TABLE 3 **The Effects of Arbitrage Risk and Demand Shock Size on S&P 500 Addition Event Returns**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	.023**	.023**	−.002	−.002	.002	.027**	.023**	.024**
	(.003)	(.003)	(.006)	(.006)	(.007)	(.002)	(.002)	(.003)
A_{1i}	16.234**		16.294**	14.131*	16.746*			
	(5.953)		(5.834)	(6.518)	(7.038)			
A_{2i}		14.257*						
		(5.761)						
E_{1i}				11.395				
				(16.360)				
Analyst dispersion$_i$					−.006			
					(.015)			
Shock mil$_i$	.000043*	.000043*						
	(.000021)	(.000021)						
Shock pct$_i$			.00509**	.00496**	.00428**			
			(.00105)	(.00103)	(.00126)			
A_{1i} × Shock mil$_i$						.206**		
						(.070)		
A_{1i} × Shock pct$_i$							4.081**	3.901**
							(1.112)	(1.320)
Analyst dispersion$_i$ × Shock pct$_i$								−.00056
								(.00060)
$\bar{R}^2$	.039	.036	.102	.104	.080	.037	.061	.060
N	259	259	259	259	177	259	259	177

NOTE.—This table presents OLS models of S&P 500 Index addition announcement day returns. The dependent variable is the excess return over the market ($R_{it} - R_{mt}$). The sample includes 259 stocks added to the S&P 500 between September 1976 and September 1989, or as limited by data. The construction and summary statistics of arbitrage risk A and explained risk E are summarized in table 1. Analyst dispersion$_i$ is the standard deviation of analysts' forecasts for 1-year-ahead earnings per share, divided by the mean estimate, for stocks that have such estimates outstanding by at least five analysts at the time of the addition (mean = .094, median = .060, SD = .118, N = 177). Shock mil$_i$ is the dollar value of S&P 500 index fund demand, in millions of current dollars (sample mean = $64 [million], median = $51 [million], SD = $64 [million], N = 259). Shock pct$_i$ is the percentage of the added firm's capitalization demanded by index funds (sample mean = 5.0, median = 5.4, SD = 1.3, N = 259). Heteroskedasticity-robust standard errors are in parentheses.

* Significant at the 5% level.

** Significant at the 1% level.

TABLE 4 **Estimates of the Price Elasticity of Demand for Individual Stocks**

Source	Elasticity Estimate	Sample
Scholes (1972, p. 195)	−3,000	345 secondary distributions of large blocks on NYSE between 1961 and 1965
Shleifer (1986, inferred)	−1	246 additions to the S&P 500 between 1976 and 1983
Loderer, Cooney, and Van Drunen (1991, p. 640)	−11.12 (mean) −4.31 (median)	409 announcements of equity issues by regulated firms between 1969 and 1982
Bagwell (1992, p. 97)	−1.65	31 Dutch auction repurchases between 1981 and 1988
Kandel, Sarig, and Wohl (1999, p. 235)	−37.2 (mean) −21.0 (median)	27 Israeli IPO auctions between 1993 and 1996
Kaul, Mehrotra, and Morck (2000, p. 911)	−10.5	292 stocks affected by Toronto Stock Exchange 300 index weights change effective November 1996
The current article (specification 8, table 3)	−11.72 (at twenty-fifth percentile arbitrage risk) −8.24 (at median arbitrage risk) −5.57 (at seventy-fifth percentile arbitrage risk)	177 additions to the S&P 500 between 1976 and 1989

NOTE.—This table reports estimates of the price elasticity of demand for individual stocks. The measure is the percent change in demand associated with a 1% higher price. The perfect market benchmark is negative infinity. In cases where the author uses a different definition, we transform the results to obtain comparable estimates. The estimates are ordered by publication date. The page on which the relevant data is published is reported.

demand, as opposed to an information or liquidity change, these figures imply an elasticity estimate of about −1. The results of Harris and Gurel (1986) imply a similar estimate, but they put less emphasis on an explanation based on sloping demand curves.

Loderer et al. (1991) estimate the price elasticity of demand from a sample of announcements of primary offerings by regulated firms. These announcement effects, the authors argue, are unlikely to be driven by adverse information. Dividing the percent increase in supply due to the new shares by the announcement effect (which is typically negative), they estimate a mean price elasticity of demand of −11.12 and a median elasticity of −4.31. These estimates, like Shleifer's, attribute the entire price effect to the change in excess demand. In additional analysis, Loderer et al. attempt to control for the impact of adverse information directly and explore the cross section of implied elasticities in more detail.

