Rational Panics, Liquidity Black Holes
And Stock Market Crashes:
Lessons From The State-Share Paradox

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ABSTRACT

A government policy aimed at the reduction of state shares in state-owned enterprises (SOE) triggered a crash in China’s stock market. The sustained depression and spillover even after the policy adjustments were over constitute a puzzle—the so-called “state-share paradox”.

The empirical study finds evidence in two dimensions. First, a regime switching model with an absorbing state suggests that government policy switches the regime to liquidity black holes. Second, there is no evidence of flight-to-liquidity during the crash, suggesting to model the crash as an aggregate phenomenon of the whole market. To carefully match the evidence, a theoretical model is set up within the framework of market microstructure. The state-share paradox is not a simply instance of news-driven crash. The model shows that China’s stock market has distinctive features of liquidity production and price discovery. The irregularities of a representative liquidity supporter generate an inverted-S demand curve and give rise to potential liquidity black holes. Multiple equilibria and the resulting large drop in prices arise from supply dynamics of short-run investors, who buy the stock from the primary market liquidate their long positions in the secondary market.

This study contributes a rational panics hypothesis to the literature. The rational panics hypothesis is neither an irrational model with noise traders, nor a standard rational expectation model under the asymmetric information framework. It is based on homogeneous agents with incomplete information, and is consistent with the evidence of absorbing regime switching and the recent literature on state-dependent preference. Our findings have larger implications for inefficiency of China’s stock market.

Keywords: State-share, Liquidity, Price discovery, Market Crash.

(JEL G18, E65, O16)
1 Introduction

The phenomenon of crashes has long puzzled both participants and observers of stock markets. China’s stock markets have seen much more crashes than those in the mature markets. We investigate crashes defined as sharp price drops in general and daily returns lower than a cutoff point, say -5%, in particular. By employing this crash definition, we are able to compare crashes in China’s stock market and the U.S. stock market. Figure 1 depicts daily returns of the Shanghai Stock Exchange A share index and SP500 composite Index from 1997 to 2003\(^1\). There are three episodes with SP500 negative daily returns lower than -5%, which are related to the Asian Crisis in 1997, the LTCM crisis in 1998 and the Internet bubble burst in 2000. In contrast, there are much more crashes (13 by the same definition) in China’s stock market. Many of them have been induced directly by government policies\(^2\). The crash we are going to examine in this paper happened in China’s stock market during 2001-02. Despite of the sound macroeconomic condition, a government policy that was aimed at reducing state shares in state-owned enterprises (SOEs) triggered a crash in China’s stock market. Although the shocks were regarding state shares, those companies without (dominant) position of state shares also experienced declining prices, increased volatility, and increased correlation. The sustained depression and spillover even after the policy adjustments were over constitute a puzzle—the so-called “state-share paradox”.

There is a large canon of literature about stock market crashes. Practitioners often describe crashes as “liquidity holes”, or more dramatically, “liquidity black holes” in the sense that price drops sharply without important new events and the stock market can remain low for a substantial amount of time without immediately bouncing back. Theoretically, a recent approach interprets crashes as alternating realizations of multiple equilibria. An information asymmetry framework is used and the folding property arises endogenously from a misinterpretation among heterogeneous investors and yields news-free and discrete price changes. Gennotte and Leland (1990) demonstrate that a relatively small amount of portfolio insurers, who mechanically sell stocks when prices

\(^1\)Since December 16, 1996, China’s stock markets start the price regulation that daily returns should be greater than -10% and lower than 10%. Before that, there were much more crashes.

\(^2\)For reference, see Chen and Shih (2002).
fall and buy when they rise, gives rise to a backward bending excess demand curve. Bar-
levy and Veronesi (2003) demonstrate that uninformed agents can end up acting in the
same way as portfolio insurers. With the backward-bending demand curve of uninformed
traders, the aggregate demand curve folds over itself, forming an inverted-S shape. Hence,
the equilibrium price must change discontinuously at some point and can remain low for
a substantial amount of time. Similar attempts, such as Xiong (2001), Kyle and Xiong
(2001), Calvo (1999), Gromb and Vayanous (2002), and Yuan (2003, 2004), further intro-
duce price-dependent trading constraints on investors’ demand for risky assets to explain
crisis and contagion.

In particular, Barlevy and Veronesi (2003) use the term “rational panic” to describe
the behavior of uninformed investors: a small decline in price leads uninformed agents to
no longer view stocks favorably and to cut their demands, causing the aggregate demand
upward slopping in some interval. Rational panic of uninformed agents is because of
information asymmetry. In the literature, there is a debate on rational exuberance and
irrational exuberance, motivated by the facts that asset prices in the U.S and elsewhere
in the last decade underwent the run-up and collapse. Greenspan in his famous 1996
speech raised the possibility of “irrational exuberance” in the stock market. Shiller (2000)
develops the idea in his book of the same name. LeRoy (2004) gives a survey of rational
exuberance. In general, rational agent models are identified with the nonexistence of noise
traders. We follow the distinction rule and define the “rational panic” as follows: certain
rational investors get panic and their panics are entirely warranted.

The state-share paradox also has the salient feature of discrete price changes and
sustained depression. Since such crash was due to news events implemented by the gov-
ernment, we should consider a news-driven explanation. That will be more similar to
bond markets in the sense that macroeconomic variables—government deficits, inflation
expectation, GDP growth, money supply for bond markets and government policy regard-
ing state shares for China’s stock market—are the main factors affecting prices. In recent
papers, Brandt and Kavajecz (2003) and Green (2004) study private information in the
government bond market and attempt to adopt the asymmetric information framework.
They show that there are several possible sources to generate information asymmetry: (1)
heterogeneous interpretation of public information; (2) dealers’ private access to customer
order flows; (3) limited private information in the traditional sense. In our story, the most impossible source of information asymmetry is heterogeneous effect on individual stocks. In other words, the firms with higher percentage of state shares to total shares with heavy weighting of state shares might drop more since the policy was aimed at the change of equity structure of listing SOEs. This is related to the so-called “flight to liquidity”: those that were more illiquid stocks declined more in value during a crash, even though there is a “contagion” by which we mean increased correlation due to declines in stock price and liquidity, common to all stocks.

