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**THE IMPACT OF ASSET REPURCHASES AND  
ISSUES IN AN EXPERIMENTAL MARKET**

By

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# The impact of asset repurchases and issues in an experimental market

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## Abstract

We create an experimental asset market in which we conduct share repurchases and share issues. Although the intrinsic value of the shares is independent of the quantity outstanding, the interventions result in changes in asset price. Specifically, we find the following. (1) A repurchase of shares increases the price of the asset, and a share issue decreases the price of the asset, compared to a benchmark of no intervention. These effects are consistent with downward-sloping demand for the asset. (2) The empirical patterns observed are consistent with a model based on that proposed by DeLong et al. (1990), which posits three trader types-- fundamental, speculator, and momentum--interacting in the market. (3) The downward pressure on prices resulting from share issues drives prices down toward, but not beyond, fundamental values. This downward resistance at the fundamental value is predicted by the model, in which it arises from the impact of an intervention on the proportion of the total stock of units and cash held by each trader type.

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## 1. Introduction

There is considerable evidence that share issues and repurchases affect asset prices. On average, the price of a stock falls after a firm announces a share issue (Myers, 1984; Asquith and Mullins, 1986) or after the issue occurs (Grinblatt and Hwang, 1989; Ritter, 1991; Loughran and Ritter, 1995; Spiess and Affleck-Graves, 1995).<sup>1</sup> Repurchase announcements or actions are also typically followed by increases in share prices (Masulis, 1980; Vermaelen, 1981; Myers, 1984; Bartov, 1991; Grullon and Michaely, 2004; Lie, 2005).<sup>2</sup> A number of explanations for these effects have been proposed.

One mechanism whereby these price effects could arise is if the demand for shares is downward-sloping. The greater the supply of shares, the lower would be the valuation of the marginal shareholder. This downward-sloping demand might arise for a number of reasons. One such reason may be heterogeneous beliefs about future resale prices. Another might be a decreasing marginal value of the lottery associated with holding a share of stock, due to the greater risk investors undertake if they hold larger positions.<sup>3</sup> Demand could be downward-sloping even in settings in which the quantity of shares outstanding does not affect their intrinsic value.

There is some evidence consistent with the notion that the demand for stocks is downward-sloping. Shleifer (1986) finds that stocks trade at higher prices in the first ten days after their inclusion in the *S&P500* than in the next ten days, suggesting that buyers with higher valuations purchase the stock first and others with lower valuations follow. Similar conclusions have been reached by some other authors (Mikkelson and Partsch (1985), Kaul et al. (2000), Wurgler and Zhuravskaya (2002), Lynch and Mendenhall (1997)), who interpret their results as consistent with the existence of a portion of

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<sup>1</sup> A particularly striking recent example of this phenomenon is the US government takeover of Fannie Mae and Freddie Mac in September, 2008. The companies faced an urgent need for liquidity to meet short term debt obligations, and attempted to float a large number of new shares. However, the act of doing so had such a large negative effect on prices that the firms' market capitalization fell dramatically. This exacerbated their liquidity crisis and precipitated the nationalization of the two companies.

<sup>2</sup> Typically, there is a spike in share price immediately following the repurchase announcement (Masulis, 1980). However, Lie (2005) finds that firms that merely announce a repurchase program without actually repurchasing shares are less likely to experience a subsequent performance improvement, whereas firms that follow through on their announcements continue to experience large performance improvements within two quarters, persisting for at least two years thereafter. Grullon and Michaely (2004) find increases only in the year of the announcement and not in subsequent years.

<sup>3</sup> If investors are risk averse, the more shares that are issued, the greater is the risk of ownership, and the lower is the price. See Easley and O'Hara (2004) for the derivation of a downward sloping demand function resulting from the presence of risk averse traders.

investors who have higher marginal values than others. If this is the case, share repurchases would increase, and share issues would decrease, prices, even if they did not affect fundamental values or beliefs.<sup>4</sup>

On the other hand, the efficient market hypothesis rules out the presence of downward-sloping demand. According to this view, a negative relationship between share price and quantity might imply that the change in quantity affected traders' beliefs about intrinsic value of shares. Scholes (1972) articulates this argument and provides an empirical test for downward-sloping demand with a sample of secondary distributions (blocks of stock offered by large shareholders rather than the issuing firm). He studies the effect of the distributions on share prices. He tests whether the amount of the price decline relative to the market is greater for larger share distributions, and whether new shareholders receive greater returns after the purchasing from the distribution. He finds that there is a price decline, but its extent is not dependent on the size of the distribution, and there are no excess abnormal returns for the new shareholders. These patterns are consistent with completely elastic demand for shares and the revelation of new information from the distribution, but inconsistent with downward-sloping demand.

Indeed, interventions in the form of share issues or repurchases are typically not exogenous, and the resulting price changes can usually be explained by the fact that the interventions either affect the fundamental value of the stock, or influence investors' beliefs about fundamentals. This would be the case, for example, if the choice to intervene was indicative of capital structure optimization, signaling, insider knowledge or executive compensation schemes (Mintz, 1988; Lowenstein, 1991; Bagnoli et al., 1989; Dittmar, 2000; Brav et al., 2005; Bhattacharya, 1979; Miller and Rock, 1985; Vermaelen, 1981, 1984).

In this paper, we study whether heterogeneity in trading strategies can, on its own, generate a response of asset prices to share repurchases and issues. We construct an experimental environment, in which the fundamental value of the asset is common

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<sup>4</sup> During the dot com bubble of the late 1990s, there were stocks trading at what appeared to be extreme price-to-earnings multiples and investors lamented their inability to capitalize on these sure opportunities due to the constraints inherent in short selling (Ofek and Richardson, 2003). Furthermore, the effects of demand and supply of assets are historically evident in other asset classes, including real estate (Lin and Yung, 2006), junk bonds (Kaplan and Stein, 1993), and emerging economies' debt (Krugman, 1995). It is clear how such markets might form bubbles as a result of demand-and-supply imbalances. It should thus not be surprising then that these factors play a role in stocks as well.

knowledge and independent of the number of shares outstanding. There are no informational asymmetries.<sup>5</sup> We exploit the ability of experimental methods to strip away all of the factors that might allow a share repurchase or issue to affect the fundamental value, and study the properties of the market response to an exogenous intervention. We then vary the supply of shares of the asset exogenously with share repurchases and share issues. The fact that all other explanations for price responses to interventions are ruled out allows us to ask whether *it is possible* for heterogeneity in trading strategies to cause prices to respond to an intervention. This is a question that is distinct from asking about *why* a price change occurred in response to a particular intervention in the field. The model we apply predicts that, even if the intervention has no informational content or effect on fundamentals, prices change in response to an intervention, and the experiment supports the model in this regard. We make no claim that informational asymmetries and other sources of downward-sloping demand are not at work in non-laboratory asset markets, where they could influence the market response to interventions.

While the repurchase or share issue in our experiment has no effect on the intrinsic value of the asset<sup>6</sup>, the intervention does affect the environment in ways that, coupled with heterogeneous and boundedly rational trader behavior, may well change outcomes. A share issue or a repurchase changes the supply of shares relative to the cash available for purchases by traders.<sup>7</sup> It can also alter the level of risk the average individual is exposed to, as the risky share makes up a different fraction of his wealth after an intervention. However, the possibility we focus on is that an intervention may change the allocation of shares and liquidity among individuals, and thereby affect the

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<sup>5</sup> Experimentally, capital structure considerations have been investigated with a focus on investors' myopic attitudes to bond and stock payoff streams (e.g., Gneezy and Potters, 1997; Eriksen and Kvaloy, 2009), as well as to differential ability of equity and debt auctions (for venture capital funding) to result in efficient outcomes in the presence of asymmetric private information (Kogan and Morgan, 2009). The experiments reported here differ from these in a number of aspects. Among the differences are that we study two-sided market trading of one asset class, we make the information regarding fundamental values common, and we focus on relative demand and supply effects in asset trading.

<sup>6</sup> Another way to introduce shares to the market is with a share split. A share split simply replaces each share held by investors with a fixed number of shares greater than one. The idea behind such a conversion is to increase share liquidity when individual share units are deemed too expensive for some investors. At least in principle, this action could relax constraints on purchases by cash-strapped traders. We conducted some pilot experimental sessions, which are not reported here, and found that investors quickly made full adjustments for share splits.

<sup>7</sup> See Caginalp et al. (1998) for a discussion of the effect of varying cash and asset endowments on bubble magnitudes.

weight or influence that traders of different types or using different strategies exert on market activity, and thereby lead the market to exhibit a price response to an intervention.