Bagwell (1992) studies a small sample of firms that conducted Dutch auction share repurchases. She expresses her results from the perspective of the repurchasing firms, which essentially face upward-sloping supply curves for repurchased shares. This is the reflection of downward-sloping demand curves from the investors' perspective. She finds that to repurchase 15% of outstand-

Table II
Portfolio Returns by Size and Dispersion in Analysts' Forecasts

Each month stocks are sorted in five groups based on the level of market capitalization as of the third Thursday of the previous month. Stocks in each size group are then sorted into five additional groups based on dispersion in analyst earnings forecasts for the previous month. Dispersion is defined as the ratio of the standard deviation of analysts' current-fiscal-year annual earnings per share forecasts to the absolute value of the mean forecast, as reported in the I/B/E/S Summary History file. Stocks with a mean forecast of zero are assigned to the highest dispersion groups, and stocks with a price less than 5$ are excluded from the sample. Stocks are held for one month, and portfolio returns are equal-weighted. The time period considered is February 1983 through December 2000. The table reports average monthly portfolio returns; *t*-statistics in parentheses are adjusted for autocorrelation.

Returns

Dispersion Quintiles	Size Quintiles small *S1*	*S2*	*S3*	*S4*	large *S5*	All Stocks
D1 (low)	1.52	1.45	1.50	1.51	1.48	1.48
D2	1.12	1.40	1.41	1.18	1.35	1.36
D3	0.99	1.20	1.32	1.11	1.36	1.23
D4	0.76	1.07	1.18	1.33	1.33	1.12
D5 (high)	0.14	0.56	0.83	1.03	1.20	0.69
D1-D5	1.37[a]	0.89[a]	0.67[b]	0.48	0.29	0.79[a]
t-statistic	(5.98)	(3.12)	(2.41)	(1.55)	(0.94)	(2.88)

[a,b,c] Statistically significant at the 1, 5, and 10 percent levels, respectively

Average Dispersion

Dispersion Quintiles	Size Quintiles *S1*	*S2*	*S3*	*S4*	*S5*	All Stocks
D1 (low)	0.010	0.011	0.012	0.014	0.014	0.012
D2	0.039	0.033	0.030	0.028	0.025	0.030
D3	0.081	0.062	0.053	0.047	0.039	0.053
D4	0.172	0.125	0.103	0.086	0.067	0.105
D5 (high)	1.256	0.963	0.813	0.722	0.462	0.852

Table IV
Portfolio Returns by Size, Book-to-Market, and Dispersion

Each month stocks are sorted into three groups based on the level of market capitalization at the end of the previous month. Each size group is then sorted into three book-to-market groups. The book-to-market ratio is computed by matching the yearly BE figure for all fiscal years ending in calendar year $t-1$ to returns starting in July of year t; this figure is then divided by market capitalization at month $t-1$ to form the book-to-market ratio, so that the book-to-market ratio is updated each month. Each size and book-to-market group is further sorted into three dispersion groups. Dispersion is defined as the ratio of the standard deviation of analysts' current-fiscal-year annual earnings per share forecasts to the absolute value of the mean forecast, as reported in the I/B/E/S Summary History file. Stocks with a mean forecast of zero are assigned to the highest dispersion groups, and stocks with a price less than 5$ are excluded from the sample. Stocks are held for one month, and portfolio returns are equal-weighted. The sample period is February 1983 through December 2000; t-statistics in parentheses are adjusted for autocorrelation.

Returns

Dispersion	Low Book-to-Market			Medium Book-to-Market			High Book-to-Market		
	Small Cap	Medium Cap	Large Cap	Small Cap	Medium Cap	Large Cap	Small Cap	Medium Cap	Large Cap
low	1.35	1.42	1.40	1.64	1.50	1.32	1.50	1.58	1.42
medium	1.27	1.40	1.20	1.29	1.11	1.27	1.13	1.46	1.37
high	0.73	1.28	1.38	0.67	0.86	1.12	0.70	1.10	1.34
low-high	0.63[b]	0.14	0.02	0.96[a]	0.64[b]	0.21	0.80[a]	0.48	0.08
t-statistic	(2.10)	(0.47)	(0.06)	(4.09)	(2.37)	(0.96)	(4.09)	(1.70)	(0.25)