Is it possible to generate an inverted-S demand curve without asymmetric information? Yes, because the inverted-S demand is essentially an aggregation of state-dependent demand schedules and asymmetric information just provides an environment to work out irregular parts of the demand. With an environment with symmetric information, state-dependent demand may directly come from a state-dependent preference. The recent literature in macroeconomics and finance has focused on state-dependent utilities to explain the puzzling behavior of individual consumer/investors and of financial variables. Examples include the works on habit formation (Constantinides, 1990; Abel, 1990; Campbell and Cochrane, 1999), loss aversion (Benzartzi and Thaler, 1995; Barberis, Huang and Santo, 2001), long-run risk aversion (Veronesi, 2000; Bansal and Yaron, 2003), crash-aversion (Bates, 2001). Vayanos (2004) argues that there is a flight to quality in the sense that investors’ effective risk aversion increases during volatile times. In other fields, Basu, Genicot and Stiglitz (2003) illustrate a good example in which a labor supply curve can take a complex form because of state dependence. This type of explanations may better solve the state-share paradox because the policy and its adjustments actually switch the states and beliefs about states.

The rest of the paper is organized as follows: institutional background are discussed and the state-share paradox is proposed in section 2. In section 3, empirical evidence shows that the salient features of this crash can be characterized by a model of regime switching with an absorbing state. It suggests that the government policy switches the regime to liquidity black holes. At the same time, cross-section evidence supports contagion without “flight-to-liquidity” and suggests to model the crash as a phenomenon of the whole market. Section 4 investigates a theoretical hypothesis to explain the empirical
evidence. Based on the state-dependent utility of a representative long-term liquidity supporter, an inverted-S demand curve is constructed and shows distinctive features of liquidity production and price discovery in China’s stock market. Section 5 looks for interpretation and implications. Multiple equilibria and the resulting large drop in prices arise from supply dynamics of short-run investors. Although the crash is apparently caused by news of government intervention, the significance of price drop is not arguably the sign of strength of the policy and the policy traps is not the consequence of different attempted policy changes. Section 6 concludes with remarks and general lessons that can be extrapolated from the Chinese case. It is suggested that the type of modeling used in this paper has larger implications for other research.

2 Institutional Background

Stock markets have two important functions—liquidity production and price discovery (O'Hara, 2003). However, China’s stock market has distinctive features of these functions because of its institutional background.

Right from the start, China’s stock market adopted a strictly planned management system, with management of issue volume incorporated into the national credit plan and monetary policy. As a result, along with bank loans and bond issue, the scale of stock issues became part of the overall money supply, facilitating the Chinese government’s control of capital. The actual management method used to control issue volume after 1993 was through the China Securities Regulatory Commission (CSRC) of the State Council convening a meeting of relevant departments and commissions, to decide on the overall scale of stock issue for that year on the basis of current economic development and the state of the market. In 1997, the CSRC announced new regulations governing the issue of new shares, with the implementation of a quota system. In order to encourage listing of large and key SOEs, within the restrictions of the overall quota, only the number of companies that could make public offerings was limited. However, owing to the numerous failings in quota management, enterprises and local government began to engage in a wide variety of public relations (PR) activities to try to secure their own shares of the quota. Such PR expenditure leads to an increase in rent-seeking activity and numerous
cases of corruption. In light of this situation, on March 16, 2000, the CSRC announced the abolition of the quota system and began moving in the direction of a listing approval system. Yet, because the government terminated the use of quotas, liquidity production of the stock market should be well supported to make more SOEs listed. Otherwise, few SOEs will be transformed and reform will slow down.

Equity in listed companies is artificially divided into different categories of shares in the same stock—state-owned shares, legal-person shares, public shares and internal employee shares, with different rights adhering to each type. State shares constitute a majority of the total shares and have all the same rights as public shares. The only difference is that they cannot be sold freely on the market. The state thereby keeps a dominant position in the SOE. The state acquired its shares when the SOE were initially converted into stock companies at book value. Contemporaneous public investors, however, could only acquire their shares at the market price. This special equity structure has substantial impact on price discovery, as shown later.

Over the last few years, attempts have been made to solve the problem of restrictions on legal-person shares and state shares. In December 1998, there were court cases in which legal-person shares were sold in an auction. At the end of 1999, an attempt was made to sell off the state shares in Zhongguo Jialing (JIALING, SH.600877) and Qian Tires (GUIZHOU TYRE, SZ.000589) through the sale by allocation method; however, as a result of pricing problems, the final results were far from ideal. In early 2000, the CSRC introduced policy initiatives that hinted at the possibility of eventually lifting the trading restriction on legal-personal shares while Shen Neng (Shenergy, SH.600642) provides a successful example of a buy-back of state shares.

On June 6, 2001, the CSRC announced that the listed state-owned enterprises would reduce their state-owned shares and legal-person shares by an amount equivalent to 10% of the total offerings, through initial public offerings (IPOs) and through seasoned equity offerings (SEO). Essentially, this is a privatization program. The immediate target of the program was financing the social security system. The revenue from the sale of state-owned shares is to be remitted to the national social security fund. If the program succeeds in the early stages, its goals become broader: enhancing competition, improving management operations, fostering the development of capital market institutions, broad-
ening share ownership or improving corporate efficiency.

Unfortunately, the forced inflow of lower-value state shares sold on the market price diluted the price of public-owned shares. The result of the government policy was a precipitous drop in the price level of the stock market. It is important to note that the fall did not happen immediately after the announcement of the policy in June. Rather, the drop began one month afterwards, in July, and lasted through October. The closing indexes of the Shanghai and the Shenzhen securities exchanges tumbled 32% and 37% respectively by October 22, 2001 (Figure 3).

