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Markets are central to modern society, so their failures can be devastating. Here, we examine a prominent failure: price bubbles. Bubbles emerge when traders err collectively in pricing, causing misfit between market prices and the true values of assets. The causes of such collective errors remain elusive. We propose that bubbles are affected by ethnic homogeneity in the market and can be thwarted by diversity. In homogenous markets, traders place undue confidence in the decisions of others. Less likely to scrutinize others' decisions, traders are more likely to accept prices that deviate from true values. To test this, we constructed experimental markets in Southeast Asia and North America, where participants traded stocks to earn money. We randomly assigned participants to ethnically homogeneous or diverse markets. We find a marked difference: Across markets and locations, market prices fit true values 58% better in diverse markets. The effect is similar across sites, despite sizeable differences in culture and ethnic composition. Specifically, in homogenous markets, overpricing is higher as traders are more likely to accept speculative prices. Their pricing errors are more correlated than in diverse markets. In addition, when bubbles burst, homogenous markets crash more severely. The findings suggest that price bubbles arise not only from individual errors or financial conditions, but also from the social context of decision making. The evidence may inform public discussion on ethnic diversity: it may be beneficial not only for providing variety in perspectives and skills, but also because diversity facilitates friction that enhances deliberation and upends conformity.

diversity | decision making | markets | sociology | economics | psychology

In modern society, markets are ubiquitous (1). We rely on them not only to furnish necessities but also to finance businesses, provide healthcare, control pollution, and predict events (2). The market has become such a central social institution because it typically excels in aggregating information and expectations from disparate traders, thereby setting prices and allocating resources better than any individual or government (3). However, markets can go astray, and here we examine a prominent failure of markets: price bubbles (4–6).

Bubbles emerge when traders err collectively in pricing, causing a persistent misfit between the market price and the true value (also known as “intrinsic” or “fundamental” value) of an asset, such as a stock (7, 8). Bubbles devastate individuals and markets, wreck nations, and destabilize the entire world economy. When a stock market bubble burst in 1929, the Great Depression materialized (6). After its “bubble economy” ruptured in 1990, Japan stagnated for decades. More recently, housing bubbles in the United States and Europe caused a financial crisis, burdening the global economy since (3, 7).

Price bubbles can wreck people, markets, and nations, but they also present a puzzle. That people occasionally err is unsurprising—psychologists and economists have documented myriad individual biases—but individual errors do not necessitate a bubble. Traders vie for advantage, so if some unwittingly misprice an asset, for example by paying lofty prices, competitors should exploit the error by offering to sell dearly, thereby profiting from others' mistakes (9).

At the same time, the sellers also increase supply and depress prices, which should prevent a bubble. In other words, even if some traders err, the market as a whole should still price accurately—markets are thought to be self-correcting (3). For price bubbles to emerge, pricing errors must be not idiosyncratic, but common among traders.

Attempting to pinpoint the cause of bubbles, some researchers have designed experimental markets that are ideally suited for accurate decision making. However, even there—with skilled participants who possess complete information about the true values of the stocks traded—bubbles persist (7, 8). Researchers have shown that bubbles are related to financial conditions such as excess cash (10), but also to behavior that exhibits “elements of irrationality” (11). Indeed, bubbles have been long ascribed to collective delusions, implied in terms such as “herd behavior” and “animal spirits” (12–14), but their exact causes remain nebulous. We suggest that that price bubbles arise not only from individual errors or financial conditions but also from the social context of decision making.

We draw on studies that have used simulations (15), ethnographic accounts of an arbitrage disaster (9), and qualitative research on the recent financial crisis (16) that point to the dangers of homogeneity. We also rely on past research investigating the effects of diversity on the performance of countries and regions, organizations, and teams. Our results suggest that bubbles are affected by a property of the collectivity of market traders—ethnic homogeneity.

Homogeneity and diversity have been studied across the social sciences. A commonly accepted view is that cognitive diversity, an assortment of perspectives and skills, enables exchange of

Significance

Markets are central to modern society, so their failures can have devastating effects. Here, we examine a prominent failure: price bubbles. We propose that bubbles are affected by ethnic homogeneity in the market and can be thwarted by diversity. Using experimental markets in Southeast Asia and North America, we find a marked difference: Market prices fit true values 58% better in diverse markets. In homogenous markets, overpricing is higher and traders' errors are more correlated than in diverse markets. The findings suggest that price bubbles arise not only from individual errors or financial conditions, but also from the social context of decision making. Informing public discussion, our findings suggest that diversity facilitates friction that enhances deliberation and upends conformity.

