{\frac{1}{2}} Z_C \Sigma^{\frac{1}{2}} \right|, \end{aligned} \quad (\text{A.50})$$

where the first step follows because the determinant of a product is the product of the determinants, and the third step because the determinant is commutative. Second,

$$\begin{aligned} \Delta &= \left| \Sigma^{\frac{1}{2}} Z_{C_1} Z'_{C_2} \Sigma^{\frac{1}{2}} \left(I + \alpha \Sigma^{\frac{1}{2}} Z_{C_1} Z'_{C_2} \Sigma^{\frac{1}{2}} \right) \right| \\ &= \left| Z'_{C_2} \Sigma^{\frac{1}{2}} \left(I + \alpha \Sigma^{\frac{1}{2}} Z_{C_1} Z'_{C_2} \Sigma^{\frac{1}{2}} \right) \Sigma^{\frac{1}{2}} Z_{C_1} \right| \\ &= \left| Z'_{C_2} \Sigma Z_{C_1} (1 + \alpha Z'_{C_2} \Sigma Z_{C_1}) \right| \\ &= Z'_{C_2} \Sigma Z_{C_1} (1 + \alpha Z'_{C_2} \Sigma Z_{C_1}). \end{aligned} \quad (\text{A.51})$$

Comparing (A.50) to (A.51), and using (A.49), we find (A.48). ■

Proof of Proposition 8. We first derive a general expression for the expected utility of a cursed trader who receives no endowment shock. This derivation does not assume that all other traders are cursed, or that they have the same risk-aversion coefficient, or that $\sigma_\zeta^2 = 0$. We can write the expected utility of trader i in the ex-ante sense as

$$-\mathbb{E} \exp \{ -\alpha_i [x_i(d-p) + z_i d] \}. \quad (\text{A.52})$$

Using the law of iterative expectations, and denoting by $I \equiv (\{s_j\}_{j=1,\dots,N}, s)$ the information set consisting of all the signals, we can write (A.52) as

$$\begin{aligned} & -\mathbb{E} [\mathbb{E} (\exp \{ -\alpha_i [x_i(d-p) + z_i d] \} | I)] \\ & -\mathbb{E} \exp \left\{ -\alpha_i \left[x_i (\mathbb{E}(d|I) - p) + z_i \mathbb{E}(d|I) - \frac{1}{2} \alpha_i (x_i + z_i)^2 \text{Var}(d|I) \right] \right\} \\ & -\mathbb{E} \exp \left\{ -\alpha_i \left[\frac{\mathbb{E}(d|I_i) - p}{\alpha_i \text{Var}(d|I_i)} \left(\mathbb{E}(d|I) - p - \frac{1}{2} \frac{\mathbb{E}(d|I_i) - p}{\text{Var}(d|I_i)} \text{Var}(d|I) \right) + z_i p \right] \right\} \end{aligned} \quad (\text{A.53})$$

$$-\mathbb{E} \exp \left\{ -\frac{\mathbb{E}(d|I_i) - p}{\text{Var}(d|I_i)} \left(\mathbb{E}(d|I) - p - \frac{1}{2} \frac{\mathbb{E}(d|I_i) - p}{\text{Var}(d|I_i)} \text{Var}(d|I) \right) \right\} \quad (\text{A.54})$$

where the second step follows because of normality, the third from (10), and the fourth because $z_i = 0$. Using Lemma A.1 with $x = \epsilon$, $K = 2$ and $\{y_j\}_{j=1,2} = (\eta_i, \eta)$, and combining with (A.7) and (A.8), we find

$$\mathbb{E}(d|I_i) = \bar{d} + \frac{\tau_{\eta_i}}{\tau_\epsilon + \tau_{\eta_i} + \tau_\eta} s_i + \frac{\tau_\eta}{\tau_\epsilon + \tau_{\eta_i} + \tau_\eta} s, \quad (\text{A.55})$$

$$\text{Var}(d|I_i) = \frac{\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta}{(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta) \tau_\zeta}. \quad (\text{A.56})$$

Setting $x = \epsilon$, $K = N + 1$ and $\{y_j\}_{j=1,\dots,N+1} = (\{\eta_j\}_{j=1,\dots,N}, \eta)$, we likewise find

$$\begin{aligned} \mathbb{E}(d|I) &= \bar{d} + \sum_{j=1}^N \frac{\tau_{\eta_j}}{\tau_\epsilon + \sum_{k=1}^N \tau_{\eta_k} + \tau_\eta} s_j + \frac{\tau_\eta}{\tau_\epsilon + \sum_{k=1}^N \tau_{\eta_k} + \tau_\eta} s \\ &= \bar{d} + \sum_{j=1}^N \frac{\tau_{\eta_j}}{\tau_\epsilon + N\tau_{\eta_c} + \tau_\eta} s_j + \frac{\tau_\eta}{\tau_\epsilon + N\tau_{\eta_c} + \tau_\eta} s, \end{aligned} \quad (\text{A.57})$$

$$\begin{aligned} \text{Var}(d|I) &= \frac{\tau_\epsilon + \tau_\zeta + \sum_{j=1}^N \tau_{\eta_j} + \tau_\eta}{(\tau_\epsilon + \sum_{j=1}^N \tau_{\eta_j} + \tau_\eta) \tau_\zeta} \\ &= \frac{\tau_\epsilon + \tau_\zeta + N\tau_{\eta_c} + \tau_\eta}{(\tau_\epsilon + N\tau_{\eta_c} + \tau_\eta) \tau_\zeta}. \end{aligned} \quad (\text{A.58})$$

Substituting conditional means and variances from (A.55)-(A.58), we can write the expected utility (A.54) as

$$-\mathbf{E} \exp \left\{ -\frac{1}{2} \frac{\tau_\zeta(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)}{(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} \left(\sum_{j=1}^N a_{ij} s_j + a_i s \right) \left(\sum_{j=1}^N b_{ij} s_j + b_i s \right) \right\}, \quad (\text{A.59})$$

where $(\{a_{ij}\}_{j=1,\dots,N}, a_i)$ are defined in (A.34)-(A.36), and

$$b_{ij} \equiv \frac{2\tau_{\eta_j}}{\tau_\epsilon + N\tau_{\eta_c} + \tau_\eta} - 2A_j - \frac{(\tau_\epsilon + \tau_\zeta + N\tau_{\eta_c} + \tau_\eta)(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)}{(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)(\tau_\epsilon + N\tau_{\eta_c} + \tau_\eta)} a_{ij} \quad \text{for } j = 1, \dots, N, \quad (\text{A.60})$$

$$b_i \equiv \frac{2\tau_\eta}{\tau_\epsilon + N\tau_{\eta_c} + \tau_\eta} - 2A - \frac{(\tau_\epsilon + \tau_\zeta + N\tau_{\eta_c} + \tau_\eta)(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)}{(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)(\tau_\epsilon + N\tau_{\eta_c} + \tau_\eta)} a_i. \quad (\text{A.61})$$