On October 23, 2001, the CSRC announced the suspension of measures to reduce the holdings of state shares. The closing indexes increased by 10% on the day, representing the maximum amount of stock volatility permitted by the government. Moreover, all firms gained on that day. Discussion about how to reduce state-owned shares continued and public anxiety appeared to be increasing. The momentum of the upward drive was quickly sapped and all of the gains were gone by the end of the week. The faltering of the rally may be an indicator that the temporary suspension of the reduction of state-owned shares is not enough to create a lasting rally. When the government tried to resume the policy, announcing a discount selling plan on January 26, 2002, the Shanghai and the Shenzhen market indexes declined 6.3% and 6.7% on the following business day, January 28. On that day, 95% of the firms in the Shanghai market and 98% of the firms in the Shenzhen market saw declines.

On June 24, 2002, the Chinese government decided to permanently terminate the policy. This sent the Shanghai and the Shenzhen markets sky high. By the end of that day, both markets closed 10% up. Almost all the firms on both markets gained. However, even after these strong measures were taken, the stock markets returned to depressed levels, inconsistent with predictions based on standard economic models. Chinese stock prices have remained at a low level. This is the so-called “state-share paradox”.

It is easy to rule out the explanation of a recession-driven crash. Figure 2 shows the Chinese GDP (quarterly) fluctuated from 1994 to 2003. Clearly, there is no recession during 2001-02. Therefore, the crash is not due to bad macroeconomic conditions. Also, we check possible influences caused by other events except the policy of reducing the state shares. It seems that they are too small to generate sharp drops and jumps and the
sustained depression. This motivates us to investigate endogenous mechanisms in China’s stock market to solve the puzzle.

3 Empirical Evidence

In this section, we attempt to provide both time-series and cross-section evidence. Good fitness to regime switching model with an absorbing state suggests that the state-share paradox occurs because the government policy switches the regime to liquidity black holes. Cross-section analysis examines the correlation between the crash and cross-section asset returns. There is strong evidence for contagion but not for a flight-to-liquidity phenomenon. This implies that crash is an aggregate phenomenon and homogeneous across assets.

3.1 Time-series Evidence

Figure 3 depicts that the closing prices of the Shanghai Stock Exchange A share index fluctuated from January 2, 2001 to December 31, 2002, based on the news of policy changes. We also divide the whole sample into three subsamples: the first one is from January 2, 2001 to June 5, 2001, the second one is from June 6, 2001 to June 21, 2002 and the third one is from June 24, 2002 to December 31, 2002. These are three windows before, during and after the policy was effective.

From Figure 3, we can see the following salient features of this crash: (1) price and its changes are in a lower regime (below the horizontal line in the Figure) after policy announcement; (2) The sharp price changes are triggered by important news; (3) The market jumped down discontinuously but did not jump down immediately as the negative news was announced; (4) Price movement is asymmetric: upward jumps are more significant than downward jumps after policy adjustments were made; (5) The market has been locked in the same kind of decreasing trend in spite of positive news.

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The data of individual stock prices and price level of the market index are from China Stock Market & Accounting Research Database (CSMAR). The data of equity structures are from Southern Fund, P.R. China. We thank Wenzhou QU and Houchuang Huang for their help with some data collection.
Most financial studies involve returns, instead of prices index. Figure 3 also shows time
plots of daily log returns of Shanghai stock market. Clearly, there exists strong volatility
clustering and some extreme movements. Using a kernel smoothing method, one can see
an estimated density with a high spike, as shown in Figure 4. Basic statistics of the whole
sample given in Table 1 show negative mean and strong skewness and kurtosis.

To get more impressions, we compare the statistics of the three subsamples. The
mean of return is positive in subsample 1 while it becomes negative in sample 2. This
implies that the policy induced declining market index. In contrast, there is evidence that
skewness of return shifts from negative values to positive ones conditional on declines in
market index. This is consistent with conditional skewness effects described by Cao, Coval
and Hirshleifer (2002). Also, variance and kurtosis are higher in subsample 2 than those
in subsample 1, suggesting increased volatilities and more extreme events. In subsample 3
after the policy was over, the market experienced further decreasing prices and increased
positive skewness. The implication is that the market has been locked in the decreasing
trend in spite of positive policy adjustments. The volatility of return decreases but is
still higher than that in sample 1. Surprisingly, the kurtosis is much higher than those in
subsample 2.

Motivated by the stylized fact that the market is in different regimes by policy an-
nouncements, we choose the following regime switching model to fit return data:

$$y_t = \mu_{s_t} + \sigma_{s_t} \varepsilon_t \quad \varepsilon_t \sim NID(0, 1) \quad s_t = 1, 2$$

where $y_t$ is log return of the closing prices of the Shanghai Stock Exchange A share index.
$\mu_{s_t}$ is mean return in one of two states denoted by $s_t$. $\sigma_{s_t}$ is standard deviation of return
in one of two states. $\varepsilon_t$ is an error term which follows normal independent distribution
with zero mean and unit variance. The transition probability between two states $p_{ij}$ gives
the probability that state $i$ will be followed by state $j$.

The estimated result is shown in Table 2. Note that $p_{11} = 2.029e-012$ is significantly
close to 0 while $p_{22} = 0.991$ is significantly close to 1. Thus $s_t = 2$ can be regarded as an
absorbed state. Also note that $\mu_2 = -0.158$. This suggests that $s_t = 2$ is a state in which
price index follows a decreasing trend. No matter what measures were taken, the stock
market returned to depressed levels positively. Therefore, we can say that the market has
been locked in an absorbing state with the sustained depression.
Note that $\mu_1 = 7.654$ while $\mu_2 = -0.158$. This suggests that price movement is asymmetric in the different regimes. Positive movements in increasing regimes are more significant than negative movements in decreasing regimes. Also note that $\sigma_1^2 = 2.245$ and $\sigma_2^2 = 1.597$. This suggests that returns are more volatile in the increasing regime. Combining both, risk premium investors require per unit of volatility increases, which can be viewed as evidence for increased risk aversion and flight to quality phenomena.