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valuable information, thereby enhancing creativity and problem solving (15, 17). However, when it comes to ethnic diversity, the effects are decidedly mixed. Ethnic diversity has been studied in multiple spheres, including economic growth (18, 19), social capital (20), cities and neighborhoods (21), organizations (17, 22), work teams (23–25), and jury deliberations (26). Some studies find benefits, but others do not. For instance, ethnic diversity in a city or region can summon a multitude of abilities, experiences, and cultures, but can also bring heterogeneity in preferences and mores, which complicates public policy decisions (18, 27) and may hamper collective action (20). In the workplace, ethnic diversity is associated with greater innovation, but also increased conflict (28).

Some of the disparity can be explained by the results we report here: Ethnic diversity facilitates friction. This friction can increase conflict in some group settings, whether a work team, a community, or a region (29). Conversely, ethnic homogeneity may induce confidence, or instrumental trust (30), in others' decisions (confidence not necessarily in their benevolence or morality, but in the reasonableness of their decisions, as captured in such everyday statements as "I trust his judgment"). However, in modern markets, vigilant skepticism is beneficial; overreliance on others' decisions is risky.

As Portes and Vikstorm (31) note, modern "markets do not run on social capital; they operate instead on the basis of universalistic rules and their embodiment in specific roles." In other words, modern markets rely less on the mechanical solidarity engendered by coethnicity, the "bounded solidarity" (32) embodied for instance in the Maghribi traders' coalition (33) or the rotating credit associations of Southeast Asia (34, 35). Instead, modern markets rely on organic solidarity, which turns on heterogeneity, role differentiation, and division of labor (31, 36). Ethnic homogeneity may be beneficial in some group settings for the same reason it may be detrimental to modern markets—it instills confidence in others' decisions.

Confidence in others' decisions matters because, in many situations, people watch others for cues about appropriate behavior (37). When people enter a market, whether to purchase stock, buy a house, or hire an employee, they heed not only the objective features of the good or service—the performance of the company, the number of bedrooms, the years of work experience—but they also note the behavior of others, attempting to decipher their mindset before deciding how to act (12, 13, 38). In a modern market, where competition is key, undue confidence in others' decisions is counterproductive: It can discourage scrutiny and encourage imitation of others' decisions, ultimately causing bubbles.

In ethnically homogenous markets, we propose, traders place greater confidence in the actions of others. They are more likely to accept their coethnics' decisions as reasonable, and therefore more likely to act alike. Compared with those in an ethnically diverse market, traders in a homogenous market are less likely to scrutinize others' behavior. Conversely, in a diverse market, traders are more likely to scrutinize others' behavior and less likely to assume that others' decisions are reasonable.

This proposition is galvanized by a persistent empirical finding across the social sciences: People tend to be more trusting of the perspectives, actions, and intentions of ethnically similar others (21, 39, 40). As intergroup contact theory and social identity theory establish, shared ethnic identity is a broad basis for establishing trust among strangers. Moreover, empirical evidence shows specifically that people surrounded by ethnic peers tend to process information more superficially (26, 41, 42). Such superficial thinking fits with the notion of greater confidence in others' decisions: If one assumes that others' decisions are reasonable, one may exert less effort in scrutinizing them. For instance, ethnically diverse juries consider a wider range of perspectives, deliberate longer, and make fewer inaccurate statements than homogeneous juries (26). Compared with those in homogeneous

discussion groups, students who are told they will join diverse discussion groups review the discussion materials more thoroughly beforehand (42) and write more complex postdiscussion essays (41). In markets, where information is incomplete and decisions are uncertain (43), traders may be particularly reliant on ethnicity as a group-level heuristic for establishing confidence in others' decisions. Such superficial information processing can engender conformity, herding, and price bubbles. As the term implies, herding is not the outcome of careful analysis but of observational imitation (14).

Therefore, we propose that, when an offer is made to buy or to sell an asset, traders in homogeneous markets are more likely to accept it than those in diverse markets. If traders in homogeneous markets place greater confidence in the decisions of their coethnics, so they are more likely to accept offers that are further from true value. This is not an individual idiosyncrasy, but a collective phenomenon: Pricing errors of traders in homogeneous markets are more likely to be correlated than those of traders in diverse markets. The culmination of these processes leads to bubbles that are bigger.