This reallocation is predicted by the model of DeLong et al. (1990), which we apply and adapt for our setting. In the model, each trader in the market is classified as belonging to one of three possible types. The three types are (1) fundamental value traders, who purchase and sell based on differences between prices and fundamentals, (2) momentum traders, who trade as if they believe that previous price trends will continue, and (3) rational speculators, who anticipate and trade on future price movements.

The fundamental value traders increase their holdings when prices are below fundamentals and decrease their holdings when prices are above fundamentals. Fundamental value traders thus behave like rational agents in classical models, who assume that the rationality of all traders is common knowledge. The momentum traders follow historical trends, increasing their holdings when prices have been increasing in the recent past and reducing them when prices have been declining. The rational speculator accumulates holdings before prices increase and reduces holdings before prices decrease, while ignoring the difference between prices and fundamentals. These traders are rational, have correct short-term expectations about future prices, and recognize that prices will not necessarily follow fundamentals. Rational speculators are similar to the rational arbitrageurs of Abreu and Brunnermeier (2003, hereafter AB) in that they try to “ride” the bubble. However, the rational speculators have more accurate beliefs. Rational arbitrageurs in AB have a diversity of opinions (also see Morris, 1996) about the exact timing of a bubble and crash, and these differences result in lack of synchronization and the persistence of the bubble. In contrast, rational speculators in our model have identical and correct beliefs about future prices.<sup>8</sup>

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<sup>8</sup> A similar model with three trader types was applied to experimental data by Caginalp and Ilieva (2008, hereafter CI). In the CI model, traders were classified into momentum traders, fundamental value traders, and neutral traders. The neutral trader is a category for those traders that could not be classified as the first two types. Rational speculators were not assigned a separate category. There are also two main implementation issues that differ between the HN and CI models. The first is that the HN classification looks at a trader’s executed trades whereas CI classifies according to offers to buy and sell. The second is that HN classify a trader as belonging to the same type throughout the life of the asset, whereas CI allows a trader to switch type in each period. Each method comes with advantages and disadvantages but the HN classification permits simple simulations along the lines of DeLong et al. (1990), and this is an important component of our research strategy.

Three empirical patterns emerging from simulations of the theoretical model serve as the hypotheses for our experiment. These patterns are the following: (1) Repurchases increase prices, while share issues reduce prices. In our setting, in which price bubbles tend to form, repurchases magnify, while share issues mitigate, overpricing. (2) Asset prices are closer to fundamentals after a share issue, and they are farther away from fundamentals after a repurchase than they would have been in the absence of an intervention. Indeed, the model predicts that if the share issue is sufficiently large, then, after an initial crash, prices would rebound and exhibit a close adherence to fundamentals for the remainder of the life of the asset. (3) A repurchase reduces the fundamental value traders' proportion of the market power, as measured by an index weighting the proportion of the total stock of shares and cash they hold. In contrast, fundamental value traders have a greater proportion of the market power after a new share issue. In the simulations, the greater market power of fundamental value traders after a share issue is associated with prices tracking fundamentals more closely after the issue.

The structure of the market adheres closely to that first studied by Smith et al. (1988). This paradigm, described in section 2, was chosen for several reasons. The first is that the DeLong et al. model makes sharp predictions. A bubble would occur in the absence of an intervention and a repurchase would increase the magnitude and duration of the bubble. Furthermore, the model predicts that a large share issue induces the asset price to track fundamental value. Since bubbles are typically observed in this experimental setting, this is a particularly stringent prediction, and finding support for this prediction would be strong evidence in favor of the model. Secondly, the asset market has a relatively long horizon by experimental standards, and thus provides enough time for an intervention to play out. Specifically, we can evaluate whether or not the effect of an intervention is immediate or occurs with a lag, as well as evaluate whether the effect is temporary or long term. Thirdly, the design has the feature that mispricing relative to fundamentals tends to occur, and the mispricing has been shown to be responsive to changes in the parametric and institutional configuration of the market. Thus, there is scope for the interventions to have an effect.

The final reason is that this paradigm has a long tradition in the experimental finance literature (Smith et al., 1988; Porter and Smith, 1995; Lei et al., 2001;

Dufwenberg et al., 2005; Haruvy and Noussair, 2006, hereafter HN; Haruvy et al., 2007), and remains the most commonly employed paradigm to study asset markets at the current time (Hussam et al, 2008; Kirchler et al., 2010, 2011; Lugovskyy et al., 2011; Corgnet et al., 2010; Palan, 2010; Oechssler et al., 2011). Thus, our choice facilitates comparison to previous studies and placement in an active literature.

We made a deliberate choice to use a setting in which bubbles and crashes are typical. This means that, like in financial markets in the field, the source of value for the asset, in addition to the dividends that the stock yields, is the option value of possibly reselling at a higher price. It also means that there is risk associated with holding the asset, so that it provides favorable conditions for the effect of differences in risk associated with different quantities available to appear. Also, the effect of share repurchases and issues are of special interest during bubble and crash episodes since firms may have more to gain by adjusting their capital structure in times of perceived mispricing by the market. A setting in which such phenomena can occur allows us to observe whether interventions moderate or exacerbate bubbles and crashes.<sup>9</sup> Finally, the application of the DeLong et al model to this environment allows us to consider whether the model can account for why bubbles occur in experimental markets.

The results of the experiment are presented in section 3. We find that the three hypotheses listed are strongly supported in our data. (1) Prices are greater after a repurchase than after a share issue. (2) The absolute difference between prices and fundamentals is greater after a repurchase than after a share issue. (3) The interventions alter the weight that fundamental value traders have in the market. This last result is established, by taking each subject's trading behavior in the experiment and classifying them as the type with which their behavior was most consistent.<sup>10</sup> A repurchase reduces the market power of fundamental value types, while a share issue does the opposite. The greater weight that fundamental value traders have after a share issue appears to account

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<sup>9</sup> There is evidence in the literature that bubbles in such settings can be moderated or reduced over time with sufficient repeated experience by subjects with the same setting and the same group of traders (Smith et al., 1988; Dufwenberg et al., 2005; Haruvy et al., 2007). However, we opted to use inexperienced subjects precisely because we are interested in the impact of capital structure on episodes of mispricing and such episodes occur with greater frequency and magnitude with inexperienced subjects.

<sup>10</sup>No incentives were given for different subjects to behave as different types. All subjects had the same incentives, to maximize the sum of (a) total dividends on assets that they hold, and (b) gains from trading. Subjects were assigned a type ex-post, based on their observed behavior.

for the strong tendency for prices to closely track fundamentals after the share issue. This conjecture is supported, in section 4.3, with additional simulations of interventions of different sizes.

## 2. Theory and Hypotheses

### 2.1. The General Setting

The structure of the market is based on the paradigm created and studied in Smith et al. (1988). The asset that is exchanged in the market has a finite lifespan of  $T$  periods. At the end of each period  $t \in \{1, \dots, T\}$ , the asset pays a dividend  $d_t$  that is independently drawn from a distribution that is identical for all periods and units of the asset. Thus, in any period  $t$  the expected dividend  $E(d_t)$  on a unit of the asset is equal to the expected value of the dividend distribution. Because the dividends are drawn independently in each period, the expected future dividend stream at time  $t$ ,  $E[\sum_t^T d_t]$ , equals the expected period dividend multiplied by the number of periods remaining in the life of the asset, so that  $E[\sum_t^T d_t] = (T - t + 1)E(d_t)$ . Since dividends are the only source of intrinsic value for the asset, the fundamental value  $f_t$  of the asset at time  $t$  equals the expected future dividend stream. In other words,  $f_t = (T - t + 1)E(d_t)$ . In the present set of experiments, the life of the asset is  $T = 15$ . The dividend is  $d_t \in \{0, 8, 28, 60\}$ , where each realization is equally likely, for all  $t$ , so that  $E(d_t) = 24$ . Therefore  $f_t = 24(16 - t) = 384 - 24t$  at time  $t$ . Note that the dividend distribution has a standard deviation of 27 per period, which is greater than the expected dividend. Therefore, risk-averse traders might value the asset at considerably less than its fundamental value.

A market for the asset exists and is populated by a set of  $N$  traders. Each trader  $i$  begins each period  $t$  with inventories of shares  $s_{it}$  and cash  $c_{it}$ . These inventories are also equal to the shares and cash that player  $i$  holds at the end of period  $t-1$ , after the dividend for period  $t-1$  has been paid. In each period any trader has the ability to exchange units of the asset for cash with any other trader in an open market provided that he always maintains non-negative cash and share balances.

Transaction prices are determined in a continuous double-auction market (Smith, 1962). Each period, the market is open for a fixed time interval. At any time while the market is open, any trader can submit an offer to sell or to purchase a share. These offers are posted publicly on all traders' computer screens. Also at any time, any trader can accept an offer that another trader has submitted. When a bid or ask is accepted by a trader, a transaction for one share takes place between the trader who posted the offer and the trader who accepted it. Thus, within a period, it is possible for different transactions to occur at different prices. An individual can trade as much as he wishes provided he has sufficient cash and units of the asset to complete the trades.