Using (3) and (4), we can write (A.59) as

$$-\mathbf{E} \exp \left\{ -\frac{1}{2} \frac{\tau_\zeta(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)}{(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} \left[\left(\sum_{j=1}^N a_{ij} + a_i \right) \epsilon + \sum_{j=1}^N a_{ij} \eta_j + a_i \eta \right] \left[\left(\sum_{j=1}^N b_{ij} + b_i \right) \epsilon + \sum_{j=1}^N b_{ij} \eta_j + b_i \eta \right] \right\}. \quad (\text{A.62})$$

To compute the expectation in (A.62), we use Lemma A.2, and set

$$Z_A \equiv 0,$$

$$Z_B \equiv 0,$$

$$Z_C \equiv \frac{\tau_\zeta(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} v_a v_b',$$

$$S_i \equiv \text{Diag}(\sigma_\epsilon^2, \{\sigma_{\eta_j}^2\}_{j=1,\dots,N}, \sigma_\eta^2),$$

$$v_a \equiv \left(\sum_{j=1}^N a_{ij} + a_i, \{a_{ij}\}_{j=1,\dots,N}, a_i \right)',$$

$$v_b \equiv \left(\sum_{j=1}^N b_{ij} + b_i, \{b_{ij}\}_{j=1,\dots,N}, b_i \right)'.$$

Lemma A.2 implies that (A.62) is equal to

$$-\frac{1}{\sqrt{\left| I + \frac{\tau_\zeta(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)}{(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} v_a v_b' \Sigma \right|}} = -\frac{1}{\sqrt{1 + \frac{\tau_\zeta(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)}{(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} v_a' \Sigma v_b}}, \quad (\text{A.63})$$

where the second step follows from Lemma A.3.

We next use (A.63) to compute the expected utility of a cursed trader under the assumptions in the proposition. When $\alpha_i = \alpha$ for all i and $\sigma_\zeta^2 = 0$, $(\{a_{ij}\}_{j=1,\dots,N}, a_i)$ are given by (A.41)-(A.43). Moreover, substituting $(\{A_j\}_{j=1,\dots,N}, A, \{a_{ij}\}_{j=1,\dots,N}, a_i)$ from (A.39)-(A.43) into (A.60) and (A.61), and using $\alpha_i = \alpha$ for all i and $\sigma_\zeta^2 = 0$, we find

$$b_{ii} = \frac{[(N-1)(\tau_\epsilon + \tau_\eta) - N\tau_{\eta c} + \tau_{\eta i}] \tau_{\eta i}}{N(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)(\tau_\epsilon + N\tau_{\eta c} + \tau_\eta)}, \quad (\text{A.64})$$

$$b_{ij} = \frac{[(2N-1)(\tau_\epsilon + \tau_\eta) + \tau_{\eta i}] \tau_{\eta j}}{N(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)(\tau_\epsilon + N\tau_{\eta c} + \tau_\eta)} \quad \text{for } j \neq i, \quad (\text{A.65})$$

$$b_i = \frac{[-(2N-1)\tau_{\eta c} + \tau_{\eta i}] \tau_\eta}{(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)(\tau_\epsilon + N\tau_{\eta c} + \tau_\eta)}, \quad (\text{A.66})$$

$$\sum_{j=1}^N b_{ij} + b_i = \frac{[(2N-1)\tau_{\eta c} - \tau_{\eta i}] \tau_\epsilon}{(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)(\tau_\epsilon + N\tau_{\eta c} + \tau_\eta)}, \quad (\text{A.67})$$

Substituting into (A.63), and using again $\sigma_\zeta^2 = 0$, we can write the term inside the squared root as

$$\begin{aligned} & 1 + \frac{(\tau_{\eta i} - \tau_{\eta c}) [(2N-1)\tau_{\eta c} - \tau_{\eta i}] \tau_\epsilon^2}{(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)^2 (\tau_\epsilon + N\tau_{\eta c} + \tau_\eta)} \sigma_\epsilon^2 \\ & + \frac{[(N-1)(\tau_\epsilon + \tau_\eta) + N\tau_{\eta c} - \tau_{\eta i}] [(N-1)(\tau_\epsilon + \tau_\eta) - N\tau_{\eta c} + \tau_{\eta i}] \tau_{\eta i}^2}{N^2(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)^2 (\tau_\epsilon + N\tau_{\eta c} + \tau_\eta)} \sigma_{\eta i}^2 \\ & - \sum_{j \neq i} \frac{(\tau_\epsilon + \tau_{\eta i} + \tau_\eta) [(2N-1)(\tau_\epsilon + \tau_\eta) + \tau_{\eta i}] \tau_{\eta j}^2}{N^2(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)^2 (\tau_\epsilon + N\tau_{\eta c} + \tau_\eta)} \sigma_{\eta j}^2 + \frac{(\tau_{\eta c} - \tau_{\eta i}) [-(2N-1)\tau_{\eta c} + \tau_{\eta i}] \tau_\eta^2}{(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)^2 (\tau_\epsilon + N\tau_{\eta c} + \tau_\eta)} \sigma_\eta^2. \end{aligned} \quad (\text{A.68})$$

Eq. (29) can be derived from (A.68) by following the same steps as when deriving (28) from (A.45). Trader i has higher expected utility than trader j if and only if the difference between the numerator inside the squared root in (29) and the corresponding term for j is positive. The difference is $\mathcal{Z}(\tau_{\eta i} - \tau_{\eta j})$, where

$$\mathcal{Z} \equiv N(\tau_\epsilon + \tau_\eta)^2 + (\tau_\epsilon + \tau_\eta) [2N(N+1)\tau_{\eta c} - (N-2)(\tau_{\eta i} + \tau_{\eta j})] - (N\tau_{\eta c} - \tau_{\eta i} - \tau_{\eta j})\tau_{\eta c}. \quad (\text{A.69})$$

Since \mathcal{Z} is linear in $\tau_{\eta i} + \tau_{\eta j} \in (0, N\tau_{\eta c})$, it is positive if this is the case at the boundaries $\tau_{\eta i} + \tau_{\eta j} = 0$ and $\tau_{\eta i} + \tau_{\eta j} = N\tau_{\eta c}$. For $\tau_{\eta i} + \tau_{\eta j} = N\tau_{\eta c}$,

$$\mathcal{Z} = N(\tau_\epsilon + \tau_\eta)^2 + N(N+4)(\tau_\epsilon + \tau_\eta)\tau_{\eta c} > 0.$$