To study the effects of diversity on markets, we created experimental markets in Southeast Asia (study 1) and North America (study 2). We selected those locales purposefully. The ethnic groups in them are distinct and nonoverlapping—Chinese, Malays, and Indians in Southeast Asia, and Whites, Latinos, and African-Americans in North America—thus allowing a broad comparison. We also sought more generalizable results by including participants beyond Western, rich, industrialized, and democratic nations (44).

Realistic trading requires financial skills, so we turned to those who are likely to possess it. For study 1, in Southeast Asia, we recruited skilled participants, trained in business or finance, for a "stock-trading simulation." We surveyed their demographics in advance and randomly assigned them to markets (trading sessions) as to create a collectivity of traders that was either ethnically homogeneous or diverse (Fig. 1). In the homogeneous markets, all participants were drawn from the dominant ethnicity in the locale; in the diverse markets, at least one of the participants was an ethnic minority. All traders could view their counterparts and note the ethnicities present in the market.

When the participants arrived in the trading laboratory, we provided them with all of the information necessary to calculate the stocks' true value accurately, including examples. After they read the instructions (and before actual trading), we assessed each participant's comprehension and financial (pricing) skills. We presented each participant separately with simple market scenarios and asked him or her to declare the prices in which he or she would buy or sell in each scenario. The participants could not see the others' responses. We used the responses to calculate ex-ante pricing accuracy: the extent to which the participants' responses, in aggregate, approximated the true values of the stocks. This measure of pricing accuracy serves as a baseline of performance. Because the responses were collected individually, and participants could not observe others' responses, social influence was minimal at this stage. Fig. 1 provides a visual overview of the experiment.

Next, participants were allocated cash and stocks and began trading. Much as in a modern stock market, participants observed all of the trading activity on their computer screens. They saw the prices at which others bid to buy and asked to sell. They saw what others ultimately paid and received. As various financial features of the market can affect bubbles (45–47), we control these through the experimental design. While trading, participants could not see each other or communicate directly. As in modern stock markets, they did not know which trader made a certain bid or offer. So, direct social influence was curtailed, but herding was possible. When trading ended, the participants received their earnings in cash. Then, we used the prices in which