[a,b,c] Statistically significant at the 1, 5, and 10 percent levels, respectively

Average Dispersion

Dispersion	Low Book-to-Market			Medium Book-to-Market			High Book-to-Market		
	Small Cap	Medium Cap	Large Cap	Small Cap	Medium Cap	Large Cap	Small Cap	Medium Cap	Large Cap
low	0.04	0.03	0.02	0.05	0.03	0.02	0.10	0.04	0.03
medium	0.08	0.05	0.03	0.09	0.05	0.04	0.21	0.11	0.07
high	0.49	0.34	0.20	0.56	0.37	0.26	1.04	0.86	0.59

Table V
Portfolio Returns by Size, Momentum, and Dispersion

Each month stocks are sorted into three groups based on the level of market capitalization at the end of the previous month. Each size group is then sorted into three momentum groups; momentum is computed based on past returns from *t*-12 to *t*-2, where "*Losers*" is an equal-weighted portfolio of stocks in the *worst*-performing 33 percent. Each size and momentum group is further sorted into three dispersion groups. Dispersion is defined as the ratio of the standard deviation of analysts' current-fiscal-year annual earnings per share forecasts to the absolute value of the mean forecast, as reported in the I/B/E/S Summary History file. Stocks with a mean forecast of zero are assigned to the highest dispersion groups, and stocks with a price less than 5$ are excluded from the sample. Stocks are held for one month, and portfolio returns are equal-weighted. The sample period is February 1983 through December 2000; *t*-statistics in parentheses are adjusted for autocorrelation.

Returns

Dispersion	Losers						Winners		
	Small Cap	Medium Cap	Large Cap	Small Cap	Medium Cap	Large Cap	Small Cap	Medium Cap	Large Cap
low	0.92	1.02	1.27	1.29	1.45	1.36	1.79	1.79	1.54
medium	0.47	0.69	1.12	1.11	1.32	1.18	1.84	1.80	1.58
high	0.09	0.63	0.93	0.82	1.22	1.06	1.56	1.81	1.73
low-high	0.82[a]	0.40	0.35	0.48[a]	0.23	0.30	0.23	-0.02	-0.19
t-statistic	(3.65)	(1.56)	(1.46)	(2.76)	(1.12)	(1.61)	(1.17)	(-0.10)	(-0.83)

[a,b,c] Statistically significant at the 1, 5, and 10 percent levels, respectively

Average Dispersion

Dispersion	Losers						Winners		
	Small Cap	Medium Cap	Large Cap	Small Cap	Medium Cap	Large Cap	Small Cap	Medium Cap	Large Cap
low	0.10	0.05	0.03	0.04	0.03	0.02	0.03	0.02	0.02
medium	0.21	0.10	0.06	0.09	0.05	0.04	0.06	0.15	0.04
high	1.18	0.85	0.55	0.61	0.33	0.22	0.39	0.28	0.25