Recall that there were three major policy adjustments: Oct 23, 2001, Jan 26, 2002, and Jun 24, 2002. The filter probabilities that return is in the regime of upward jumps around these dates, are pretty close to 1 as shown in Figure 5. Indeed, policy adjustments triggered large upward jumps, but momentum of the upward drive was quickly sapped and it followed a longer process with relatively smaller jumps to return to depressed levels.

Figure 3 gives us an overall picture that China’s stock market was locked in decreasing regime except some impulse deviations driven by policy adjustments. More accurately, the expected duration of a depression is

$$\frac{1}{p_{21}} = 116 \text{ trading days} \approx 5 \text{ months}$$

which is consistent with the average duration of policy adjustments. On the other hand, the expected duration of an impulse growth is

$$\frac{1}{p_{12}} = 1 \text{ day}$$

The strong implication is that positive effect of policy adjustments was exactly overnight.

Overall, the regime switching model with an absorbing state can well explain the sustained depression by highly asymmetric dynamics in mean, variance and transition probability. The absorbing state offers an intuition to model the state-share paradox as liquidity black holes.

We also derive the moments for the regime-switching model based on Timmermann (2000) and compare them with the moments of the whole sample data. From Table 1, the mean and variance from the model are almost the same as those from data. But the model does not well fit higher moments, especially skewness. Moreover, it is important to point out that the model cannot cover all stylized facts of the crash. There is no evidence to support why the market did not jump down immediately as the negative news was announced.
3.2 Cross-Section Evidence

Since the policy was aimed at the reduction of state shares, variation in equity structure of listing SOEs should be important for the cross-section of assets. The hypotheses we attempt to test in this section are whether declines are common to all stocks so that the correlation increased in and after the crash and whether the crash was more severe for those stocks and portfolios with heavy state shares. The former is also called contagion hypothesis while the latter is also called flight-to-liquidity hypothesis.

First, we test the so-called contagion effect, with null hypothesis as follows

\[ H_0 : \text{corr} (R_i, R_j | \text{during/after the crash}) > \text{corr} (R_i, R_j | \text{before the crash}) \]

where corr denotes correlation, \( R_i \) and \( R_j \) are returns of two portfolios with different weights of state shares.

There were 562 stocks and 707 stocks listed in the Shanghai Stock Exchange at the beginning of our sample on January 2, 2001, and at the end of the sample on December 31, 2002, respectively. The percentages of state shares for these stocks are shown in Figure 6. We also consider 3 subsamples to be consistent with section 3.1.

Different methods are used to form eleven equally-weighted portfolios for the robustness of results. The first two methods are dynamic in the sense that sample stocks on the run are sorted by their ratios of state shares every trading day. For both methods, the first portfolio has no state shares. With the first method, each of the next ten portfolios includes equal number of total stocks excluding those in the first portfolio\(^4\). For dynamic portfolios formed with the first method, stocks might switch to different portfolios for changes of their own or others’ equity structure over time. In contrast, with the second method, we form ten intervals divided by deciles of the state share ratio\(^5\) on December 31, 2002 (the lower histogram in Figure 6 gives more details). These fixed intervals are applied to the each trading day. For dynamic portfolios formed with the second method, stocks might switch to different portfolios just for changes of their own equity structure over time. To control for such problems, the third method is used to form static portfolios.

\(^4\)If the remaining stocks cannot be equally divided into ten deciles, the last portfolio will have more stocks than nine others.

\(^5\)The cutting ratios of state shares for these ten intervals are 0.18, 0.31, 0.39, 0.49, 0.53, 0.63, 0.67, and 0.71.
In this case, sample stocks listed before 2001 are sorted by their ratios of state shares on the particular date of the policy announcement, that is, June 6, 2001. The first portfolio includes 102 stocks without state shares on June 6, 2001. Each of the next ten portfolios includes 46 stocks. The stocks for each portfolio do not change over the entire sample period.

Next, mean return and mean ratio of state shares for each portfolio are calculated. Table 3 and 4 report basic statistics of mean ratio and mean return of the portfolios based on the first method. From Table 4, the same information is available as that from the market index (Table 1). There are similar results (not reported) based on the other two methods. Moreover, mean of correlations is calculated as the equally-weighted average of pairwise correlations of eleven portfolios for each sub-sample. We also use dynamic portfolios based on the first method for illustration. As shown in Table 5, the mean of pairwise correlations across these portfolios increased when and after the policy was taking place in subsample 2 and subsample 3. Both Friedman and ANOVA tests in Table 5 report that the means of correlations are different among three subsamples. Further test by multiple comparison test shows that the means of correlations in subsample 2 and subsample 3 are not statistically different. However, they are significantly different from the mean of correlations in subsample 1. Similar results based on the other two methods are not reported.

Second, to check whether there exists a flight-to-liquidity phenomenon, we run two cross-section regressions with and without controlling for individual stocks’ beta coefficients. In general

\[ y_{it} = c_0 + c_1 r_{it} + c_2 \beta_{it} + c_{it} \]

\[ H_0 : \ c_1 < 0 \]

where \( y_{it} \) is the return of stock \( i \) at trading day \( t \), \( r_{it} \) is the ratio of state shares relative to total share of stock \( i \) at trading day \( t \) and \( \beta_{it} \) is beta coefficient of stock \( i \) at trading day \( t \). Similar analysis is also applied to portfolios.