The experimental design, described in more detail in section three, consists of three treatments: the *Benchmark* treatment, in which no external intervention takes place, the *Repurchase* treatment where a share repurchase occurs, and the *Share Issue* treatment where additional shares are sold into the market. In the Repurchase treatment, an intervention occurs at time  $t^*$ , in which  $\frac{1}{2} \sum_i s_{it^*}$ , one-half of the total stock of units that all traders hold, is purchased. In the Share Issue treatment, an intervention occurs at time  $t^*$  as well, when  $\frac{1}{2} \sum_i s_{it^*}$  additional shares are sold to traders. Thus the Repurchase and the Share Issue represent interventions of equal size. In our experiment  $t^* = 6$ , so that the intervention takes place just after one third of the life of the asset has elapsed.<sup>11</sup>

## 2.2. Simulation Methodology

In this section we detail the methodology of the simulation model that we use to generate the hypotheses evaluated in the experiment.<sup>12</sup> In the model, participants in the market are assumed to use one of three trading strategies. The three trader types considered were proposed by DeLong et al. (1990), hereafter DSSW. The parameters for the simulation are those estimated in a prior, experiment that used a similar paradigm.

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<sup>11</sup> The subjects know that an intervention will occur in some future period but do not know the period  $t^*$  in which the intervention will happen. Prior knowledge of  $t^*$  would have, at least in principle, permitted coordination by subjects, thus fundamentally changing the nature of the market. For example, Abreu and Brunnermeier (2003) argue that news events at a defined future point make it possible for rational speculators to synchronize their exit strategies.

<sup>12</sup> This same simulation methodology is detailed in Haruvy and Noussair (2006).

The high incidence of bubbles documented in previous studies suggests the existence of agents who trade on momentum. These agents purchase units after price increases, as if they expect prices to continue rising, and sell rapidly once a crash occurs. We denote these traders as *momentum traders*. The existence of a crash suggests that there are also traders in the population who speculate, but realize that speculation on an upward price movement is unlikely to be profitable very late in the time horizon and who sell their units at that time, precipitating a crash. We call these traders *rational speculators*. We also include the third type DSSW propose, called *fundamental value investors*, who trade based on fundamental values, purchasing (selling) when prices are below (above) fundamentals. DSSW and HN referred to this type of trader as a Passive Trader. However, for clarity, we employ the term Fundamental Value trader here. To summarize:

- 1) *Fundamental Value Traders* (FV): Increase (decrease) share holdings when median price is below (above) fundamental value.
- 2) *Momentum Traders* (MM): Increase (decrease) share holdings in response to an upward (downward) price trend in the recent past.
- 3) *Rational Speculators* (RA): Correctly anticipate the next period's price movement. If the price move is upward (downward), they increase (decrease) holdings of shares.

Each of the three trader types has a demand function that is linear in past, present, and/or future prices. Momentum traders use only past prices, fundamental value investors use only present prices, and speculators use only present and expected future prices, in determining their strategies. A trader's demand may take on a negative value, in which case the trader becomes a net supplier to the market. Specifically, the demand function of the *momentum traders* in period  $t$  is of the form  $-\delta + \beta(p_{t-1} - p_{t-2})$ , where  $p_{t-1}$  and  $p_{t-2}$  are the average transaction prices in periods  $t-1$  and  $t-2$ , and  $\delta$  and  $\beta$  are parameters. The demand function of the *fundamental value traders* is  $-\alpha(p_t - f_t)$ . Finally, the *rational speculator*, who has demand given by  $\gamma(E(p_{t+1}) - p_t)$ , trades based on the difference

between the expected price in the next period and the current spot price. We set  $E(p_{t+1}) = p_{t+1}$  and thus assume that speculators have correct expectations of the next period's price. The simulation has four demand parameters denoted by  $\delta$ ,  $\beta$ ,  $\alpha$ , and  $\gamma$ .

**Adjustment parameters:** The simulations assume the parameter values and proportions of trader types estimated in Haruvy and Noussair (2006). Those values were estimated by minimizing the distance between simulated price patterns and actual data in that experiment, which consisted of several treatments, between which cash endowments and short-selling constraints differed. The values are  $\alpha=0.75$ ,  $\beta=0.13$ ,  $\gamma=0.55$ , and  $\delta=0.48$ . We refer to these as adjustment parameters. The proportions of trader types are 0.33, 0.42, and 0.25, for fundamental value, momentum and rational speculators respectively.

One set of market simulations is generated for each of the three treatments. Each set consists of 150 simulations, corresponding to 150 groups of nine simulated traders. Traders are drawn at random from the three types with probabilities corresponding to the appropriate adjustment parameters. Thus, while across all 150 repetitions, the proportions of types in the randomly generated samples are on average roughly equal to the underlying assumed proportions, any individual sample of 9 generated players may include a larger or smaller proportion of any trader type.

**Beliefs of rational speculators:** The demand functions of the three types are very similar to DSSW. However, there is a difference with regard to the beliefs about the price of the next period. Since the speculator must have beliefs regarding future prices, we require a model of such beliefs. Ideally, we would like the expectations of the speculators to reflect the true future prices. Unfortunately, since the number of traders is small, a single speculator's demand this period may affect prices next period (via the momentum traders) and hence his expectations this period. This would destroy the uniqueness of the solution path and would add strategic considerations not intended for this model of a competitive environment. Therefore, we model the speculator as best responding to a population containing feedback and fundamental value traders. We do this with two iterations. In the first iteration, we assume that the speculator believes that future prices will be at fundamental values. Given these beliefs and the demands of the other two types, prices are determined for each period. Then the speculator takes the new prices as

his beliefs for each period and the system is solved again. This type of belief is known as a level-1 belief (Stahl, 1993; Nagel, 1995; Camerer et al. 2004). In the last two periods (14 and 15) we fix the speculator's beliefs at fundamental values since the scope for speculation is minimal near the end of the life of the asset.

**Equilibrium price determination:** Prices in the simulation are determined by a market clearing condition: the requirement that quantity demanded equals quantity supplied. Periods 1 and 2 are fixed at empirical values (the actual average prices observed in the experimental treatment that is simulated). The price in period 15 is assumed to be 24, the period 15 fundamental value. These restrictions are necessary because the momentum types take prices in the two prior periods as exogenous and the rational speculator type takes the price one period ahead as exogenous.

Each trader begins period 1 with the initial endowment of money and shares allocated to him in the experiment. There is a grid search on prices for each period. Prices are determined by setting net demand equal to zero (equating demand and supply). The price is adjusted until the net excess demand equals zero. We solve for period prices one by one, proceeding sequentially. There are two iterations through the 15 periods to solve for prices. The first iteration determines the beliefs of the speculators; the second iteration solves for the actual prices.

The adjustment parameters ensure that a trader with a positive net demand does not necessarily use all of his cash in a single period to purchase shares and a trader with a net supply does not necessarily sell all his shares right away. Thus, the small values of these parameters serve to moderate extreme price fluctuations and to smooth demand and supply changes over multiple periods. They thus help achieve interior equilibrium points.

Occasionally, however, quantity demanded will not equal quantity supplied at any price. This is because traders of a given type are all assumed identical so that a population dominated by one type will exhibit reduced trade. Nonetheless, the switch points from net demand to net supply are well-defined for the fundamental value and rational speculator types, so therefore equilibrium is well-defined for samples with a sufficient number of these types. When the grid search finds such a switch point, it identifies it as an equilibrium. Thus, even in an unbalanced sample that favors one type or another, we can find an equilibrium price, even if it is one where net demand does not

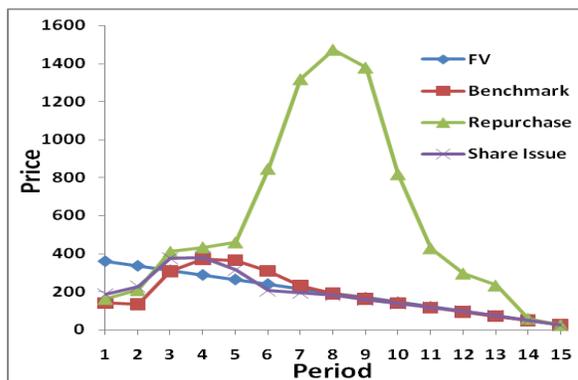
meet net supply. The equilibrium is at the point of switching from positive demand to positive supply or vice versa.