For $\tau_{\eta_i} + \tau_{\eta_j} = 0$,

$$\mathcal{Z} = N(\tau_\epsilon + \tau_\eta)^2 + 2N(N+1)(\tau_\epsilon + \tau_\eta)\tau_{\eta_c} - N\tau_{\eta_c}^2,$$

and is positive if (30) holds. Therefore, if (30) holds, trader i has higher expected utility than trader j if and only if $\tau_{\eta_i} > \tau_{\eta_j}$. If instead (30) does not hold, $\mathcal{Z} < 0$ for $\tau_{\eta_i} + \tau_{\eta_j} = 0$, and there exist $\tau_{\eta_i} > \tau_{\eta_j}$ such that trader i has lower expected utility than trader j . ■

Proof of Proposition 9. Eq. (13) implies that

$$A_i = \lambda \frac{\tau_{\eta_i}}{\alpha_i(\tau_\epsilon + \tau_\zeta + \tau_{\eta_i} + \tau_\eta)} \quad (\text{A.70})$$

for $i \in C$ and a constant λ that does not depend on i . Since $\sigma_{z_i} = 0$ for all i and rational traders receive no private signals, (12) implies that

$$\tau_{\theta_i} = \frac{\left(\sum_{j \in C} A_j\right)^2}{\sum_{j \in C} \frac{A_j^2}{\tau_{\eta_j}}}. \quad (\text{A.71})$$

Substituting A_i from (A.70) into (A.71), we find that for $i \in R$, τ_{θ_i} is equal to τ_θ in (34). Substituting A_i from (A.70) into (13), noting that $\tau_{\eta_i} = 0$ for $i \in R$, and solving for λ , we find (32). Solving for A using (17), we find (33). ■

Proof of Proposition 10. Eqs. (21) and (32) imply that (i) holds if

$$\begin{aligned} & \frac{1 + \frac{\sum_{j \in R} \frac{\tau_\theta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_\eta + \tau_\theta)}}{\sum_{j \in C} \frac{\tau_{\eta_j}}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)}}}{\sum_{j \in C} \frac{\tau_\epsilon + \tau_{\eta_j} + \tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)} + \sum_{j \in R} \frac{\tau_\epsilon + \tau_\eta + \tau_\theta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_\eta + \tau_\theta)}} > \frac{1}{\sum_{j \in C} \frac{\tau_\epsilon + \tau_{\eta_j} + \tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)}} \\ \Leftrightarrow & \sum_{j \in C} \frac{\tau_\epsilon + \tau_{\eta_j} + \tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)} \frac{\sum_{j \in R} \frac{\tau_\theta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_\eta + \tau_\theta)}}{\tau_{\eta_j}} > \sum_{j \in R} \frac{\tau_\epsilon + \tau_\eta + \tau_\theta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_\eta + \tau_\theta)} \\ \Leftrightarrow & \tau_\theta \sum_{j \in C} \frac{\tau_\epsilon + \tau_{\eta_j} + \tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)} > (\tau_\epsilon + \tau_\eta + \tau_\theta) \sum_{j \in C} \frac{\tau_{\eta_j}}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)} \\ \Leftrightarrow & \tau_\theta \sum_{j \in C} \frac{1}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)} > \sum_{j \in C} \frac{\tau_{\eta_j}}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)}. \end{aligned} \quad (\text{A.72})$$

Using (34), we find that (A.72) is equivalent to

$$\sum_{j \in C} \frac{\tau_{\eta_j}}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)} \sum_{j \in C} \frac{1}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)} > \sum_{j \in C} \frac{\tau_{\eta_j}}{\alpha_j^2(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)^2},$$

which holds.

Eqs. (22) and (33) imply that (ii) holds if

$$\begin{aligned}
& \frac{\sum_{j \in C} \frac{\tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)} + \sum_{j \in R} \frac{\tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_\eta + \tau_\theta)}}{\sum_{j \in C} \frac{\tau_\epsilon + \tau_{\eta_j} + \tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)} + \sum_{j \in R} \frac{\tau_\epsilon + \tau_\eta + \tau_\theta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_\eta + \tau_\theta)}} < \frac{\sum_{j \in C} \frac{\tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)}}{\sum_{j \in C} \frac{\tau_\epsilon + \tau_{\eta_j} + \tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)}} \\
& \Leftrightarrow \sum_{j \in C} \frac{\tau_\epsilon + \tau_{\eta_j} + \tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)} < \frac{\sum_{j \in C} \frac{\tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)}}{\sum_{j \in R} \frac{\tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_\eta + \tau_\theta)}} \sum_{j \in R} \frac{\tau_\epsilon + \tau_\eta + \tau_\theta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_\eta + \tau_\theta)} \\
& \Leftrightarrow \sum_{j \in C} \frac{\tau_\epsilon + \tau_{\eta_j} + \tau_\eta}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)} < (\tau_\epsilon + \tau_\eta + \tau_\theta) \sum_{j \in C} \frac{1}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)} \\
& \Leftrightarrow \sum_{j \in C} \frac{\tau_{\eta_j}}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)} < \tau_\theta \sum_{j \in C} \frac{1}{\alpha_j(\tau_\epsilon + \tau_\zeta + \tau_{\eta_j} + \tau_\eta)}. \tag{A.73}
\end{aligned}$$

Eq. (A.73) holds because it is identical to (A.72).