The estimated results are shown in Table 6. In Panel A and B, the regression coefficients of ratios of individual stocks are both zero statistically, implying returns of individual stocks are unrelated with their ratios of state shares. Thus, there is no evidence that the prices of those stocks with heavy state shares dropped more.
The robustness of the results can be seen from cross-section regressions using portfolio data. For the dynamic portfolios based on the first method, we run the mean return differences of portfolios between subsample 1 and subsample 2 on the mean ratios of state shares of each portfolio in subsample 1. The estimated results are shown in Panel A of Table 7. The regression coefficient of mean ratios of state shares is significantly zero. For the static portfolios base on the third method, we regress return differences of static portfolios between subsample 1 and subsample 2 on mean ratios of state shares in subsample 1, ratio changes of state shares between subsample 1 and subsample 2, controlling for portfolios’ beta coefficients. The estimated results are shown in Panel B of Table 7. The regression coefficient of mean ratios of state shares in subsample 1 is zero statistically and the regression coefficient of ratio changes of state shares between subsample 1 and subsample 2 is zero statistically at 5% significance level. Again, both results in Panel A and B do not provide evidence that the prices of those portfolios with heavy state shares dropped more.

Hence, the hypothesis of flight-to-liquidity is not supported and there is not a substitution effect during the crash. Overall, we find strong contagion by declining prices, increased volatilities and increased correlations for all portfolios. The failure of flight-to-liquidity hypothesis suggests that the crash is more likely to be homogeneous across different stocks and portfolios. Therefore, it is better to model the crash as an aggregate phenomenon of the whole market.

4 An Inverted-S Demand Curve

In what follows, a theoretical explanation will be developed to be consistent with institutional background and empirical evidence. The model is set up within the framework of market microstructure with one risky asset and two types of traders. First, there is a continuum of risk neutral homogeneous traders. Each trader holds 1 units of the asset and liquidate his or her positions optimally in response to a given noise-trading process. We may think of them as convergence traders in Kyle and Xiong (2002) or short horizon traders in Morris and Shin (2003). Second, there is a risk averse agent who provides the residual demand curve facing the risk-neutral traders as a whole. It is important to point
out that the agent is more than a dealer in inventory models or long-term investors in Kyle and Xiong (2002) because he provides long-term liquidity to support the reforms of Chinese SOEs.

More importantly, price discovery in China’s stock market is different from the standard mechanism described in the microstructure literature. The traders interact in the market for a risky asset, where expected demand and expected supply turn out to be interdependent. This innovation generates an inverted-S actual demand curve and will be the crucial feature of our model that drives the main results. An intuitive sketch of the inverted-S curve is illustrated in the first place and a numerical formalization based on a state-dependent preference is established.

4.1 Intuitive Sketch

The demand curve for a good is typically downward sloping with respect to price of that good. In terms of an asset, the idea that the demand curve is downward sloping was suggested by Grossman and Stiglitz (1980). Recall that derivation of the demand curve is based on a representative agent who works out the quantities demanded by maximizing his utility, taking prices as given. This assumption becomes unrealistic if the agent does not, in fact, take the offering price for granted.

In China’s stock market, public investors discount the offering price if state shares are expected to be bundled in the public offering. A hypothetical example is helpful in illustrating this phenomenon. Suppose a SOE is planning to convert into a stock company. The enterprise’s original capital is divided into one million state-owned shares. The SOE issues one million additional public shares for sale on the market. The SOE acquires state-owned shares at book value—say, one yuan; however, the market price of the public shares offered to contemporaneous public investors is much higher than book value—say, five yuan. At root, this dual-pricing approach arises from the Chinese pattern of gradual transition.

The offering is tempered by government policy, which essentially requires that the enterprise must spend ten percent of the proceeds from public offerings to buy back state shares. Thus, 0.5 million yuan of the total five million yuan (one million shares, valued at five yuan each) would be taken by the government. The SOE thereby only receives 4.5
million yuan on a five-million-yuan offering. Ultimately, because of remittances to the
government, the SOE only realizes a portion (90% here) of its potential capitalization.
The policy is equivalent to imposing a tax on the public offering.

Moreover, the government policy requires that a state share be bought back at the
price of a public share. Thus, 0.1 million of the one million state shares would return
to the enterprise. On the enterprise’s balance sheet, the total number of state shares
outstanding would then be 0.9 million while the total number of public shares outstanding
would still be one million. It would appear that investors would gain more voting rights,
based on the increased portion of public shares relative to state shares. This positive
effect may increase the demand for public shares. On the other hand, state shares no
longer constitutes majority. Public investors may think that the state would not take full
responsibilities for SOE and the bankruptcy risk of SOE would increase. This negative
effect may decrease the demand of public shares.

Assuming that public investors are rational and that the pricing effect dominates other
effects, the expected resale of a public share after the buyback is 4.5 yuan. Knowing the
state’s policy in advance, public investors cut down on their demand. This loosely captures
the notion of rational panics among public investors. The more state shares are to be
reduced through buy back, the more severe the dilution of the value of a public-owned
share. It seems reasonable to suppose that the price expected by public investors will
decrease as the number of state shares to be bought back increases.

This phenomenon will be continued in the secondary market after public offerings.
Price discovery process needs to be recast in special terms to incorporate the dual-pricing
system. Suppose that each short-horizon trader buys 1 units of the stock from the primary
market and hold in the secondary market so that he is a supplier of the stock when his
long positions are liquidated. The long-term investors provide residual demands for the
stock.

Define an expected demand function $D^e(p^e, r)$, where $D^e$ is the residual expected
demand, $p^e$ is defined as the price expected by long-term investors, and $r$ is the expected
ratio of state shares reduced, relative to the public offerings received by the enterprise.
Assume that the inverse function $p^e(D^e, r)$ is continuously differentiable with respect to $r$,
then $\frac{dp^e}{dr} < 0$. Note that, for each $r \in [0, 1]$, we can draw a demand curve $D^e = D^e(p^e, r)$. 