The momentum type does not behave like the other two types. It is characterized by a net demand or a net supply that is independent of the current price. Occasionally, there will be a draw of a population with a strong momentum type presence and at times that demand or supply will not be met by the other types. When that happens, prices could theoretically go to positive or negative infinity. It turns out that the simulations are fairly robust to reasonable upper bounds on the magnitude of price change. A bound of 350 for the price change from one period to the next appears to fit best and is the level that we employ. Only rarely do such samples materialize in a random draw and demand and supply become unbalanced only briefly, so the effect of the boundaries to the price change is merely to ensure that these outliers do not skew the average prices. Figures 1 and 2a-c show the average values of some key variables over the 150 simulated markets.

### 2.3. Hypotheses

Figure 1 shows the results of simulations of the market price patterns for the three treatments. The vertical axis indicates the price level, and the horizontal axis is the market period. The Benchmark treatment produces a bubble, lasting from period 4 until period 7. The Share Issue treatment shows a decrease in price at the time of the intervention in period 6 to below fundamental values, but tracks fundamentals closely afterwards. The Repurchase treatment exhibits an acceleration of the bubble at the time of the intervention, and a market crash beginning in period 10.

**Figure 1: Prices in Simulated Markets Corresponding to the Three Treatments**



To measure overall price level, we employ a metric called *Total Bias*. We define *Total Bias* as

$$Total\ Bias = \sum_{t=1}^T (p_t - f_t) \quad (1)$$

where  $p_t$  and  $f_t$ , respectively, indicate the median transaction price and the fundamental value in period  $t$ . A positive Total Bias corresponds to prices that exceed fundamental values on average over the life of the asset, and a negative Total Bias indicates that prices are lower than fundamentals on average. Greater bias in one market than another indicates a higher price level relative to fundamental value in the first market. The Total Bias measure is used to test our first hypothesis, that share repurchases increase prices and share issues lower prices, relative to the Benchmark treatment.

**Hypothesis 1: Repurchases lead to higher prices, and share issues lead to lower prices, than would have existed in the absence of the intervention. That is, *Total Bias (Repurchase treatment) > Total Bias (Benchmark treatment) > Total Bias (Share Issue treatment)*.**

While hypothesis 1 follows from the model we have described earlier and is supported by strong intuition, it should be emphasized that it is not obvious that it would be observed. While risk-averse agents might demand lower prices for the asset as its share of their total portfolio increases, if agents are risk neutral, the quantity of shares should make no difference. Indeed, if relatively risk tolerant buyers buy the newly issued shares, the price might increase in response to an issue of additional shares. Similarly, if a greater supply of shares creates a more liquid market, it might encourage additional speculative demand, and increase prices. This might occur if speculators feel more confident that the market is liquid enough that they can resell the shares before the market crashes (Noussair and Ruffieux, 2004).

Another pattern that appears in figure 1 is that the treatments differ in how far prices diverge from fundamentals. The figure suggests that pricing is on average closer to fundamental values in the Share Issue treatment than in the Benchmark treatment, which is in turn closer than in the Repurchase treatment. To test the hypothesis that different

treatments differ in this type of mispricing, we employ a measure of proximity to fundamental values. The measure is called the *Total Dispersion* of prices in a market and it is defined as:

$$Total\ Dispersion = \sum_{t=1}^T |p_t - f_t|. \quad (2)$$

**Hypothesis 2: The share issue moves prices closer to fundamental value, while the repurchase moves prices farther away from fundamentals, than they would be in the absence of an intervention. *Total Dispersion (Repurchase treatment) > Total Dispersion (Benchmark treatment) > Total Dispersion (Share Issue treatment)*.**

Hypothesis two also follows from the model. In a setting in which the Baseline treatment leads to prices greater than fundamentals, it might appear at first glance that, provided Hypothesis 1 is supported, hypothesis 2 is trivial or redundant. The argument is that a share issue, which introduces new supply and lowers prices, would move them closer to fundamentals, relative to the Baseline treatment, in which the prices are greater than fundamentals. A repurchase would have the opposite effect. However, monotonically downward sloping demand alone would not necessarily imply a movement towards fundamental values in response to an increase in the supply of shares. It is possible that prices could decrease, and overshoot fundamentals. That such a possibility exists is suggested by the results of Haruvy and Noussair (2006), who show that a greater short-sale capacity lowers market prices, and if the capacity is sufficiently large, prices fall below fundamentals. This could also occur if the issue eliminates speculation and agents trade purely based on the value of future dividends. If agents are risk averse, they would value the lottery comprising the asset at less than expected value, and the market price would be less than fundamentals.

The simulations show that in the Share Issue treatment, prices tend to track fundamental values closely after the intervention. This is not a consequence of hypothesis 1 and in our view, would provide especially strong support for the model if observed in the experimental data. Closer inspection of the allocation of cash and share inventories held by individuals of each type in the simulations suggests that this pattern is related to

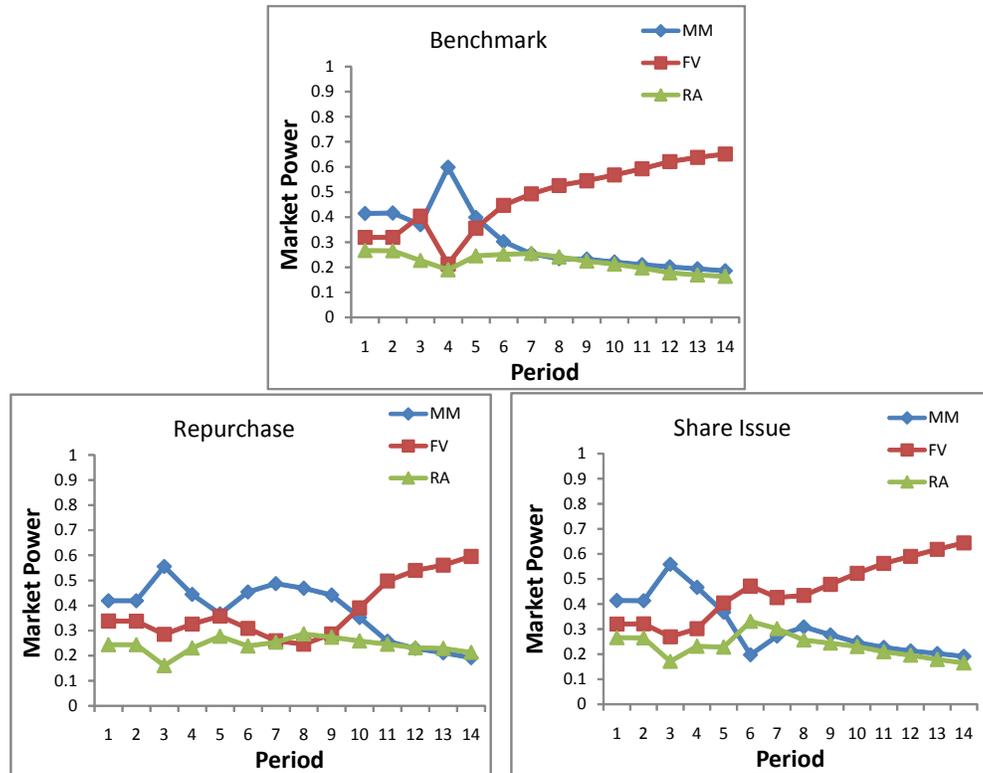
the fact that an intervention exerts an effect on the relative market influence of the three trader types. If a share issue shifts influence away from momentum traders and toward fundamental value traders, it provides a plausible account for the ability of the share issue to reduce mispricing. If the opposite effects occur after a share repurchase, with momentum traders gaining influence and fundamental value traders losing influence, it would provide an account of how the share repurchase could exacerbate the bubble.

Consider the following measure of the market power of subject  $i$  in period  $t$ :

$$Power_{i,t} = 0.5(s_{it} / s_t) + 0.5(c_{it} / c_t) \quad (3)$$

where  $s_t$  and  $c_t$  indicate total shares and cash in period  $t$ , respectively. The measure is a convex combination of subject  $i$ 's relative share of the total cash and stock available in the period, with equal weight on each dimension. We use this measure to study whether differences in price paths between treatments can be explained by a reallocation of market influence among trader types as a consequence of an intervention.

**Figures 2a – 2c: Market Power in Simulations Corresponding to the Three Treatments**



Figures 2a – 2c illustrate the evolution of market power of the three types of trader in each of the three sets of simulations. The vertical axis indicates the total market power of all agents of each type, and the horizontal axis is the market period. To understand the patterns in figures 2a-c, recall the dynamics of the typical bubble price pattern as displayed in figure 1. Also bear in mind that purchases at low prices and sales at high prices increase a trader’s relative market power.