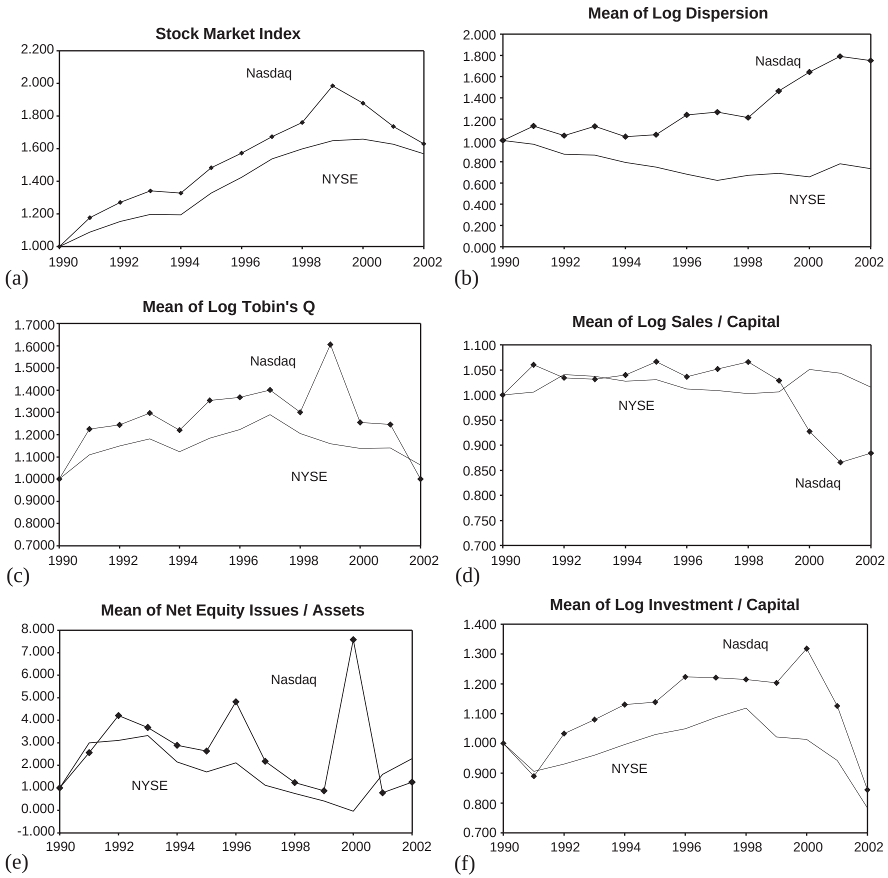

Fig. 3. Comparison of Nasdaq vs. NYSE firms for the time period 1990–2002. Figure (a) plots the stock market index. Figures (b)–(f) plot the log of the (trimmed) sample means in each year, normalized to one in 1990.

1990–2002.[18] For comparison's sake, we also plot the Nasdaq versus NYSE stock price indices as well.

Nasdaq firms experienced a steady increase in dispersion relative to NYSE firms over the period 1990–2001, followed by a slight decline in 2002.[19] Nasdaq firms experienced a steady increase in their investment rate relative to NYSE firms over most of this period. Nasdaq firms also show a relatively sharp increase in both

[18]With the exception of the net-equity issuance, we report the mean of the log of all variables for each sub-sample. For all variables, we trim outliers using a 1% of cutoff rule applied to the combined NYSE and Nasdaq sample.

[19]Because of reporting issues with IBES vs. Compustat, we lose approximately 20% of our observations in the last year of the sample. Thus the mean dispersion estimates for 2002 may not be entirely representative. Consistent with the idea that increases in dispersion contributed to the stock market boom, using medians rather than means, we see a sharper reduction in dispersion in the last year of our sample.

Table 1
Estimates of three-variable VAR

	$\ln mpk_t$	$\ln d_t$	$\ln(I/K)_t$
$\ln mpk_{t-1}$	0.933	0.436	0.459
	(30.408)	(10.920)	(9.523)
$\ln mpk_{t-2}$	−0.093	−0.229	−0.308
	(4.117)	(7.267)	(8.647)
$\ln d_{t-1}$	0.044	0.531	0.091
	(3.996)	(27.754)	(4.322)
$\ln d_{t-2}$	0.029	0.121	0.097
	(4.871)	(10.582)	(7.948)
$\ln(I/K)_{t-1}$	−0.164	−0.080	0.459
	(13.763)	(4.416)	(22.042)
$\ln(I/K)_{t-2}$	0.052	0.087	0.134
	(5.972)	(6.416)	(8.266)

Notes: Robust t-statistics appear in parentheses. Sample contains 18,421 firm-year observations.

our orthogonalization scheme will be helpful when identifying increases in dispersion that are not related to fundamentals.

Fig. 4 reports the impulse response functions from this three-variable VAR. We report the effects of shocks to mpk_t which, we interpret as a shock to the fundamental investment opportunities of the firm, and we report the effects of a shock to dispersion, which in our model leads to an increase in the bubble (price relative to fundamentals).

The effect of a one-standard deviation shock to mpk_t is reported in the first row of Fig. 4. The immediate effect of the shock is to increase both mpk_t and investment by approximately the same magnitude (0.2), following which both variables return to steady-state at approximately the same rate. This finding implies a unit elasticity between investment and the marginal product of capital following a shock to fundamentals.

The effect of a one standard deviation shock to dispersion is reported in the second row of Fig. 4. Consistent with our model, an innovation to dispersion leads to a pronounced increase in investment. The peak response of investment is on the order of 0.1 percent and occurs in the year following the shock. The increase in dispersion also causes a rise in mpk_t but, the magnitude is relatively small. Using unit elasticity as a reasonable measure of how investment should respond to fundamentals, most of the increase in investment following a shock to dispersion can be attributed to changes in dispersion that are orthogonal to future *mpk*.[23]

[23]If we interpret approximately unit elasticity response of investment to the innovation in *mpk* as providing a reasonable measure of how investment responds to fundamentals, then we would attribute 1/3 (0.03 out of 0.1) of the rise in investment to fundamentals following a shock to dispersion. The remaining 2/3 response (0.07 out of 0.1) would be attributable to movements in dispersion not linked to fundamentals.