14
We shall call each such curve a “quasi-demand curve” or “\( r \)-demand curve”. Figure 7 illustrates a family of \( r \)-demand curves, assuming usual downward sloping. The textbook demand curve is the relation between \( p^e \) and \( r \) with \( D^e(p^e, 0) \), which is shown as in Figure 7. This family of demand curves loosely captures the notion of panic of the long-term investor: the demand curve shifts left as \( r \) increases, implying that the expected price decreases for a fixed quantity \( \tilde{D}, p^e(\tilde{D}, r') < p^e(\tilde{D}, r) < p^e(\tilde{D}, 0) \) if \( r' > r > 0 \).

This panic is entirely warranted so that it is called rational panic. We can see this point by constructing the “actual aggregate demand curve” from the \( r \)-demand curves. This will depend on interaction between demand and supply. Let us suppose that the expected aggregate supply for stock is the usual upward sloping function of offering price \( p \), denoted by \( S^e(p) \). As shown in Figure 8, the supply curve intersects each \( r \)-demand curve. Once state shares are to be sold, the expected price of long-term investors is lower than the price offered by short horizon investors for the same amount of quantities demanded and supplied. Define the ratio between two prices as a strictly decreasing function of \( r \)

\[
\frac{p^e}{p} = f(r) \quad \frac{\partial f}{\partial r} < 0
\]

and

\[
\frac{p^e}{p} < 1 \text{ if } r > 0
\]

Now, given any point on any \( r \)-demand curve, we can easily work out the \( p^e/p \) that will actually come to prevail. Suppose for instance, we are at point B and thus the quantities demanded and supplied are OA. Then the expected price of long-term investors is AB and the offering price of short-horizon is AC. Hence the ratio of two prices is given by AB/AC. Note that B is a point on the \( r \)-demand curve. If AB/AC is not equal to \( p^e/p \), the actual demand can never occur at B. Let us assume that for the \( r \)-demand curve this criterion is satisfied at point B. We can then think of B as a point on the actual demand curve. It is a point that satisfies rational panics. In other words, suppose that the quantity is OA when the expected portion of state shares reduced is \( r \). If long-term investors expect the price to be \( p^e \), then their demand would be point B, so that their rational panics are confirmed. If on each \( r \)-demand curve one picks the point that satisfies rational panics, and then connects the dots, the actual aggregate demand curve of stocks is derived. Let the thick line be such a curve.
Note that the actual aggregate demand curve coincides with the part upper than point E of 0-demand curve (that is the $r$-demand curve without sale of state shares). This is because at any such point, the expected price of long-term investors exceeds the offering price. This implies that at these points there are no panics, only manias. Also, the actual aggregate demand curve coincides with the part lower than point F of 1-demand curve (that is the $r$-demand curve with sale of total state shares). This is because at any such point, no more state shares are to be sold and thus no more panics will be expected. Between point E and F, the actual demand curve is upward slopping because the more state shares sold, the less demand.

It is important to note that the actual demand curve folds over itself, forming an inverted-S shape. The folding property arises endogenously, under diverging opinions about pricing between long-term investors and short-term investors. The divergence increases as the expected proportion of state shares sold increases.

### 4.2 Numerical Illustration

As Gennotte and Leland (1990) and Barlevy and Veronesi (2003) show, an inverted-S demand curves can be derived using asymmetric information and misinterpretation among heterogeneous investors. In our story, one possible source of asymmetric information is heterogeneous concern about public information. For example, investors with heavy portfolio of SOEs may have higher motivation to process public information of government policy. Another possibility is that some investors may have private access to the government policy.

However, investors facing the state-share paradox are more likely to have symmetric information but to disagree on prices between short-term investors and long-term investors and thus we choose an alternative approach for several reasons. First, the failure of flight-to-liquidity hypothesis suggests that heterogeneous concern is not significant. Second, private access to the government policy may explain why the fall did not happen immediately after the original policy announcement but cannot explain the impulse jumps driven by policy adjustments. More importantly, the empirical evidence from the regime-switching model suggests that there are different regimes and policy announcements triggering switches across regimes.
The model we use is the standard constant absolute risk-aversion (CARA) with incomplete information about state-share uncertainty. Suppose that long-term investors are homogeneous so that there exists a representative-investor. The investor is forward looking and has a CARA utility function \( u(W) = -\exp(-\lambda W) \), where \( \lambda \) is the coefficient of absolute risk aversion. A single risky stock is traded in Period 1. In Period 2 it is liquidated and the agent consumes it. Ex ante when viewed from Period 0, its liquidation value is composed by two independent random variables

\[ v + \varepsilon \]

where \( v \) is realized after trading at Period 1, and \( \varepsilon \) is realized at Period 2.

We do not need to impose normality assumption on the distribution \( v \) since it is realized at date 1. The uncertainty at date 1 is just \( \varepsilon \) which assumed to follow a distribution \( N(0, \sigma^2) \). Let \( \mu \) denote he realization of \( v \) at date 1. Then, the important feature for our exercise is that the liquidation value of the asset is normal with mean \( \mu \) and variance \( \sigma^2 \) at Period 1.

One difference from the above traditional CARA-Normal setting is that the investor is uncertain whether and how much the state shares will be reduced. In this case, the agent posses a probability distribution on the states and preferences becomes “state-dependent”. The agent is assumed to have state-share-averse utility function over terminal outcomes of the form

\[ U(W, \gamma) = -e^{-\gamma W} u(W) = -e^{-(\lambda+\gamma) W} \]

where \( \gamma \in [0, \bar{\gamma}] \) captures the extent of state-share aversion regarding the unknown wealth loss conditional on the policy aimed at reduction of state shares and \( \bar{\gamma} < 1 \) denotes an upper bound which is threshold value for maximum loss. \( \lambda+\gamma \) can be viewed as coefficient of the so-called effective risk aversion, which is not constant any more since \( \gamma \in [0, \bar{\gamma}] \).