In the early periods of each treatment, momentum traders tend to increase their market power as they purchase shares aggressively at low prices<sup>13</sup>. In the Benchmark treatment, however, after a bubble forms, the MM traders make purchases from fundamental value traders at high prices, reducing their power, while increasing the power of FV traders. As prices fall and the market operates near fundamentals for the

<sup>13</sup> Recall that the proportions in periods 1 and 2 are fixed exogenously at the levels estimated in the data of HN (2006).

remainder of the life of the asset, FV traders steadily accumulate market power, since they only make trades that are profitable on average.

In the Repurchase treatment, the intervention increases the market power of MM traders and decreases that of FV traders as a large bubble forms. At the time of the intervention, the fundamental value traders quickly run out of shares and prices continue to rise in response to the demand generated by the repurchase. The momentum traders, however, hold out for higher prices and thus sell to the experimenter near the top of the bubble, increasing their market power. However, after the intervention is completed, the MM traders return to making unprofitable purchases at high prices, leading to a reduction in their market power.

Under a Share Issue, the intervention causes an increase in the market power of FV traders and a decrease in that of MMs. The intervention supplies new shares to the market, lowering the market price to a level below fundamentals. The FV traders purchase the bulk of these units, and do so at favorable prices. RA traders also purchase some of the units as they anticipate the subsequent increase in price to fundamentals, but MM traders miss out on the bargain. These shares generate cash dividends, so the fundamental value traders have large and increasing quantities of both cash and shares to keep the market from deviating too far from fundamentals for the remainder of the life of the asset. As the market operates close to fundamentals, FV traders steadily accumulate market power by receiving dividends and by taking advantage of small price fluctuations. Hypothesis 3 posits that in the experiment, the share of the market power of fundamental value traders would exhibit similar differences between treatments as in the simulations.

**Hypothesis 3: Over the life of the asset, the average market power of Fundamental Value traders is lowest under the Repurchase treatment. The Market Power of Fundamental Value traders is greatest under the Share Issue treatment.**

### 3. Experimental Design

Our dataset consists of six sessions conducted under each treatment, for a total of 18 sessions<sup>14</sup>. Four sessions of each treatment were conducted at Tilburg University, and two at the University of Texas at Dallas. Subjects were recruited via an online system and through posters and announcements. No subject participated in more than one session of this experiment. On average, the sessions lasted 2 hours. Table 1 provides a summary of the parameter choices for the experiment.<sup>15</sup> The market was computerized and used continuous double auction trading rules implemented with the z-Tree computer program (Fischbacher, 2007) developed at the University of Zurich.

Upon arrival in a session, subjects were trained in making purchases and sales in the z-Tree program. The training phase did not count toward final earnings. Subjects were then assigned one of three possible initial portfolios of cash and shares (see Table 1) and the market for the asset was conducted. The three initial portfolios differed in terms of asset and cash, with type 1 having a relatively large number of shares and type 3 a relatively high cash endowment. Each of the three portfolios has the same value if the asset is valued at its fundamental. Subjects' earnings in the experiment were equal to the cash they had at the end of the experiment, and corresponded to their initial cash, plus the value of dividends they received, plus (minus) any profit (loss) from trading. Subjects had no financial incentives to act as any of the behavioral types described in section 2. They did receive a fixed participation fee in addition to their earnings in the asset market (converted to Euros or US dollars at predetermined exchange rates).

The implementation of the interventions operated as follows. In period 6, an intervention occurred in the Share Issue and Repurchase treatments, but not in the Benchmark treatment. In the Share Issue (Repurchase) intervention, the computerized firm received a trading requirement that involved selling (buying) a certain number, equal to 50% of the total stock of units, of shares to (from) the market. The computerized firm then participated in the market until its target had been achieved. To achieve its target,

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<sup>14</sup> Two sessions only included 8 subjects. Nevertheless, because in these sessions there was one fewer agent with portfolio 2 (see Table 1), the average number of initial shares and cash per subject were the same in all sessions.

<sup>15</sup> The initial portfolios were identical to those used in Smith et al. (1988) for their "Design 4" parameterization, but with initial endowments of shares and cash of each individual doubled, and units denominated in terms of "francs", an experimental currency, rather than in terms of cents.

the computerized firm periodically (every 5 seconds) checked whether the bid-ask spread was above or below a certain threshold. If the bid-ask spread was above the threshold, the firm placed a new offer to sell (buy) for one unit that was lower (higher) than the current best standing offer to sell (buy) by the amount of the threshold (set to 10 francs, units of experimental currency). Otherwise the firm accepted the best standing offer to buy (sell). The firm's strategy was chosen to balance the benefit of bidding small increments versus the length of time required to complete the intervention. The firm's strategy is close optimal in the sense that it pays the minimum expenditure or receives the maximum revenue possible to complete the intervention, except for modest losses due to the small discrete amount that it increments the best standing bid or ask. The parametric structure of the markets and interventions is summarized in table 1.

**Table 1: Experimental Parameters**

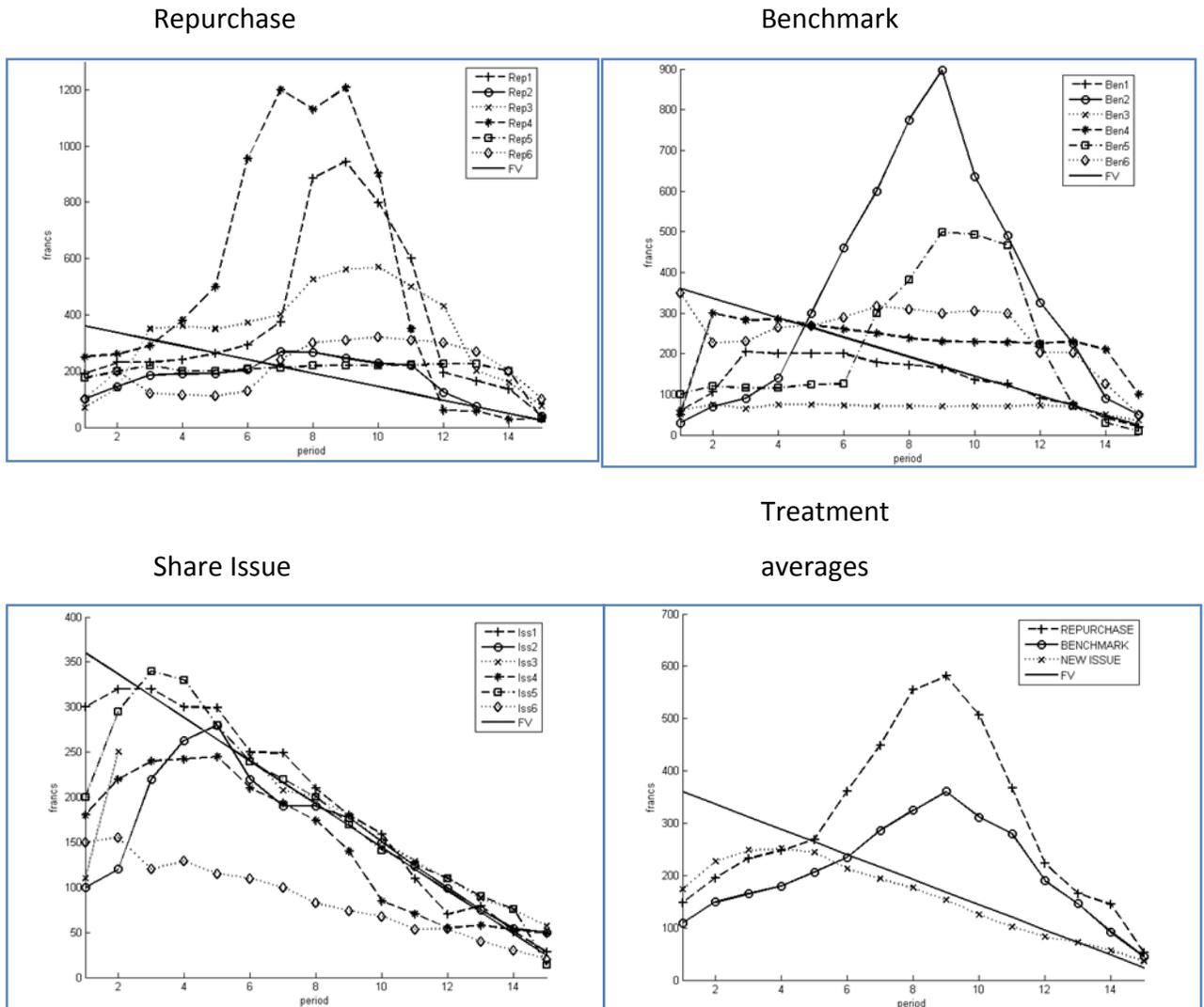
Period length	240 seconds
Dividend distribution	A four-point distribution of 0, 8, 28 and 60 francs, with equal probability.
Expected period dividend	24 francs
Fundamental value at time $t$	$24 \cdot (16 - t)$ francs
Initial portfolios	Portfolio 1: 6 shares and 450 francs. Portfolio 2: 4 shares and 1170 francs. Portfolio 3: 2 shares and 1890 francs.
Exchange rate	170 francs = 1 Euro or 150 francs = 1 US dollar.
Number of periods, $T$	15
Number of traders, $N$	9
Length of time between firm actions	5 seconds
Bid-ask spread threshold	10 francs
Time of intervention start, $t^*$	Beginning of Period 6

## 4. Results

### 4.1. Price patterns

Figure 3 illustrates the median transaction price by period in each session, along with the fundamental value. Each of panels (a)-(c) corresponds to one of the treatments. Within each panel, one time series represents the fundamental value and the others each represent prices in one session. Panel (d) presents the averages over the six sessions of each treatment.