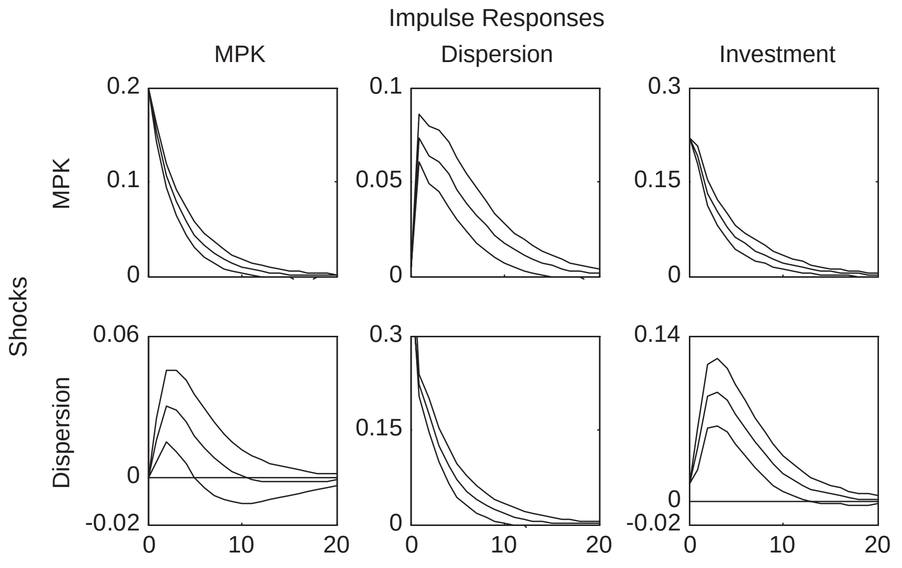

Fig. 4. Impulse response functions for 3-variable VAR model. Response variables appear across columns; shocks appear across rows (only shocks to LMPK and LDSPRA are shown; shocks to LCXK are omitted). Horizontal axis shows 20-year response horizon.

To examine the empirical link between dispersion, Tobin's Q and net equity issuance, we add these variables to the baseline VAR. For parsimony, we focus on the impulse response functions rather than coefficient values.[24] We again consider innovations based on a Cholesky decomposition using the following ordering: $[mpk_t, d_t, I/K_t, Q_t, neq_t]$. The model is again estimated in logs (except for net equity issuance, which is measured as a percentage of equity outstanding). The results are reported in Fig. 5.

The impulse response to a one standard deviation shock to mpk_t is reported in the first row of Fig. 5. Adding the additional variables does not change the basic relation between fundamentals and investment that we observed in Fig. 4. A shock to mpk_t leads to a modest rise in Tobin's Q and a small increase in equity issuance upon impact of the shock. Both of these responses are consistent with the notion that Tobin's Q and equity issuance respond endogenously to fundamental investment opportunities.

The response of investment and fundamentals to an innovation in dispersion is also similar to the results obtained using the three-variable VAR system albeit slightly weaker. Investment responds with some lag and shows a peak response on the order of 0.08. The increase in mpk_t is again positive but relatively small in

[24]Our model suggests that in a regression of investment on Tobin's Q and dispersion, we should find a negative effect of dispersion on investment. Adding Tobin's Q to the investment equation reduces the coefficient on dispersion but, they remain positive. Because such regressions do not control for the contemporaneous correlations however, we do not necessarily interpret this as a rejection of the model. Rather, it highlights the need for additional identification through the Choleski decomposition.