Since $\sigma_{z_i} = 0$ for all i and rational traders receive no private signals, (12), (A.10), and $\tau_{\theta_i} = \tau_\theta$ imply that the demand of a rational trader i is

$$x_i = \frac{\bar{d} + \frac{\tau_\eta}{\tau_\epsilon + \tau_\eta + \tau_\theta} s + \frac{\tau_\theta}{\tau_\epsilon + \tau_\eta + \tau_\theta} \frac{\sum_{i \in C} A_i s_i}{\sum_{i \in C} A_i} - p}{\alpha_i \left(\frac{1}{\tau_\epsilon + \tau_\eta + \tau_\theta} + \frac{1}{\tau_\zeta} \right)}. \tag{A.74}$$

Substituting p from (31) into (A.74), we find that the quantity that trader i buys in equilibrium is

$$x_i = \frac{\frac{\tau_\eta}{\tau_\epsilon + \tau_\eta + \tau_\theta} s + \frac{\tau_\theta}{\tau_\epsilon + \tau_\eta + \tau_\theta} \frac{\sum_{i \in C} A_i s_i}{\sum_{i \in C} A_i} - \sum_{i \in C} A_i s_i - A s}{\alpha_i \left(\frac{1}{\tau_\epsilon + \tau_\eta + \tau_\theta} + \frac{1}{\tau_\zeta} \right)}. \tag{A.75}$$

Eq. (A.75) implies that (iii) holds if

$$\frac{\tau_\theta}{\tau_\epsilon + \tau_\eta + \tau_\theta} \frac{1}{\sum_{i \in C} A_i} > 1, \tag{A.76}$$

$$\frac{\tau_\eta}{\tau_\epsilon + \tau_\eta + \tau_\theta} < A. \tag{A.77}$$

Substituting $(\{A_j\}_{j=1, \dots, N}, A)$ from (32) and (33) into (A.76) and (A.77), respectively, we find that each of the latter equations is equivalent to (A.72), which holds. ■

Proof of Proposition 11. The expected utility of a cursed trader i is given by (A.63). The introduction of rational traders changes $(\{A_j\}_{j=1, \dots, N}, A)$, and hence $(\{a_j\}_{j=1, \dots, N}, a)$ and $(\{b_j\}_{j=1, \dots, N}, b)$.

When $\alpha_i = \alpha$ for all i and $\sigma_\zeta^2 = 0$, Proposition 9 implies that

$$\tau_\theta = N_c \tau_{\eta c},$$

$$A_i = \frac{(1 + N_r) \tau_{\eta_i}}{N_c(\tau_\epsilon + \tau_{\eta c} + \tau_\eta) + N_r(\tau_\epsilon + \tau_\eta + N_c \tau_{\eta c})} \quad \text{for all } i, \quad (\text{A.78})$$

$$A = \frac{(N_c + N_r) \tau_\eta}{N_c(\tau_\epsilon + \tau_{\eta c} + \tau_\eta) + N_r(\tau_\epsilon + \tau_\eta + N_c \tau_{\eta c})}. \quad (\text{A.79})$$

Using (36), we can write (A.78) and (A.79) as

$$A_i = \frac{\tau_{\eta_i}}{N_c(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)} (1 + (\tau_\epsilon + \tau_\eta) \mu) \quad \text{for all } i, \quad (\text{A.80})$$

$$A = \frac{\tau_\eta}{\tau_\epsilon + \tau_{\eta c} + \tau_\eta} (1 - \tau_{\eta c} \mu), \quad (\text{A.81})$$

respectively. Substituting $(\{A_j\}_{j=1, \dots, N}, A)$ from (A.80) and (A.81) into (A.34)-(A.36), we find

$$a_{ii} = \frac{[(N_c - 1)(\tau_\epsilon + \tau_\eta) + N_c \tau_{\eta c} - \tau_{\eta_i}] \tau_{\eta_i}}{N_c(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)} - \frac{(\tau_\epsilon + \tau_\eta) \tau_{\eta_i} \mu}{N_c(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)}, \quad (\text{A.82})$$

$$a_{ij} = -\frac{\tau_{\eta_j}}{N_c(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)} - \frac{(\tau_\epsilon + \tau_\eta) \tau_{\eta_j} \mu}{N_c(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)} \quad \text{for } j \neq i, \quad (\text{A.83})$$

$$a_i = \frac{(\tau_{\eta c} - \tau_{\eta_i}) \tau_\eta}{(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)} + \frac{\tau_{\eta c} \tau_\eta \mu}{\tau_\epsilon + \tau_{\eta c} + \tau_\eta}, \quad (\text{A.84})$$

$$\sum_{j=1}^{N_c} a_{ij} + a_i = \frac{(\tau_{\eta_i} - \tau_{\eta c}) \tau_\epsilon}{(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)} - \frac{\tau_\epsilon \tau_{\eta c} \mu}{\tau_\epsilon + \tau_{\eta c} + \tau_\eta}. \quad (\text{A.85})$$

Substituting $(\{A_j\}_{j=1, \dots, N}, A, \{a_{ij}\}_{j=1, \dots, N}, a_i)$ from (A.80)-(A.84) into (A.60) and (A.61), and using $\alpha_i = \alpha$ for all i and $\sigma_\zeta^2 = 0$, we find

$$b_{ii} = \frac{[(N_c - 1)(\tau_\epsilon + \tau_\eta) - N_c \tau_{\eta c} + \tau_{\eta_i}] \tau_{\eta_i}}{N_c(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)(\tau_\epsilon + N_c \tau_{\eta c} + \tau_\eta)} - \frac{(\tau_\epsilon + \tau_\eta + 2N_c \tau_{\eta c} - \tau_{\eta_i})(\tau_\epsilon + \tau_\eta) \tau_{\eta_i} \mu}{N_c(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)(\tau_\epsilon + N_c \tau_{\eta c} + \tau_\eta)}, \quad (\text{A.86})$$

$$b_{ij} = \frac{[(2N_c - 1)(\tau_\epsilon + \tau_\eta) + \tau_{\eta_i}] \tau_{\eta_j}}{N_c(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)(\tau_\epsilon + N_c \tau_{\eta c} + \tau_\eta)} - \frac{(\tau_\epsilon + \tau_\eta + 2N_c \tau_{\eta c} - \tau_{\eta_i})(\tau_\epsilon + \tau_\eta) \tau_{\eta_j} \mu}{N_c(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)(\tau_\epsilon + N_c \tau_{\eta c} + \tau_\eta)} \quad \text{for } j \neq i, \quad (\text{A.87})$$

$$b_i = \frac{[-(2N_c - 1) \tau_{\eta c} + \tau_{\eta_i}] \tau_\eta}{(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)(\tau_\epsilon + N_c \tau_{\eta c} + \tau_\eta)} + \frac{(\tau_\epsilon + \tau_\eta + 2N_c \tau_{\eta c} - \tau_{\eta_i}) \tau_{\eta c} \tau_\eta \mu}{(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)(\tau_\epsilon + N_c \tau_{\eta c} + \tau_\eta)}, \quad (\text{A.88})$$

$$\sum_{j=1}^{N_c} b_{ij} + b_i = \frac{[(2N_c - 1) \tau_{\eta c} - \tau_{\eta_i}] \tau_\epsilon}{(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)(\tau_\epsilon + N_c \tau_{\eta c} + \tau_\eta)} - \frac{(\tau_\epsilon + \tau_\eta + 2N_c \tau_{\eta c} - \tau_{\eta_i}) \tau_\epsilon \tau_{\eta c} \mu}{(\tau_\epsilon + \tau_{\eta c} + \tau_\eta)(\tau_\epsilon + N_c \tau_{\eta c} + \tau_\eta)}. \quad (\text{A.89})$$