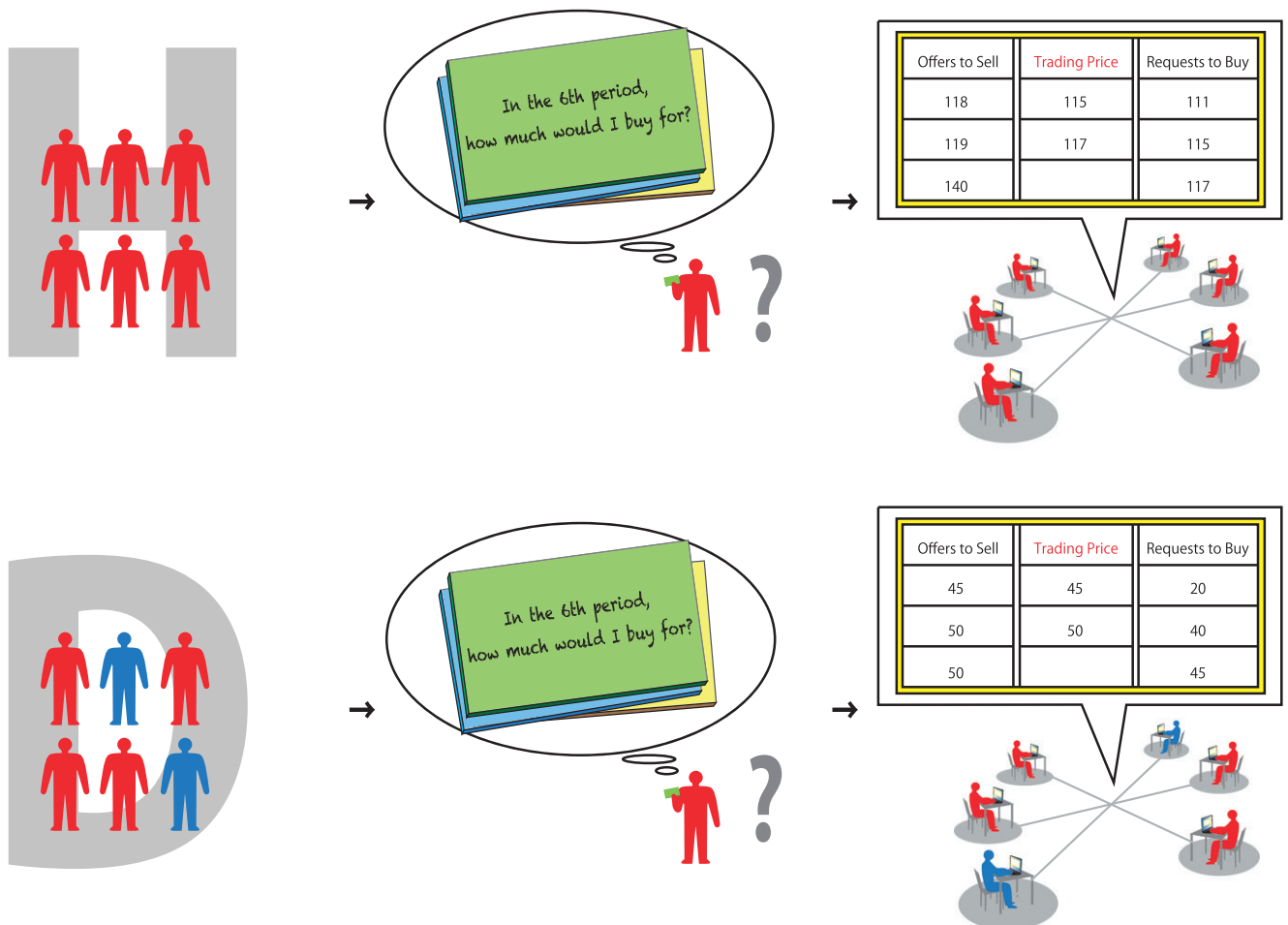


Fig. 1. The experiment. Participants were randomly assigned to markets that were ethnically homogeneous or diverse (Left). After they received the information needed to price stocks accurately, we assessed each participant's financial skills individually, using 10 hypothetical market scenarios to establish a baseline of pricing accuracy (Center). Trading in a computerized stock market, each participant was free to buy and sell stocks and/or to make requests to buy ("bid") or offers to sell ("ask"). All trading information was true, public, and anonymous: All participants could see all completed transactions and bid and ask offers (Right; see example in *SI Appendix*, Fig. S8). The data reflect actual prices in the sixth period of trading in two of the markets of study 1. The experiment did not involve deception.

stocks were bought and sold to calculate the ex-post pricing accuracy: the extent to which market prices, on average, approximated the true values of the stocks.

For study 2, a replication in North America, we followed the same protocol. An exact, or direct, replication further suggests that the pattern we observed is general, independent of specific culture or demographics (48). So we selected a wholly different site, distinct by culture and encompassing a different mix of ethnicities.

Results

We begin, most generally, by calculating the magnitude of bubbles in diverse and homogenous markets. As done frequently (4), we assess the magnitude by the extent to which prices, in aggregate, match the true values of stocks (Haessel's R^2). We find a marked difference: Traders in ethnically homogeneous markets are significantly less accurate, and thus more likely to cause price bubbles ($b = 0.297$, $t_{(27)} = 4.06$, $P < 0.001$, robust regression of Haessel's R^2 on a treatment indicator, controlling for location-fixed effects; "b" denotes the estimated coefficient on a binary treatment indicator; details are in *SI Appendix*, Table S2). Across markets and locations, pricing accuracy is 58% higher in diverse markets (*SI Appendix*, Table S1). Markets in the two sites differ in absolute pricing accuracy, probably because of educational

differences, but the contrast between diverse and homogeneous markets is remarkably alike (Fig. 2 A and B).

It is possible that traders in homogenous markets were somehow less skilled to begin with, but because we measured each participant's pricing accuracy before trading, establishing a baseline, we can pinpoint how this accuracy is affected by trading in a diverse or homogeneous market (ex-post accuracy; Fig. 3). This is a cautious measure: As one may expect that prices in trading (ex-post) will be more accurate than those measured in a questionnaire before trading (ex-ante). Foremost, markets are thought to be self-correcting (3), so by aggregating offers to buy and sell from all traders, the market price should be more accurate than individual estimates. Second, the market scenarios that we used for measuring ex-ante pricing accuracy provided the participants an opportunity to contemplate and practice pricing, an opportunity that should enhance accuracy during trading. Finally, participants could earn money by performing well in trading, but not with the pretrading market scenarios, so they had an incentive to excel.