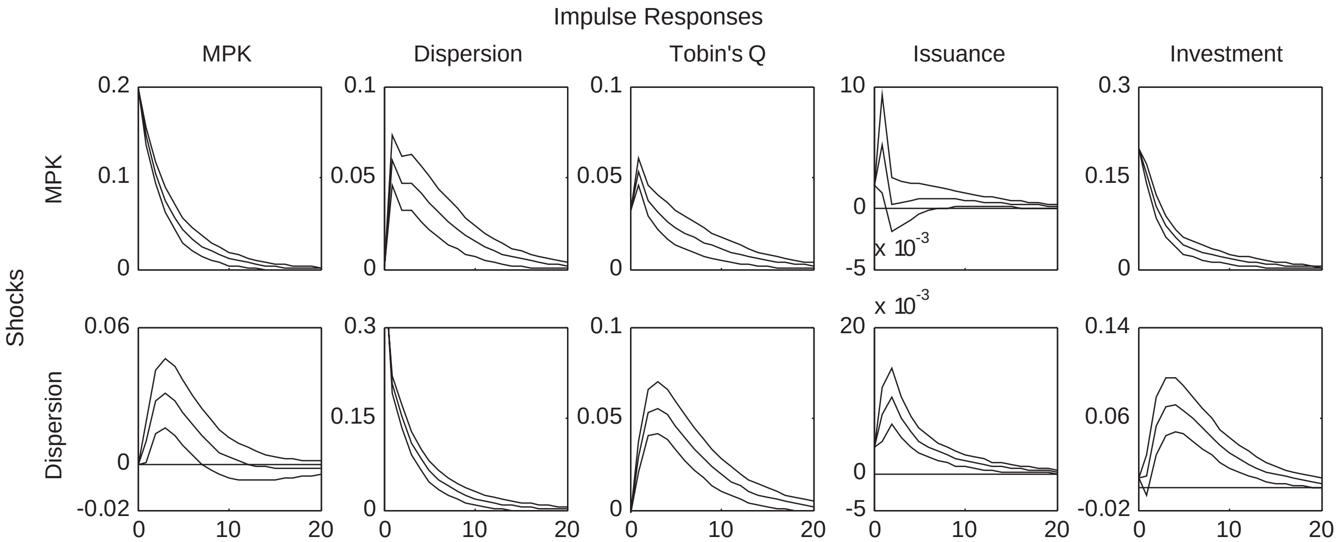

Fig. 5. Impulse response functions for 5-variable VAR model. Response variables appear across columns; shocks appear across rows (only shocks to LMPK and LDSPRA are shown; shocks to LTQ1, ENIV and LCXK are omitted). Horizontal axis shows 20-year response horizon.

Table 2
Variance decomposition at a 10-year horizon

Shocks	Fraction of total variance explained				
	ln *mpk*	ln *d*	ln *Q*	*neq*	ln(*I*/*K*)
ln *mpk*	0.869	0.068	0.153	0.043	0.480
ln *d*	0.015	0.897	0.015	0.059	0.014
ln *Q*	0.002	0.012	0.727	0.003	0.075
neq	0.002	0.000	0.083	0.884	0.015
ln(*I*/*K*)	0.111	0.023	0.021	0.010	0.416

mpk and Tobin's Q. Interestingly, dispersion accounts for more of the variance of net equity issuance (6 percent) than any other variable besides net equity issuance itself. In the absence of mispricing, the firm is indifferent between equity issuance and other forms of finance. Thus, from the model's perspective, it is not surprising that dispersion shocks would account for a large fraction of the variation in share issuance.

The variance decompositions suggest that dispersion only accounts for a small fraction of investment. This finding is not surprising for several reasons. First, as mentioned above, our panel data estimates do not identify the macro variation in the bubble component.[25] Second, analysts are reasonably informed agents. Dispersion in analysts' forecasts is therefore likely to understate the true amount of disagreement in the market place. Finally, the model itself implies that the effect of bubbles on investment will be limited, since the firm is unwilling to fully exploit the bubble in equilibrium.

4. Conclusion

This paper develops a model in which increases in dispersion of investor opinion cause stock prices to rise above their fundamental values. We consider the optimal share issuance and investment decisions of rational managers in response to such mispricing, and also consider how these actions, in turn, influence equilibrium prices. Our model predicts that an increase in dispersion causes increases in Tobin's Q, net new share issues, and real investment. A proxy for the dispersion of investor beliefs is constructed using the variance of analysts' earnings forecasts. Using a recursive ordering of a panel data VAR for identification, we find that shocks to dispersion have positive and statistically significant effects on Tobin's Q, net equity issuance, and real investment. These results all confirm the model's key predictions.

Although we find that dispersion-driven bubbles distort real investment, it is important to note that large stock price bubbles do not necessarily imply large

[25] Our aggregate plots, though anecdotal, suggest that the distortion caused by dispersion could be more substantial than our panel data estimates suggest.