The derivations of $(\{a_j\}_{j=1,\dots,N}, a)$ and $(\{b_j\}_{j=1,\dots,N}, b)$ are simplified by noting that for $\mu = 0$ and $N_c = N$ these quantities are already derived in Propositions 7 and 8, as (A.41)-(A.43) and (A.64)-(A.66), respectively. Substituting into (A.63), and using again $\sigma_\zeta^2 = 0$, we can write the term inside the squared root as $\mathcal{Y}_0 + \mathcal{Y}_1\mu + \mathcal{Y}_2\mu^2$, where \mathcal{Y}_0 is given by (A.68) for $N_c = N$,

$$\begin{aligned} \mathcal{Y}_1 \equiv & -\frac{(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)}{(\tau_\epsilon + \tau_{\eta_c} + \tau_\eta)^2(\tau_\epsilon + N_c\tau_{\eta_c} + \tau_\eta)} \left\{ \tau_{\eta_c} [(2N_c - 1)\tau_{\eta_c} - \tau_{\eta_i}] (\tau_\epsilon^2\sigma_\epsilon^2 + \tau_\eta^2\sigma_\eta^2) \right. \\ & \left. + \frac{(\tau_\epsilon + \tau_\eta) \left[[(N_c - 1)(\tau_\epsilon + \tau_\eta) - N_c\tau_{\eta_c} + \tau_{\eta_i}] \tau_{\eta_i}^2\sigma_{\eta_i}^2 + [(2N_c - 1)(\tau_\epsilon + \tau_\eta) + \tau_{\eta_i}] \sum_{j \neq i} \tau_{\eta_j}^2\sigma_{\eta_j}^2 \right]}{N_c^2} \right\} \\ & - \frac{(\tau_\epsilon + \tau_\eta + 2N_c\tau_{\eta_c} - \tau_{\eta_i})}{(\tau_\epsilon + \tau_{\eta_c} + \tau_\eta)^2(\tau_\epsilon + N_c\tau_{\eta_c} + \tau_\eta)} \left\{ (\tau_{\eta_i} - \tau_{\eta_c})\tau_{\eta_c} (\tau_\epsilon^2\sigma_\epsilon^2 + \tau_\eta^2\sigma_\eta^2) \right. \\ & \left. + \frac{(\tau_\epsilon + \tau_\eta) \left[[(N_c - 1)(\tau_\epsilon + \tau_\eta) + N_c\tau_{\eta_c} - \tau_{\eta_i}] \tau_{\eta_i}^2\sigma_{\eta_i}^2 - (\tau_\epsilon + \tau_{\eta_i} + \tau_\eta) \sum_{j \neq i} \tau_{\eta_j}^2\sigma_{\eta_j}^2 \right]}{N_c^2} \right\}, \end{aligned} \quad (\text{A.90})$$

$$\mathcal{Y}_2 \equiv \frac{(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)(\tau_\epsilon + \tau_\eta + 2N_c\tau_{\eta_c} - \tau_{\eta_i})}{(\tau_\epsilon + \tau_{\eta_c} + \tau_\eta)^2(\tau_\epsilon + N_c\tau_{\eta_c} + \tau_\eta)} \left[\tau_\epsilon^2\tau_{\eta_c}^2\sigma_\epsilon^2 + \frac{(\tau_\epsilon + \tau_\eta)^2 \left(\tau_{\eta_i}^2\sigma_{\eta_i}^2 + \sum_{j \neq i} \tau_{\eta_j}^2\sigma_{\eta_j}^2 \right)}{N_c^2} + \tau_{\eta_c}^2\tau_\eta^2\sigma_\eta^2 \right]. \quad (\text{A.91})$$

Noting that the variance is the inverse of the precision and that

$$\sum_{j \neq i} \tau_{\eta_j} = \sum_{j=1}^N \tau_{\eta_j} - \tau_{\eta_i} = N\tau_{\eta_c} - \tau_{\eta_i},$$

we can simplify (A.90) and (A.91) to

$$\mathcal{Y}_1 = -\frac{(\tau_\epsilon + \tau_\eta) \{ (\tau_\epsilon + \tau_{\eta_i} + \tau_\eta) [(2N_c - 1)\tau_{\eta_c} - \tau_{\eta_i}] + (\tau_{\eta_i} - \tau_{\eta_c})(\tau_\epsilon + \tau_\eta + 2N_c\tau_{\eta_c} - \tau_{\eta_i}) \}}{N_c(\tau_\epsilon + \tau_{\eta_c} + \tau_\eta)^2} \quad (\text{A.92})$$

$$\mathcal{Y}_2 = \frac{(\tau_\epsilon + \tau_\eta)\tau_{\eta_c}(\tau_\epsilon + \tau_{\eta_i} + \tau_\eta)(\tau_\epsilon + \tau_\eta + 2N_c\tau_{\eta_c} - \tau_{\eta_i})}{N_c(\tau_\epsilon + \tau_{\eta_c} + \tau_\eta)^2}. \quad (\text{A.93})$$

Trader i has higher expected utility than trader j if and only if the difference between $\mathcal{Y}_0 + \mathcal{Y}_1\mu + \mathcal{Y}_2\mu^2$ and the corresponding term for j is positive. The difference is

$$\frac{\mathcal{Z}_0(\tau_{\eta_i} - \tau_{\eta_j})}{N_c(\tau_\epsilon + \tau_{\eta_c} + \tau_\eta)^2(\tau_\epsilon + N_c\tau_{\eta_c} + \tau_\eta)},$$

where

$$\mathcal{Z}_0 \equiv \mathcal{Z} + (\tau_\epsilon + \tau_\eta)(\tau_\epsilon + N_c\tau_{\eta c} + \tau_\eta)\mathcal{Z}_1,$$

\mathcal{Z} is given by (A.69), and

$$\mathcal{Z}_1 \equiv -(2N_c\tau_{\eta c} - \tau_{\eta_i} - \tau_{\eta_j})(2\mu - \tau_{\eta c}\mu^2).$$