We find that ethnic diversity makes a difference during trading. In diverse markets, average fit improves during trading: pricing errors drop. However, in homogeneous markets, average fit does not improve—instead, it often deteriorates. In such markets, prices established during trading were no more accurate

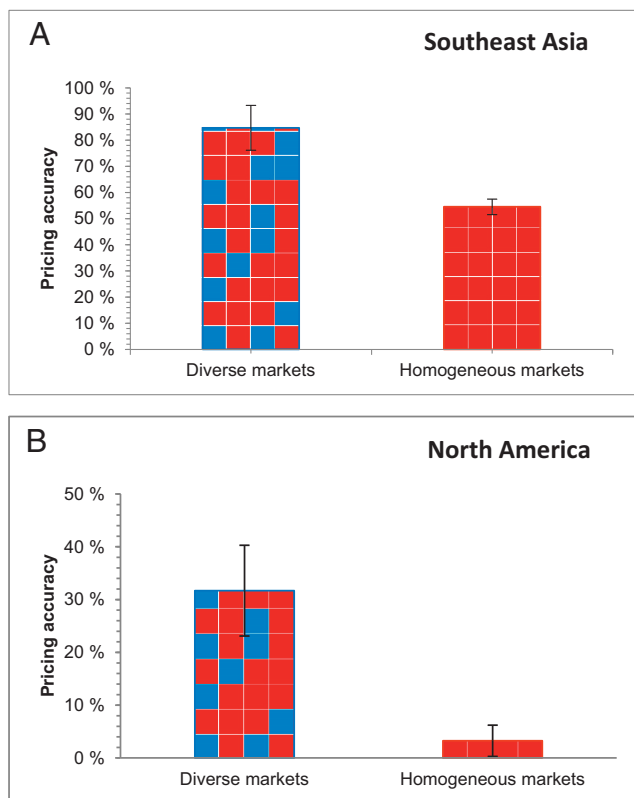


Fig. 2. Pricing accuracy in diverse and homogeneous markets across studies: (A) Southeast Asia and (B) North America. Pricing accuracy in trading (ex-post fit between market prices and true values) across diversity conditions and sites, measured by Haessel's R^2 . Higher score signifies higher pricing accuracy; the lower the score, the worse the accuracy, the greater the bubble. Error bars represent SEMs. Difference (across diversity conditions) in ex-post pricing accuracy in Southeast Asia = 0.302, $t_{(21)} = 3.059$, two-tailed $P < 0.01$; in North America = 0.284, $t_{(9)} = 3.593$, two-tailed $P < 0.05$. The results are robust whether using parametric or nonparametric statistical tests (*SI Appendix*). They are based on 2,022 market transactions by 180 individual traders in 30 markets, of which 16 were homogeneous and 14 diverse. Details are in *SI Appendix*, Table S1.

(often less accurate) than the average individual responses collected separately before trading. When surrounded by coethnics, even those with superior pricing skills, as assessed before trading, were likely to commit pricing errors, buying and selling above true value. Homogeneous markets do not correct individual errors—they preserve or even exacerbate them (Fig. 3).

We find that the ethnic composition of a market causes significant differences in pricing accuracy during trading, and also affects how accuracy changes. Whereas accuracy improves in diverse markets, in homogeneous markets errors are preserved or exacerbated. We find no evidence of preexisting differences in accuracy between traders in homogeneous and diverse markets. Regressing ex-ante accuracy on a treatment condition (homogeneous or diverse), while controlling for location-fixed effects, shows that treatment had no significant effect [$b = -0.003$, $t_{(27)} = -0.04$, $P = 0.926$; *SI Appendix*, Table S7]. Rather, the differences stem from trading in a homogeneous (or diverse) market.

Next, we investigate the individual behaviors underlying these results. We find that trading prices are significantly lower in diverse markets [$b = -9.997$, $t_{(2,018)} = -6.13$, $P < 0.001$, transaction-level regression of price on diversity condition, controlling for true value, period, and location-fixed effects; column (1) of *SI Appendix*, Table S3]. However, in diverse markets prices are not only lower—they are significantly closer to the true values. Pricing errors are smaller. The results hold regardless of whether we

consider absolute distance to true value [$b = -8.942$, $t_{(2,018)} = -6.55$, $P < 0.001$; column (2) of *SI Appendix*, Table S3], relative distance [$b = -0.262$, $t_{(2,018)} = -4.78$, $P < 0.001$; column (3) of *SI Appendix*, Table S3], or relative absolute distance [$b = -0.278$, $t_{(2,018)} = -4.90$, $P < 0.001$; column (4) of *SI Appendix*, Table S3].