**Figure 3: Median period prices, all sessions of each treatment**



We first consider whether Hypotheses 1 and 2 are supported. The figures above show that prices are higher in the Repurchase treatment than in the Benchmark treatment. In turn, they are higher in the Benchmark treatment than under Share Issue. Furthermore, in the Repurchase and Benchmark treatments, prices are substantially greater than fundamentals for most of the trading horizon. Table 2 below indicates the Total Bias averaged over all sessions of each treatment, as well as in periods 6 – 15, after the intervention has taken place.

**Table 2: Measures of Mispricing, Treatment Averages**

<b>Measure of Mispricing</b>	<b>Repurchase Treatment</b>	<b>Benchmark Treatment</b>	<b>Share Issue Treatment</b>
Total Bias	1596	196	-519
Total Dispersion	2795	2032	698
Total Bias*: Per. 6 to 15	3102	1421	-165
Total Dispersion*: Per. 6 to 15	3228	1897	363

\*Statistics for the interval of periods 6-15 are rescaled by 1.5 to be on the same scale as the statistics for all 15 periods.

The  $p$ -values resulting from rank-sum tests of our hypotheses (taking each session in its entirety as an observation) are shown in table 3. We find that Total Bias is significantly different at the 5% level between the Repurchase and the Share Issue treatments ( $p$ -value=0.015), while neither of the two treatments is significantly different from the Benchmark treatment. The significance of the difference between prices under the two different interventions, coupled with the fact that, as shown in table 2, all pairwise treatment differences we observe are in the direction predicted by our hypothesis, lead us to conclude that the hypothesis is supported. The average bias in the Share Issue treatment, averaged over the 10 periods after the intervention, is only 12.5% of fundamental value, compared to 107.6% under Benchmark and 235% in Repurchase.

A similar pattern is observed in Table 2 with respect to Total Dispersion, our measure of aggregate mispricing. The ranking of treatment averages follows the same pattern as it did for Total Bias. Specifically, Repurchase sessions have the highest magnitude of mispricing relative to fundamentals, followed by Benchmark, and then

Share Issue. Table 3 reports that two of the three differences between treatments are highly significant ( $p < 0.015$ ), providing strong support for Hypothesis 2. Average dispersion in the share issue treatment in periods 6 to 15 is roughly half of that for the 15 periods. Indeed, other than a single session in the Share Issue treatment with average per-period dispersion of 69, the remaining five sessions had dispersion of under 30, with an average of 15.31. Thus, dispersion in the Share Issue treatment is only about 12% of the average fundamental value (132) for periods 6-15, which is remarkably small in comparison with the other treatments, albeit significantly different from 0.

**Table 3: Hypothesis results: P-values**

<b>Hypothesis</b>	<b>Variable</b>	<b>Repurchase differs from Benchmark</b>	<b>Benchmark differs from Share Issue</b>	<b>Repurchase differs from Share Issue</b>
<b>H1</b>	<b>Total Bias</b>	0.485	0.310	0.015**
<b>H2</b>	<b>Total Dispersion</b>	0.394	0.015**	0.009**
<b>H3</b>	<b>Market Power of FV Traders</b>	0.643	0.114	0.049**

## 4.2 Market Power

We now consider how the interventions affect the market power that each type holds. In order to classify subjects, we first assign a period score that measures how well a subject's behavior in each period coincides with how each of the three theoretical trader types would have behaved (see table 4 below)<sup>16</sup>. Then we sum the period scores to get an aggregate measure of how well a subject's behavior coincides with each of the three types over the span of the entire market. He is then classified as belonging to the type for which he has the highest score, provided that he satisfies the condition corresponding to the type in at least 50% of all periods in the session. Those individuals not fitting any of the three types are classified as "other".

<sup>16</sup> When a trader's actions in period  $t$  corresponds to any particular type, his score for that type increases by the absolute change in his share holding between period  $t-1$  and  $t$ . When a trader's share holding remains unchanged from one period to the next, the trader's score is incremented by 1 for each of the three types.

**Table 4: Criteria for classification of traders to types**

Trader type	Condition
Fundamental Value	<i>If <math>(p_t &gt; f_t)</math>, then <math>(s_{it} &lt; s_{i,t-1})</math>.</i> <i>If <math>(p_t &lt; f_t)</math>, then <math>(s_{it} &gt; s_{i,t-1})</math>.</i>
Momentum	<i>If <math>(p_{t-1} &lt; p_{t-2})</math>, then <math>(s_{it} &lt; s_{i,t-1})</math>.</i> <i>If <math>(p_{t-1} &gt; p_{t-2})</math>, then <math>(s_{it} &gt; s_{i,t-1})</math>.</i>
Rational Speculator	<i>If <math>(p_t &gt; p_{t+1})</math>, then <math>(s_{it} &lt; s_{i,t-1})</math>.</i> <i>If <math>(p_t &lt; p_{t+1})</math>, then <math>(s_{it} &gt; s_{i,t-1})</math>.</i>

The first row of *Figure 4* presents the average market power over time of an individual of each of the three different trader types, while the second shows the market power for an individual of each trader type, averaged over all sessions of a treatment. Turning first to the effect of an intervention in period 6, we find that the average FV type has more market power after a share issue than after a repurchase, and vice-versa for RA types. MMs also acquire considerably more market power in the latter periods of the Repurchase sessions. Thus, it appears that the interventions have the effect of transferring market power to or away from FV types.