Since \mathcal{Z}_0 is linear in $\tau_{\eta_i} + \tau_{\eta_j} \in (0, N_c\tau_{\eta c})$, it is positive if this is the case at the boundaries $\tau_{\eta_i} + \tau_{\eta_j} = 0$ and $\tau_{\eta_i} + \tau_{\eta_j} = N_c\tau_{\eta c}$. For $\tau_{\eta_i} + \tau_{\eta_j} = N_c\tau_{\eta c}$,

$$\begin{aligned} \mathcal{Z}_0 &= N_c(\tau_\epsilon + \tau_\eta)^2 + N_c(N_c + 4)(\tau_\epsilon + \tau_\eta)\tau_{\eta c} - (\tau_\epsilon + \tau_\eta)(\tau_\epsilon + N_c\tau_{\eta c} + \tau_\eta)N_c\tau_{\eta c}(2\mu - \tau_{\eta c}\mu^2) \\ &= N_c(\tau_\epsilon + \tau_\eta) [4\tau_{\eta c} + (\tau_\epsilon + N_c\tau_{\eta c} + \tau_\eta)(\tau_{\eta c}\mu - 1)^2] > 0. \end{aligned}$$

For $\tau_{\eta_i} + \tau_{\eta_j} = 0$,

$$\mathcal{Z}_0 = N_c(\tau_\epsilon + \tau_\eta)^2 + 2N_c(N_c + 1)(\tau_\epsilon + \tau_\eta)\tau_{\eta c} - N_c\tau_{\eta c}^2 - (\tau_\epsilon + \tau_\eta)(\tau_\epsilon + N_c\tau_{\eta c} + \tau_\eta)2N_c\tau_{\eta c}(2\mu - \tau_{\eta c}\mu^2),$$

and is positive if (35) holds. Therefore, if (35) holds, trader i has higher expected utility than trader j if and only if $\tau_{\eta_i} > \tau_{\eta_j}$. If instead (35) does not hold, $\mathcal{Z} < 0$ for $\tau_{\eta_i} + \tau_{\eta_j} = 0$, and there exist $\tau_{\eta_i} > \tau_{\eta_j}$ such that trader i has lower expected utility than trader j . Eq. (36) implies that

$$2\mu - \tau_{\eta c}\mu^2 = \frac{N_r(N_c - 1)\{2N_r(\tau_\epsilon + \tau_{\eta c} + \tau_\eta) + N_c[2\tau_\epsilon + (N_c + 1)\tau_{\eta c} + 2\tau_\eta]\}}{[N_c(\tau_\epsilon + \tau_{\eta c} + \tau_\eta) + N_r(\tau_\epsilon + \tau_\eta + N_c\tau_{\eta c})]^2},$$

and hence $2\mu - \tau_{\eta c}\mu^2 > 0$. ■

Proof of Proposition 12. When $\alpha_i = \alpha$, $\tau_{\eta_i} = \tau_{\eta c}$, $\tau_{z_i} = \tau_{z c}$, $A_i = A_c$ and $B_i = B_c$ for all i , (12) implies that

$$\tau_{\theta_i} = \tau_{\theta c} \equiv \frac{(N - 1)\tau_{\eta c}\tau_{z c}}{\tau_{z c} + \frac{B_c^2}{A_c^2}\tau_{\eta c}} \quad (\text{A.94})$$

for all i , (15) and (17) imply that

$$A_c = \frac{\tau_{\eta c} + \tau_{\theta c}}{N(\tau_\epsilon + \tau_{\eta c} + \tau_\eta + \tau_{\theta c})}, \quad (\text{A.95})$$

$$A = \frac{\tau_\eta}{\tau_\epsilon + \tau_{\eta c} + \tau_\eta + \tau_{\theta c}}, \quad (\text{A.96})$$

and (16) implies that

$$\frac{B_c}{A_c} = \alpha \frac{\tau_\epsilon + \tau_\zeta + \tau_{\eta c} + \tau_\eta + \tau_{\theta c}}{\tau_\zeta \tau_{\eta c}}. \quad (\text{A.97})$$

Substituting $\tau_{\theta c}$ from (A.94) to (A.95)-(A.97), we find (38)-(40), respectively. Eq. (40) is cubic in $\frac{B_c}{A_c}$, and hence has at least one solution. Any of its solutions satisfies

$$\frac{B_c}{A_c} \tau_\zeta \tau_{\eta c} - \alpha(\tau_\eta + \tau_\zeta + \tau_{\eta c} + \tau_\eta) > 0, \quad (\text{A.98})$$

and hence is positive. The derivative of the left-hand side of (40) with respect to $\frac{B_c}{A_c}$ is

$$2 \frac{B_c}{A_c} \tau_{\eta c} \left(\frac{B_c}{A_c} \tau_\zeta \tau_{\eta c} - \alpha(\tau_\eta + \tau_\zeta + \tau_{\eta c} + \tau_\eta) \right) + \left(\tau_{zc} + \frac{B_c^2}{A_c^2} \tau_{\eta c} \right) \tau_\zeta \tau_{\eta c},$$

and is positive at any solution of (40) because of (A.98). Therefore, (40) has a unique solution. ■

Proof of Proposition 13. When $A_i = A_c$ and $B_i = B_c$ for all i , (11) implies that

$$\epsilon + \theta_i = \frac{\sum_{j \neq i} s_j - \frac{B_c}{A_c} \sum_{j \neq i} z_j}{N - 1}. \quad (\text{A.99})$$

Substituting p from (18) into (A.10), and using (A.99) and $\alpha_i = \alpha$, $\tau_{\eta_i} = \tau_{\eta c}$, $\tau_{z_i} = \tau_{zc}$, $A_i = A_c$, $B_i = B_c$ and $\tau_{\theta_i} = \tau_{\theta c}$ for all i , we can write the quantity that trader i trades in equilibrium as

$$x_i = \frac{\tau_\zeta(\tau_\epsilon + \tau_{\eta c} + \tau_\eta + \tau_{\theta c})}{\alpha(\tau_\epsilon + \tau_\zeta + \tau_{\eta c} + \tau_\eta + \tau_{\theta c})} \left(\sum_{j=1}^N a_{ij} s_j + a_i s + \sum_{j=1}^N b_{ij} z_j \right), \quad (\text{A.100})$$

where

$$a_{ii} \equiv \frac{\tau_{\eta c}}{\tau_\epsilon + \tau_{\eta c} + \tau_\eta + \tau_{\theta c}} - A_c, \quad (\text{A.101})$$

$$a_{ij} \equiv \frac{\tau_{\theta c}}{(N-1)(\tau_\epsilon + \tau_{\eta c} + \tau_\eta + \tau_{\theta c})} - A_c \quad \text{for } j \neq i, \quad (\text{A.102})$$

$$a_i \equiv \frac{\tau_\eta}{\tau_\epsilon + \tau_{\eta c} + \tau_\eta + \tau_{\theta c}} - A, \quad (\text{A.103})$$

$$b_{ii} \equiv B_c - \frac{\alpha(\tau_\epsilon + \tau_\zeta + \tau_{\eta c} + \tau_\eta + \tau_{\theta c})}{\tau_\zeta(\tau_\epsilon + \tau_{\eta c} + \tau_\eta + \tau_{\theta c})}, \quad (\text{A.104})$$

$$b_{ij} \equiv B_c - \frac{B_c}{A_c} \frac{\tau_{\theta c}}{(N-1)(\tau_\epsilon + \tau_{\eta c} + \tau_\eta + \tau_{\theta c})} \quad \text{for } j \neq i. \quad (\text{A.105})$$