The relationship between \( \gamma \) and \( r \), defined previously as the expected ratio of state shares reduced,

\[ r \in [0, 1] \rightarrow \gamma \in [0, \bar{\gamma}] \]

is one-to-one monotone mapping. As illustrated in the section 4.1, the policy is equivalent to imposing a tax. The stronger the policy, the higher \( \gamma \).
Proposition 1  Provided that the investor with initial wealth \( W_0 \) buys a number of \( D \) shares to maximize the expected utility, the investor’s expected demand at Period 1 is

\[
D^e(p^e, \gamma) = \frac{\mu - p^e}{(\lambda + \gamma)\sigma^2}
\]

where \( D^e \) denotes expected demand and \( p^e \) denotes the expected price at Period 1.

Proof. See appendix. ■

Corollary 2  There is a family of expected demand curves since \( \gamma \in [0, \tilde{\gamma}] \).

Corollary 3  The family of expected demand curves is downward-sloping with respect to \( p^e \) with the slope \( \frac{-1}{(\lambda+\gamma)\sigma^2} \).

It is important to point out that as long as the expected price falls below the fundamental value, the long-term investor always provides liquidity to the market. Larger \( \gamma \) mean less expected demand (that is the expected demand curve shifts to the left) and thus represent less liquidity from the long-term investor. When \( \gamma \) reaches at the upper bound \( \tilde{\gamma} \), the market is approaching the so-called liquidity black holes. As shown later, the liquidity produced by the long-term investor offers an exit strategy for short horizon traders during the crash. The rationale behind the long-term liquidity production is not only from the microstructure literature but also from institutional background of China’s stock market.

The expected price, defined as the inverse function of the expected demand, is

\[
p^e = p^e(D^e, \gamma, \mu, \lambda, \sigma^2)
\]

Let the expected supply curve be given by

\[
S^e = a + bp
\]

where \( b > 0 \) capture upward slopping expected supply curve, and \( p \) is offering price by short-horizon investors and can be defined by the inverse function as follows

\[
p = p(S^e, a, b)
\]

Let the long-term investor has an expectation of \( \gamma \) given by \( \gamma^e \). This expectation is rational if and only if

\[
\min \left\{ 1, \frac{p^e}{p \bigg|_{Q^e=Q^*}} \right\} = 1 - \gamma^e
\]

18
where for a same amount of quantities demanded and supplied, we compare the ratio of
two prices and 1 and let the smaller value equal to belief of residual wealth conditional on
possible state-share policy. This is just a formalization of intuitive illustration in section 4.1. If the long-term investor expect that \( \gamma^e > 0 \) will be the loss conditional on the policy
aimed at reduction of state shares, he will end up underestimating the offering price from
short-run investors, that is \( p^e < p \). The underestimation is warranted if and only if \( p, p^e \)
and \( \gamma^e \) satisfy the above condition\(^6\).

Let \( D(p, p^e, \gamma^e) \) be the correspondence so that for all \( \gamma^e \in D(p^e, \gamma^e) \), \( \gamma^e \) satisfies the
above equation. The \( D(p, p^e, \gamma^e) \) is the “actual demand curve”. It can be verified that
\( D(p, p^e, \gamma^e) \) is an inverted-S curve if we choose the following values of the parameters.

\[
\mu = 6.30, \lambda = 1.15, \sigma = 0.426, \bar{\gamma} = 0.3, a = 5.50, b = 19.7
\]

Figure 9 depicts the inverted-S demand curve numerically. Compared with the intui-
tive sketch in Figure 8, the numerical illustration is piecewise linear by assuming the
simplistic forms for expected demand and expected supply.

## 5 Interpretation and Implications

The explanation in this section suggests that the state-share paradox is not a simply
instance of news-driven crash. Although the crash is apparently caused by news of gov-
ernment intervention, the significance of price drop is not arguably the sign of strength
of the policy and the policy traps is not the consequence of different attempted policy
changes. Although multiple equilibria and the resulting large drop in prices arise from
supply dynamics of short-run investors, the dual pricing system and the liquidity support
represent major policy failures.

Suppose that there is no uncertainty. The expected supply, \( S^e(p) \) in Figure 8 or 10,
coincides with the actual aggregate supply for the stock. E represents the only point of
equilibrium. The equilibrium price at point E is \( p^e \). However, the actual aggregate supply
curve may shift from the expected one, since there is a shock induced by government
policy.

\(^6\)Similar formulation of rational expectation condition in the literature can be found in Basu, Genicot
and Stiglitz (2003) and models of loan pushing.
Figure 8 shows that if the government announces the policy aimed at the reduction of state shares, this does not change the aggregate demand of the long-term investor. But the supply changes because short horizon traders behave optimally in response to a given shock. Since the focus of our model is on the inverted-S demand curve which provides potential liquidity black holes, we do not further model supply change as bank run like Morris and Shin (2003) and other mechanism. We just simplify matters by assuming that the supply curve shifts to the right and becomes more inelastic which implies larger price impact induced by the shock. In Figure 10(a), There are three levels of demand that would intersect with supply curve: H, I, and G, which gives rise to multiple equilibria. Among these points, H and G are stable equilibrium points while I is unstable one. Suppose the demand that actually occurs is at H after the policy announcement on June 6, 2001 but before the crash.

In Figure 10(b), while the actual aggregate supply curve shifts right further, it is enough to eventually shift supply a fractional amount further to the right of the inverted-S demand curve. In reality, the sharp fall did not happen until a month after the announcement of the government’s policy. Using this model, this phenomenon can be explained by the supply curve getting closer to, but not yet reaching the critical point E. Once this point was passed in July 2001, the market “catastrophe” occurred. At that point, a new low-price equilibrium, L, was established.