Whether the market is homogeneous or diverse explains a great deal of variance in trading prices. When we consider the effect of homogeneity and diversity together with controls, we find that these explain almost a third of the variance in trading prices (*SI Appendix*, Table S3, all specifications).

Pricing errors happen when traders accept an offer to buy or sell at prices that differ from true value, so we examined what makes an offer acceptable. We find that offers are more likely to be accepted in homogeneous markets than in diverse ones [$b = 0.150$, $z_{(6,178)} = 2.61$, $P < 0.01$, Probit regression; column (2) of *SI Appendix*, Table S4], even after statistically controlling for other variables that affect prices. In addition, the effects of homogeneity are more pronounced the further an offer is from true value. Traders in homogeneous markets are more likely to accept offers that are above true value. This supports the notion that traders in homogeneous markets place undue confidence in the decisions of others—they are more likely to spread others' errors by accepting inflated offers, paying prices that are far from true values. Traders in diverse markets are more likely to reject such offers (analyses in *SI Appendix*, Table S4).

Finally, we examine the burst of bubbles, analyzing the effect of diversity on the peak-to-trough change in pricing. We find that bubbles in homogeneous markets burst more severely. Diversity softens the blow: Even if diverse markets occasionally move away from true values, crashes are significantly less severe [$b = -2.510$, $t_{(28)} = -2.09$, $P < 0.045$, session-level regression of peak-to-trough distance on treatment controlling for location; *SI Appendix*, Table S5]. The diversity condition explains more than a quarter of the peak-to-trough change (*SI Appendix*, Table S5).

Of course, people can err idiosyncratically, because of ignorance or confusion. They certainly do so in our experiments, but common error—a statistical measure that filters out idiosyncratic errors to identify similar errors (49)—is significantly higher in homogeneous markets than in diverse ones [$b = -1.009$, $t_{(27)} = -1.90$, $P < 0.068$, session-level regression of common error on treatment, controlling for location; *SI Appendix*, Table S6]. In homogeneous markets, errors are more likely to be correlated.

Discussion

Markets are central to modern society, and their failures can devastate people, communities, and nations. We find that price bubbles are fueled by the ethnic homogeneity of traders. Homogeneity, we suggest, imbues people with false confidence in the judgment of coethnics, discouraging them from scrutinizing behavior. In contrast, traders in diverse markets reliably price assets closer to true values. They are less likely to accept offers inflated and more likely to accept offers that are closer to true value, thereby thwarting bubbles. This pattern is similar in Southeast Asia and North America, even if the two sites differ greatly in culture and ethnic composition, in what is implied by "ethnic diversity" and how it is operationalized.

The experimental markets we use here are a judicious setting for examining the effects of homogeneity. Real markets are less transparent and more uncertain: The probability of future events is unknown. Uncertainty enables alternative interpretations of the same information, letting biases exert even stronger effect on decisions. We suspect that our results underestimate the detrimental effect of homogeneity in real markets.

It is not surprising that people err in cognitive tasks: Economists and psychologists have cataloged numerous individual cognitive biases (43). However, we suggest that biases may stem not only from the limits of individual cognition, but also from the social context in which decisions are embedded. Homogeneity (or diversity) is not a feature of individuals, but of a collective:

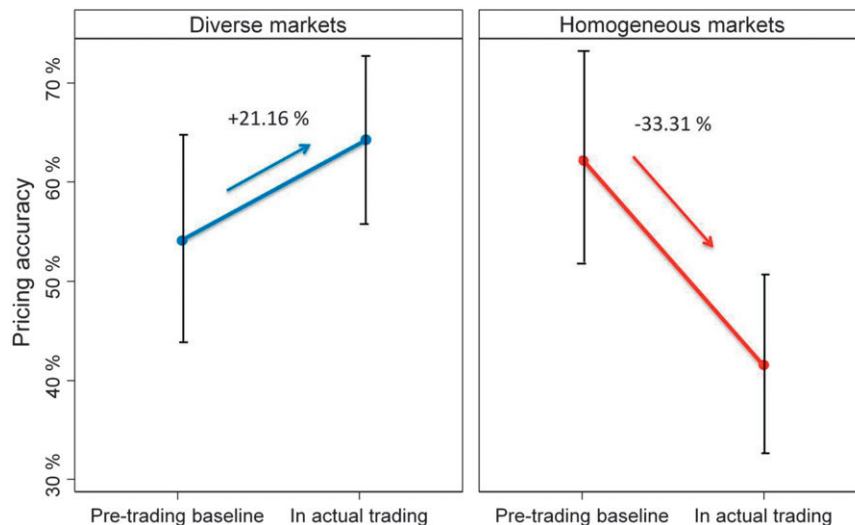


Fig. 3. Average change in pricing accuracy in diverse and homogeneous markets. Average change is from ex-ante (pretrading baseline) to ex-post pricing accuracy (in actual trading). When negative, pricing accuracy deteriorates during trading; when positive, it improves. Error bars represent SEMs. Change in diverse markets: $t_{(14)} = 2.211$, two-tailed $P < 0.05$. Change in homogeneous markets: $t_{(16)} = -2.944$, two-tailed $P < 0.05$. The results are robust whether using parametric or nonparametric statistical tests (*SI Appendix*). They are based on 2,022 market transactions by 180 individuals in 30 markets, of which 16 were homogeneous and 14 diverse (*SI Appendix*, Table S1).

a team, a community, or a market. Collective biases have been long alluded to, but rarely measured (14). More broadly, homogeneity may play a critical role in herding—the convergence of people’s beliefs and behaviors through interaction—also known as (or related to) cascading, social contagion, peer effects, informational social influence, social proof, or institutionalization (50). If, as we find, markets populated by skilled traders possessing complete information are still so affected by homogeneity, it may have an even more pronounced role in other instances of herding, such as the spread of fashions, fads, false beliefs, and riots.

Our findings also inform the debate on diversity and multiculturalism (51). Some proponents of ethnic diversity justify it as a moral imperative, a reparation for inequality. Others argue that ethnic diversity can boost performance by bringing a broader range of perspectives, but the evidence is equivocal.

We propose a novel benefit: In our experiments, ethnic diversity leads all traders, whether of majority or minority ethnicity, to price more accurately and thwart bubbles. Ethnic diversity was valuable not necessarily because minority traders contributed unique information or skills, but their mere presence changed the tenor of decision making among all traders. Diversity benefited the market.

This explanation differs from those revolving around the benefits of cognitive diversity, when people contribute an assortment of perspectives and skills. It is thus broadly consistent with research that examines the detrimental effects inherent in ethnic homogeneity (52–54). Our explanation further attempts to connect individual processes to market-level outcomes. Through these lenses, the disparate findings on ethnic diversity appear more congruent: Diversity facilitates friction. In markets, this friction can disrupt conformity, interrupt taken-for-granted routines, and prevent herding. The presence of more than one ethnicity fosters greater scrutiny and more deliberate thinking, which can lead to better outcomes. Such friction, however, can cause conflict and complicate collective decisions. The challenge, then, is in establishing rules and institutions to address ethnic diversity and its effects. Without them, conflict can be destructive; with them, diversity can benefit the collective.

Materials and Methods

In both studies 1 and 2, participants were randomly assigned to an ethnically diverse or homogeneous six-person market (Fig. 1). Random assignment is meant to ensure that the markets were not systematically different from each other. Participants sat in a waiting room with the other traders, and then each was led to a separate cubicle. We presented each participant, separately, with instructions and the information needed to price stocks accurately. Then, we assessed the baseline pricing accuracy of each participant by asking about a range of hypothetical market scenarios (e.g., “How much would you pay for a stock in round 6?”). When answering the questions, participants were permitted to consult the instructions and information.

Next, participants familiarized themselves with the market—a double auction market based on the seminal design of Smith et al. (7) and programmed in z-Tree (55) (the code is publicly available). The participants had a practice trading and could ask questions. Then, they began trading for real money over a series of 10 rounds. Trading conditions resembled a modern, computerized stock market: Each participant was free to buy and sell stocks and/or to make offers for buying (“bid”) or selling (“ask”). Trading information was public and anonymous: all participants could see all completed transactions and bid and ask offers, but not the identities of the other traders (*SI Appendix*, Fig. S8). When trading concluded, participants received a cash payment as per their market earnings.

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