Using (3) and (4), we can write (A.100) as

$$x_i = \frac{\tau_\zeta(\tau_\epsilon + \tau_{\eta c} + \tau_\eta + \tau_{\theta c})}{\alpha(\tau_\epsilon + \tau_\zeta + \tau_{\eta c} + \tau_\eta + \tau_{\theta c})} \left[\left(\sum_{j=1}^N a_{ij} + a_i \right) \epsilon + \sum_{j=1}^N a_{ij} \eta_j + a_i \eta + \sum_{j=1}^N b_{ij} z_j \right]. \quad (\text{A.106})$$

Since x_i is normal,

$$\begin{aligned} E(|x_i|) &= \sqrt{\frac{2\text{Var}(x_i)}{\pi}} \\ &= \sqrt{\frac{2}{\pi}} \frac{\tau_\zeta(\tau_\epsilon + \tau_{\eta c} + \tau_\eta + \tau_{\theta c})}{\alpha(\tau_\epsilon + \tau_\zeta + \tau_{\eta c} + \tau_\eta + \tau_{\theta c})} \sqrt{\left(\sum_{j=1}^N a_{ij} + a_i \right)^2 \sigma_\epsilon^2 + \sum_{j=1}^N a_{ij}^2 \sigma_{\eta_j}^2 + a_i^2 \sigma_\eta^2 + \sum_{j=1}^N b_{ij}^2 \sigma_{z_j}^2}, \end{aligned} \quad (\text{A.107})$$

where the second step follows from (A.106). Substituting A_c , A and B_c from (A.95)-(A.97) into (A.101)-(A.105), we find

$$\begin{aligned} a_{ii} &= \frac{(N-1)\tau_{\eta c} - \tau_{\theta c}}{N(\tau_\epsilon + \tau_{\eta c} + \tau_\eta + \tau_{\theta c})}, \\ a_{ij} &= -\frac{(N-1)\tau_{\eta c} - \tau_{\theta c}}{N(N-1)(\tau_\epsilon + \tau_{\eta c} + \tau_\eta + \tau_{\theta c})} \quad \text{for } j \neq i, \\ a_i &= 0, \\ b_{ii} &\equiv -\frac{\alpha(\tau_\epsilon + \tau_\zeta + \tau_{\eta c} + \tau_\eta + \tau_{\theta c})}{\tau_\zeta \tau_{\eta c}} \frac{(N-1)\tau_{\eta c} - \tau_{\theta c}}{N(\tau_\epsilon + \tau_{\eta c} + \tau_\eta + \tau_{\theta c})}, \\ b_{ij} &\equiv \frac{\alpha(\tau_\epsilon + \tau_\zeta + \tau_{\eta c} + \tau_\eta + \tau_{\theta c})}{\tau_\zeta \tau_{\eta c}} \frac{(N-1)\tau_{\eta c} - \tau_{\theta c}}{N(N-1)(\tau_\epsilon + \tau_{\eta c} + \tau_\eta + \tau_{\theta c})} \quad \text{for } j \neq i. \end{aligned}$$

Substituting into (A.107), we find

$$\begin{aligned} E(|x_i|) &= \sqrt{\frac{2[(N-1)\tau_{\eta c} - \tau_{\theta c}]^2}{\pi N(N-1)\tau_{\eta c}} \left(\frac{\tau_\zeta^2}{\alpha^2(\tau_\epsilon + \tau_\zeta + \tau_{\eta c} + \tau_\eta + \tau_{\theta c})^2} + \frac{1}{\tau_{\eta c} \tau_{z c}} \right)} \\ &= \sqrt{\frac{2[(N-1)\tau_{\eta c} - \tau_{\theta c}]^2}{\pi N(N-1)\tau_{\eta c}} \left(\frac{A_c^2}{B_c^2 \tau_{\eta c}^2} + \frac{1}{\tau_{\eta c} \tau_{z c}} \right)} \\ &= \sqrt{\frac{2(N-1)^2 \tau_{\eta c}^2 \left(1 - \frac{\tau_{z c}}{\tau_{z c} + \frac{B_c^2}{A_c^2} \tau_{\eta c}} \right)^2}{\pi N(N-1)\tau_{\eta c}} \left(\frac{A_c^2}{B_c^2 \tau_{\eta c}^2} + \frac{1}{\tau_{\eta c} \tau_{z c}} \right)}, \end{aligned} \quad (\text{A.108})$$

where the second step follows from (A.97) and the third from (A.94). Rearranging (A.108) yields (41).

We next determine how volume depends on N . As shown in the proof of Proposition 12, the derivative of the left-hand side of (40) with respect to $\frac{B_c}{A_c}$ is positive at the solution $\frac{B_c}{A_c}$. Since the derivative with respect to N is negative, $\frac{B_c}{A_c}$ is increasing in N . Therefore, (41) implies that volume is increasing in N .

We next determine how volume depends on $\tau_{\eta c}$. Setting $\omega \equiv \frac{B_c}{A_c} \sqrt{\tau_{\eta c}}$, we can write (40) as

$$(\tau_{zc} + w^2) (\omega \tau_\zeta \sqrt{\tau_{\eta c}} - \alpha(\tau_\eta + \tau_\zeta + \tau_{\eta c} + \tau_\eta)) - \alpha(N - 1) \tau_{\eta c} \tau_{zc} = 0 \quad (\text{A.109})$$

and (41) as

$$\sqrt{\frac{2(N - 1)\omega^2}{\pi N \tau_{zc} (\tau_{zc} + \omega^2)}}. \quad (\text{A.110})$$