**Figure 4: Market Power per Subject of Each Type (Vertical bars indicate beginning of interventions.)**

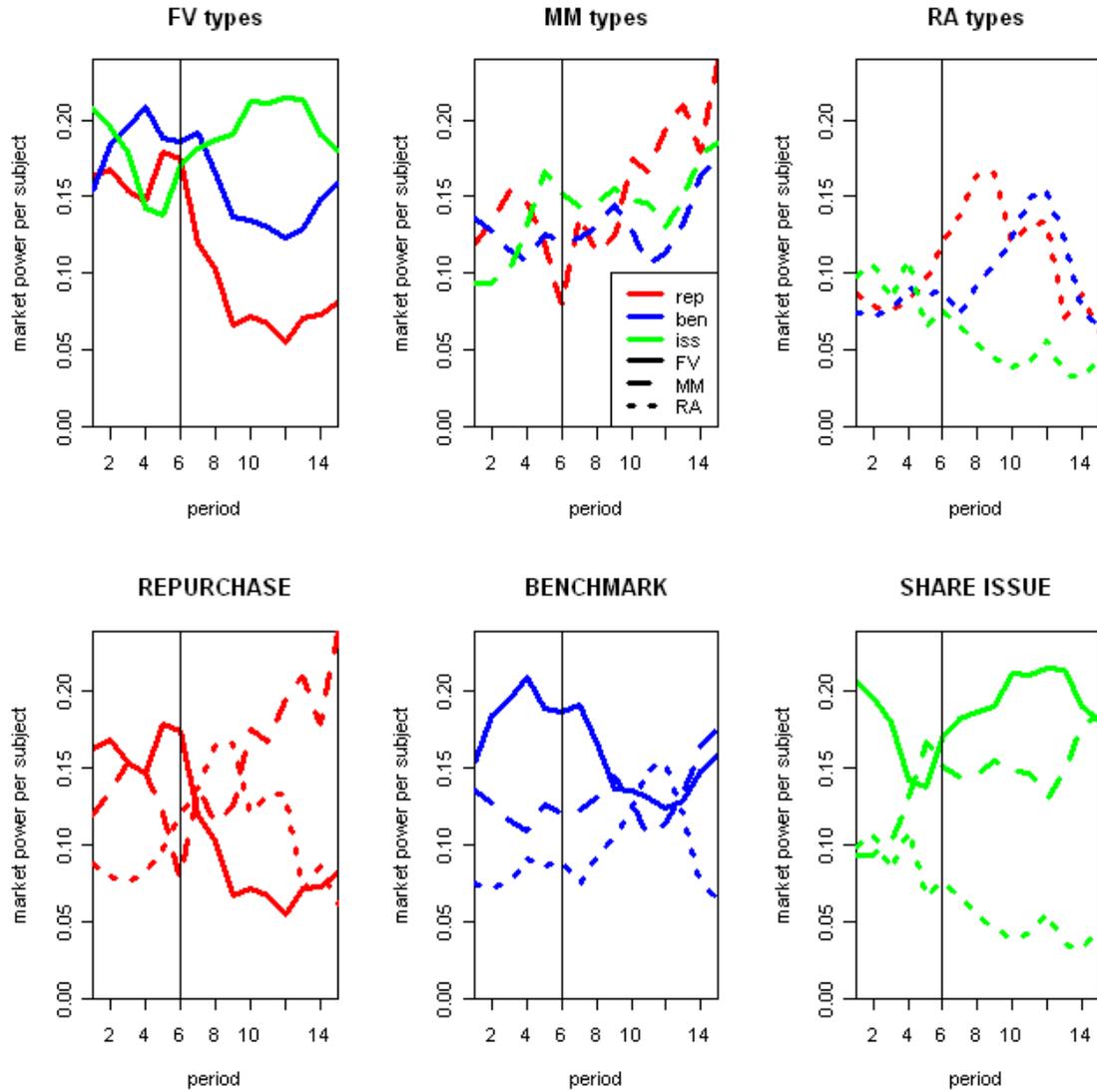


Table 5 shows the average number of individuals in a market that are classified as belonging to each of the three types, by treatment. It shows that in the Repurchase treatment, more individuals are MM traders than in the other treatments. On the other hand, there are fewer FV traders in the Repurchase than in the other treatments. There are also more individuals classified as FV traders in the Share Issue than in the other treatments. Thus hypothesis 3 receives strong support. More individuals are classified as FV traders in Share Issue than in Benchmark, and fewer act as FV traders in Repurchase

than in Benchmark. Furthermore, as shown in Table 3, the average FV trader has significantly more market power in the Share Issue than in the Repurchase treatment.

**Table 5: Average Number of Traders of Each Type, by Treatment**

	Repurchase	Benchmark	Share Issue
Rational Speculator	2.28	1.94	2.03
Momentum	3.86	2.94	2.53
Fundamental Value	2.53	3.28	4.11

The fact that more traders are classified as Momentum traders under Repurchase, and more as Fundamental Value traders under Share Issue, is not anticipated in the model, in which types are exogenous. It suggests that there may be a component of endogeneity in the classification. Perhaps the Share Issue induces individuals to act in a way that lends itself to categorization as a Fundamental Value trader, and a similar effect might be at work in the Repurchase treatment for the Momentum type. Differences in the distribution of types in this direction would not alter the content of hypotheses 1 – 3, though it would affect somewhat how the model is being interpreted, namely as a setting in which the choice of type is influenced by whether or not, and what type of, intervention occurs.

Such an effect would be detected in a comparison between how individuals are classified before and after an intervention. Some degree of reclassification in the later time interval might be expected. Any difference in classification between periods 1 – 5 and 6 – 15 in the Baseline treatment, in which there was no intervention, can be interpreted as a benchmark level of type switching. A greater degree of reclassification in the Repurchase and Share Issue treatment than in the Baseline could indicate any of a number of phenomena, such as the switching of strategies in response to the interventions, inaccuracy of the classification criteria in capturing the strategy individuals actually use, or a misspecification of the set of types.

The logistic regression reported below tests for such a possibility. The dependent variable is a binary variable which takes on the value 1 if a reclassification occurs after period 6, and 0 otherwise. Each individual trader is treated as a single observation. The

explanatory variables are dummy variables for treatment and for the trader's type in periods 1-5. The regression results suggest that only the momentum type is significant. It seems that players starting out with momentum classification are more likely to stay with their classification than other types. The treatment is never significant, which suggests that an intervention does not increase or decrease the probability of switching between types compared to the benchmark treatment. In other words, we can find no statistical evidence for endogeneity in classification.<sup>17</sup>

**Table 6: Logistic Regression to Test for Classification Endogeneity: Dependent variable is whether type reclassification occurs following period 6.**

Parameter	Estimate	Std Error	p-value
Intercept	1.428	0.412	0.001
Repurchase Treatment	-0.002	0.491	0.996
Share Issue Treatment	0.468	0.532	0.379
Momentum Type	-1.281	0.5	0.011
Fundamental Value Type	-0.082	0.636	0.898
Rational Speculator Type	0.517	0.811	0.524

### 4.3 The effect of repurchases and issues of different sizes

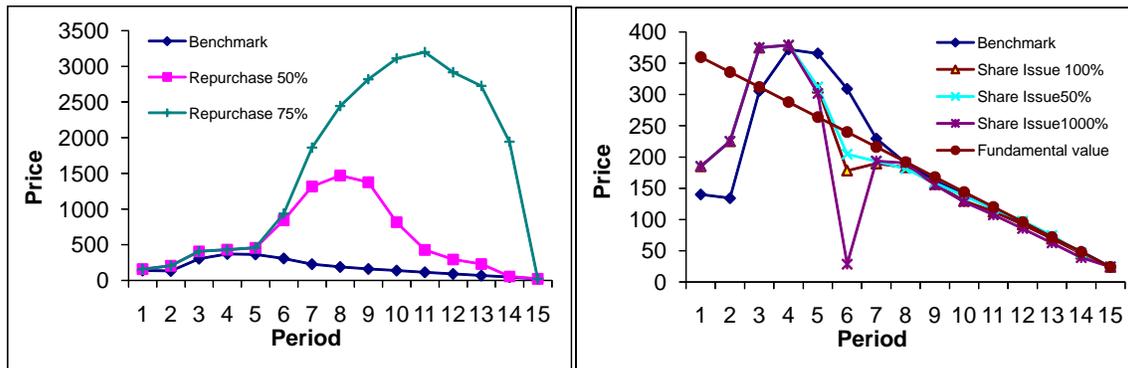
We now consider the potential effect of interventions of different sizes, with a focus on how robust the downward resistance of prices at fundamentals is to larger share issues. The results of simulations of several scenarios are given in figure 5. In addition to simulations of the interventions we actually conducted in our experiment, the figure contains average price paths resulting from a repurchase of 75% of the total stock of units, as well as from share issues of 100% and 1000% of the initial stock of units.<sup>18</sup>

<sup>17</sup> Alternative specifications, including adding interaction effects between treatment and initial classifications, yield similar results. The finding of no endogeneity thus appears to be robust to specification.

<sup>18</sup> In the simulations of share issues, the entire supply of units can be and is sold in period 6, because there is a sufficient amount of disposable cash held by agents to purchase many units at very low prices. In the simulations of repurchases, it may take multiple periods for the intervention to be completed. A cash constraint for the repurchasing firm at 10,000 currency units per period is imposed in the simulations and the constraint is typically binding in periods 6 and 7. In the experiment, because of the 5-second interval between the submission of one of the firm's bids and the next, a constraint limiting the speed of completion of the intervention exists. The time available in period 6 sometimes expires before the experimenter has completed his intervention.

The figure shows that a larger repurchase creates a larger bubble, both in magnitude and duration. Comparison of the 75% and the 50% repurchases reveal a similar pattern in period 6 but higher prices thereafter under a larger repurchase. The larger share issues of 100% and 1000% flood the market initially, but the market price quickly returns to fundamental value. The price decreases in period 6, rebounds in period 7, and then tracks fundamentals closely from period 8 onward. The quick recovery to fundamental values occurs as FV traders purchase the bulk of the large quantities on offer when the large increase in supply from the intervention reduces prices in period 6. The price pattern suggests that the downward resistance of prices at fundamental values following a share issue would be strong, even in the face of very large issues.

**Figure 5: Simulated prices for repurchases of 50% and 75% of the outstanding shares and for share issues of 100% and 1000% of outstanding shares (interventions occur in period 6.)**



## 5. Conclusion

In our experimental markets, we observe that share repurchases and issues have an impact on price levels, quite apart from any informational content they may provide to the market. Modeling traders as following particular momentum, rational speculative, and fundamental trading strategies can largely explain the effect of the interventions on prices. The model we specify has the features that repurchases tend to remove weight in the market from traders who use fundamental values as a limit price, whereas share issues

tend to concentrate power in the hands of fundamental value traders. This reallocation of weight to fundamental value traders that accompanies a share issue appears to move market prices closer to fundamentals. The simulation results reported in figure 5 show a strong asymmetry between the two types of interventions.