Eq. (A.110) implies that the effects of $\tau_{\eta c}$ on volume and ω have the same sign. The derivative of the left-hand side of (A.109) with respect to ω is equal to $\sqrt{\tau_{\eta c}}$ times the same derivative with respect to $\frac{B_c}{A_c}$. Therefore, it is positive at the solution ω . The derivative with respect to $\tau_{\eta c}$ is

$$(\tau_{zc} + w^2) \left(\frac{\omega \tau_\zeta}{2\sqrt{\tau_{\eta c}}} - \alpha \right) - \alpha(N - 1) \tau_{zc},$$

and is equal to

$$\begin{aligned} & \frac{1}{\tau_{\eta c}} \left[(\tau_{zc} + w^2) \left(\frac{1}{2} \omega \tau_\zeta \sqrt{\tau_{\eta c}} - \alpha \tau_{\eta c} \right) - \alpha(N - 1) \tau_{\eta c} \tau_{zc} \right] \\ &= \frac{1}{\tau_{\eta c}} \left[(\tau_{zc} + w^2) \left(\frac{1}{2} \omega \tau_\zeta \sqrt{\tau_{\eta c}} - \alpha \tau_{\eta c} \right) - (\tau_{zc} + w^2) (\omega \tau_\zeta \sqrt{\tau_{\eta c}} - \alpha(\tau_\eta + \tau_\zeta + \tau_{\eta c} + \tau_\eta)) \right] \end{aligned}$$

at the solution w . It is negative if and only if

$$\omega > \frac{2\alpha(\tau_\eta + \tau_\zeta + \tau_\eta)}{\tau_\zeta \sqrt{\tau_{\eta c}}}.$$

This condition is equivalent to the left-hand side of (A.109) being negative for $w = \frac{2\alpha(\tau_\eta + \tau_\zeta + \tau_\eta)}{\tau_\zeta \sqrt{\tau_{\eta c}}}$.

We can write the latter condition as

$$[\tau_\zeta^2 \tau_{\eta c} \tau_{zc} + 4\alpha^2(\tau_\eta + \tau_\zeta + \tau_\eta)^2] (\tau_\eta + \tau_\zeta + \tau_\eta - \tau_{\eta c}) - (N - 1) \tau_\zeta^2 \tau_{\eta c}^2 \tau_{zc} < 0. \quad (\text{A.111})$$

The left-hand side of (A.111) is a quadratic function of $\tau_{\eta c}$ that is positive for $\tau_{\eta c} = 0$ and goes to $-\infty$ when $\tau_{\eta c}$ goes to ∞ . Therefore, there exists a unique $\tau_{\eta c}^* > 0$ such that (A.111) holds for $\tau_{\eta c} > \tau_{\eta c}^*$ and the opposite inequality holds for $\tau_{\eta c} < \tau_{\eta c}^*$. Volume and ω are thus decreasing in $\tau_{\eta c}$ for $\tau_{\eta c} < \tau_{\eta c}^*$ and increasing in $\tau_{\eta c}$ for $\tau_{\eta c} > \tau_{\eta c}^*$, i.e., are inverse hump-shaped in $\tau_{\eta c}$. ■

Proof of Proposition 14. We first determine traders' demands assuming that the price takes the form (42). The information I_i of trader i consists of her private signal s_i , the public signal s , and the signal $\epsilon + \theta_i$ that is revealed from the price. Since all private signals enter the price with the same coefficient, (12) implies that $\theta_i = \frac{\sum_{j \neq i} \eta_j}{N-1}$. To compute the distribution of ϵ conditional on I_i , we use Lemma A.1 with $x = \epsilon$, $K = 3$, and $\{y_j\}_{j=1,2,3} = \{\eta_i, \eta, \theta_i\}$. Combining with (10), (A.7) and (A.8), and using trader i 's assessments of precision, we find

$$x_i = \frac{\bar{d} + \frac{\kappa \tau_{\eta c}}{\tau_\epsilon + \kappa \tau_{\eta c} + \tau_\eta + (N-1)\gamma \tau_{\eta c}} s_i + \frac{\tau_\eta}{\tau_\epsilon + \kappa \tau_{\eta c} + \tau_\eta + (N-1)\gamma \tau_{\eta c}} s + \frac{(N-1)\gamma \tau_{\eta c}}{\tau_\epsilon + \kappa \tau_{\eta c} + \tau_\eta + (N-1)\gamma \tau_{\eta c}} (\epsilon + \theta_i) - p}{\alpha \left(\frac{1}{\tau_\epsilon + \kappa \tau_{\eta c} + \tau_\eta + (N-1)\gamma \tau_{\eta c}} + \frac{1}{\tau_\zeta} \right)}. \quad (\text{A.112})$$

We next substitute (A.112) into the market-clearing condition (7), substituting also the price p from (42). This yields an equation that is linear in $\left(\frac{\sum_{i=1}^N s_i}{N}, s \right)$. Identifying terms in $\frac{\sum_{i=1}^N s_i}{N}$ and s yields (43) and (44), respectively. ■

Proof of Proposition 15. Substituting p from (42) into (A.112) and using (43), (44), and

$$\epsilon + \theta_i = \epsilon + \frac{\sum_{j \neq i} \eta_j}{N-1} = \frac{\sum_{j \neq i} s_j}{N-1},$$

we can write the quantity that trader i trades in equilibrium as

$$x_i = \frac{\tau_\zeta}{\alpha [\tau_\epsilon + \tau_\zeta + [(N-1)\gamma + \kappa]\tau_{\eta c} + \tau_\eta]} \sum_{j=1}^N a_{ij} s_j, \quad (\text{A.113})$$

where

$$a_{ii} \equiv \frac{N-1}{N} (\kappa - \gamma) \tau_{\eta c}, \quad (\text{A.114})$$

$$a_{ij} \equiv -\frac{1}{N} (\kappa - \gamma) \tau_{\eta c} \quad \text{for } j \neq i. \quad (\text{A.115})$$

Since x_i is normal,

$$\begin{aligned}
E(|x_i|) &= \sqrt{\frac{2\text{Var}(x_i)}{\pi}} \\
&= \sqrt{\frac{2}{\pi} \frac{\tau_\zeta}{\alpha [\tau_\epsilon + \tau_\zeta + [(N-1)\gamma + \kappa]\tau_{\eta c} + \tau_\eta]} \sqrt{\left(\sum_{j=1}^N a_{ij}\right)^2 \sigma_\epsilon^2 + \sum_{j=1}^N a_{ij}^2 \sigma_{\eta_j}^2}}. \tag{A.116}
\end{aligned}$$

Substituting $\{a_{ij}\}_{j=1,\dots,N}$ from (A.114) and (A.115) into (A.116), we find (45). ■

Proof of Proposition 16. The proposition follows by setting $\gamma = 0$ in (45) since cursedness is equivalent to extreme contemptuousness. ■