Of course, experiments do not contain many important features of stock markets. As noted earlier, this is the case by design. We wish to focus on only one of the components of the effect of the intervention on asset price, namely the direct effect of the change in the quantity of asset available. As other work in the literature points out, in non-laboratory settings the consequences of interventions on the firm's debt-equity balance, information signals, and tax positions of shareholders, are typically non-negligible. The research presented here shows how interventions can still have an effect on market prices, even controlling for the other consequences they might have on intrinsic values or on the beliefs of traders. Downward-sloping demand is not induced with exogenous incentives, but arises endogenously from the aggregation of the trading behavior of the three behavioral types.

The main conclusions with regard to Hypotheses 1 and 2 are consistent with risk-averse agents balancing their portfolios, and this effect might be at work here. However, some more subtle patterns in the data seem to indicate that this is not the whole story. In the Share Issue treatment, in which prices track fundamentals, it would presumably be clear to agents that there are no capital gains to be realized, so that the only source of earnings are dividends. If all agents are risk averse, then, the asset would trade at prices below fundamental value.

Other evidence for downward-sloping demand in asset markets has been offered by HN (2006), who study the effect of short selling. In that work, short selling constraints were shown to be an important factor in bubble magnitude (also see Allen et al., 1993). Introducing a sufficient number of additional shares to the market through looser short selling restrictions created pricing below fundamentals. The short sellers tended to be the momentum traders and the rational speculators. In contrast, the increase in supply of shares implemented here through the share issues results in the allocation of those shares primarily to the fundamental value traders. This helps to reduce mispricing rather than to increase it, as in the case of short selling.

Because of the change in the allocation of shares among types resulting from the two types of intervention, it appears that a larger repurchase would serve to persistently increase prices even more than in our experiments. Demand from momentum traders and rational speculators would be further encouraged, even as fundamental value traders, who would wish to sell, would run out of their units more quickly. On the other hand, a larger issue of asset would not lower prices beyond fundamentals, at least not for longer than a period or two. The units the experimenter sells would be purchased primarily by the fundamental value traders. This means that fundamental value traders would have a greater percentage of the shares after the issue and receive the dividends on these shares, which adds to their cash balances. This encourages prices to track fundamentals even more closely, because fundamental value traders would have a greater ability to exploit any deviations from fundamentals in a manner that would push prices back toward intrinsic values.

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## **Appendix: Experimental Instructions**

### **Instructions for experiment**

#### **1. General Instructions**

This is an experiment on decision making in a market. The instructions are simple and if you follow them carefully and make good decisions, you might earn a considerable amount of money, which will be paid to you in cash at the end of the experiment. The experiment consists of a sequence of trading Periods in which you will have the opportunity to buy and sell in a market. The currency used in the market is francs. All trading will be done in terms of francs. The cash payment to you at the end of the experiment will be in euros. The conversion rate is: **170 francs to 1 euro**.

#### **2. How to use the computerized market**

In the top right hand corner of the screen you see how much time is left in the current trading Period. The goods that can be bought and sold in the market are called Shares. In the center of your screen you see the number of Shares you currently have and the amount of Money (francs) you have available to buy Shares.

If you would like to offer to sell a share, use the text area entitled “Enter offer to sell” in the first column. In that text area you can enter the price at which you are offering to sell a share, and then select “Submit Offer To Sell”. Please do so now. Type a number in the appropriate space, and then click on the field labeled “Submit Offer To Sell”. You will notice that nine numbers, one submitted by each participant, now appear in the second column from the left, entitled “Offers To Sell”. Your offer is listed in blue. Submitting a second offer will replace your previous offer.

The lowest offer-to-sell price will always be on the bottom of that list. You can select an offer by clicking on it. It will then be highlighted. If you select “Buy”, the button at the bottom of this column, you will buy one share for the currently selected sell price. Please purchase a share now by selecting an offer and clicking the “Buy” button. Since each of you had offered to sell a share and attempted to buy a share, if all were successful, you all have the same number of shares you started out with. This is because you bought one share and sold one share. Please note that if you have an offer selected and the offer gets changed, it will become deselected if the offer became worse for you. If the offer gets better, it will remain selected.

When you buy a share, your Money decreases by the price of the purchase. When you sell a share your Money increases by the price of the sale. You may make an offer to buy a unit by selecting “Submit Offer To Buy.” Please do so now. Type a number in the text area “Enter offer to buy”, then press the red button labeled “Submit Offer To Buy”. You can replace your offer-to-buy by submitting a new offer. You can accept any of the offers-to-buy by selecting the offer and then clicking on the “Sell” button. Please do so now.

In the middle column, labeled “Transaction Prices”, you can see the prices at which Shares have been bought and sold in this period. You will now have about 10 minutes to buy and sell shares. This is a practice period. Your actions in the practice period do not count toward your earnings and do not influence your position later in the experiment. The only goal of the practice period is

to master the use of the interface. Please be sure that you have successfully submitted offers to buy and offers to sell. Also be sure that you have accepted buy and sell offers. If you have any questions, please raise your hand and the experimenter will come by and assist you.

### **3. Specific Instructions for this experiment**

The experiment will consist of 15 trading periods. In each period, there will be a market open for 4 minutes, in which you may buy and sell shares. Shares are assets with a life of 15 periods, and your inventory of shares carries over from one trading period to the next. You may receive dividends for each share in your inventory at the end of each of the 15 trading periods.

At the end of each trading period, including period 15, the computer will randomly determine the dividend value for all shares in that period. Each period, each share you hold at the end of the period:

- earns you a dividend of 0 francs with probability 1/4
- earns you a dividend of 8 francs with probability 1/4
- earns you a dividend of 28 francs with probability 1/4
- earns you a dividend of 60 francs with probability 1/4

Each of the four dividend values is equally likely, thus the average dividend in each period is 24. Dividends are added to your cash balance automatically. After the dividend is paid at the end of period 15, there will be no further earnings possible from shares.

----- **Insert only for Repurchase Treatment** -----

#### **4. Share Buyback**

Over the course of the 15 periods, the computer will buy back half of the shares from the market. It will do so by submitting offers to buy shares. These offers will look and work exactly the same as offers created by other subjects. They will be listed under the “Offers to Buy” column and they can be accepted by using the “Sell” button. Once the computer has purchased back half of the shares, it will no longer participate in the market.

-----**Insert only for Share issue Treatment** -----

#### **4. Share Sale**

Over the course of the 15 periods, the computer will sell a number of shares on the market. The number of shares will equal half of the existing shares in the market. It will do so by submitting offers to sell shares. These offers will look and work exactly the same as offers created by other subjects. They will be listed under the “Offers to Sell” column and they can be accepted by using the “Buy” button. Once the computer has sold all of its shares, it will no longer participate in the market.

----- **End of Insert** -----

## 5. Average Holding Value Table

You can use your **AVERAGE HOLDING VALUE TABLE** to help you make decisions. There are 5 columns in the table. The first column, labeled Ending Period, indicates the last trading period of the experiment. The second column, labeled Current Period, indicates the period during which the average holding value is being calculated. The third column gives the number of holding periods from the period in the second column until the end of the experiment. The fourth column, labeled Average Dividend per Period, gives the average amount that the dividend will be in each period for each unit held in your inventory. The fifth column, labeled Average Holding Value Per Unit of Inventory, gives the average value for each unit held in your inventory from now until the end of the experiment. That is, for each share you hold for the remainder of the experiment, you will earn on average the amount listed in column 5.

Suppose for example that there are 7 periods remaining. Since the dividend on a Share has a 25% chance of being 0, a 25% chance of being 8, a 25% chance of being 28 and a 25% chance of being 60 in any period, the dividend is on average 24 per period for each Share. If you hold a Share for the remaining 7 periods, the total dividend for the Share over the 7 periods is on average  $7 \times 24 = 168$ . Therefore, the total value of holding a Share over the 7 periods is on average 168.

AVERAGE HOLDING VALUE TABLE

Ending Period	Current Period	Number of Holding Periods	x	Average Dividend Per Period	=	Average Holding Value Per Share in Inventory
15	1	15		24		360
15	2	14		24		336
15	3	13		24		312
15	4	12		24		288
15	5	11		24		264
15	6	10		24		240
15	7	9		24		216
15	8	8		24		192
15	9	7		24		168
15	10	6		24		144

15	11	5	24	120
15	12	4	24	96
15	13	3	24	72
15	14	2	24	48
15	15	1	24	24

## 6. Your Earnings

Your earnings for the entire experiment will equal the amount of cash that you have at the end of period 15, after the last dividend has been paid. The amount of cash you will have is equal to:

The cash (called “Money” on your screen) you have at the beginning of the experiment

+ dividends you receive

+ money received from sales of shares

- money spent on purchases of shares