The government has attempted three possible solutions: (1) the suspension of the policy, (2) the partial discount of the price of state shares, and (3) the permanent removal of the policy. As shown in Figure 11(a), none of these solutions have been successful. A potential small left shift of the supply curve, gained through the suspension of the policy and discounting of the price of state shares will lead to a small increase in the equilibrium price. The permanent removal of the policy might lead the supply curve to intersect the upper branch of the demand curve. But it does not bounce the supply curve back to the original level because when the state shares were actually sold, the effects on behaviors of short horizon investors are not transitory. Indeed, the government’s restructuring efforts imply the possibility of multiple equilibria (M, K and N). Among these points, M and N are stable equilibrium points while K is unstable one. However, because the crash has already moved the demand level down to the lower equilibrium price N, which is stable,
it can be expected to prevail, despite the ameliorative efforts of the state. Ultimately, the government’s efforts are insufficient to induce the necessary price jump out of the liquidity black holes. The market thus settles in the lowest of the multiple equilibria states. The lower level, stable equilibrium explains the asymmetric jumps, i.e., why the stock prices remained at a paradoxically low level, even after the government acknowledged that its policy was a failure.

Due to the stability of the low-level equilibrium, amelioration of the crash will be difficult to achieve. Yet, in the mind of the theorist, a recovery of the market is possible. As shown in Figure 11(b), one way for an upward jump in prices to be achieved is through a large shift of the demand curve to the right, so that another critical tangential point F is on the right of the supply curve. This solution might be accomplished through the infusion of large quantities of government funds to lower the parameter $\gamma$. This, of course, would be infeasible as the original intent of the reduction of state-owned shares was to generate cash flow for the social security fund. Clearly, spending money to bolster the stock market would be the equivalent of transferring money from one pocket to the other. In the end, the large shift would be difficult to induce. Instead if the solution was sought without careful considerations, the liquidity black holes might become bigger and bigger.

The last but not the least is that fundamental solutions should be to iron out the irregular demand curve. Essentially, this irregular demand curve is derived from the dual-pricing system. Thus, the crash can be blamed on the dual-track approach. Indeed, the Chinese have gained certain advantages through their gradual approach to transition. Yet, given the drawbacks of the dual-pricing system, particularly the crash discussed in this paper, further reflection is clearly necessary.

In terms of strategy, a smarter solution is to transfer all state shares to preferred shares and remit these shares to the national social security fund directly. The rationale is the following: (1) state shares have been owned by the state and are equivalent to social capital, and are thus reasonable to be initial capital for the national social security fund; (2) preferred shares can generate future cash flow like dividend for the national social security fund; (3) the national security fund has incentive and capability to monitor the listing SOEs so that corporate efficiency and management operation can be improved at the same time; (4) preferred shares can not be sold freely on the stock market for sure.
and forever. This will eliminate uncertainty of the reduction of state shares and iron out the irregular demand curve\(^7\).

6 Conclusions

China’s stock market has distinct features of two important functions of stock markets—liquidity production and price discovery. The irregularities generate an inverted-S demand curve, give rise to potential liquidity black holes, and are key features to explain the state-share paradox. The dual pricing system and liquidity support represent major policy failures and the policy implications of this modeling suggest a removal of these types of irregular pricing schemes.

The “state-share paradox” is against almost all notion of market efficiency. Indeed, Zhang and Zhou (2001) and Chen and Hong (2003) show that China’s stock market is not weakly efficient. The question is that why would anyone buy or hold the shares prior to the crash? Our explanation is that there is a long-term liquidity producer who offers an exit strategy for short-horizon traders during the crash. Again, this is the essence of inefficiency of China’s stock market.

\(^7\)We are grateful to Zenglong ZHENG for the insightful discussion at this point.
REFERENCES


Appendix

Proof of Proposition 1: the maximization problem is

$$\max \ E \left( - \exp\left( - (\lambda + \gamma) W \right) \right)$$

subject to

$$W = W_0 + D(v + \varepsilon - p^e)$$

where $\lambda$ is the coefficient of absolute risk aversion, $\gamma$ is the coefficient of state-share aversion, $W$ is wealth at Period 1. $W_0$ is initial wealth at Period 0. $v$ and $\varepsilon$ are two components of liquidation value which are realized at Period 1 and at Period 2, respectively. $p^e$ is the expected price. $D$, the expected demand, is the control variable.

Substituting the budget constraint into the objective function yields

$$\max \ E \left( - \exp\left( - (\lambda + \gamma) (W_0 + D (v + \varepsilon - p^e)) \right) \right)$$

Since $v$ is realized after trading at Period 1, the uncertainty at Period 1 is just $\varepsilon$. Since $\varepsilon$ is assumed to follow a distribution $N(0, \sigma^2)$, $v + \varepsilon$ follows a distribution $N(\mu, \sigma^2)$ conditional on $\mu$, the realization of $v$. Then, the problem becomes to minimize

$$\int_{-\infty}^{\infty} \exp\left( - (\lambda + \gamma) (W_0 + D (x - p^e)) \right) \frac{1}{\sigma \sqrt{2\pi}} \exp \left( - \frac{(x - \mu)^2}{2\sigma^2} \right) dx$$

$$= A \exp \left( (\lambda + \gamma) D p^e \right) \frac{1}{\sigma \sqrt{2\pi}} \int_{-\infty}^{\infty} \exp \left( - (\lambda + \gamma) D x - \frac{(x - \mu)^2}{2\sigma^2} \right) dx$$

$$= A \zeta \exp \left( (\lambda + \gamma) (p^e - \mu) D + \frac{(\lambda + \gamma)^2 \sigma^2}{2} D^2 \right)$$

where $A = \exp\left( - (\lambda + \gamma) W_0 \right)$ and

$$\zeta = \frac{1}{\sigma \sqrt{2\pi}} \int_{-\infty}^{\infty} \exp \left( - \frac{(x - (\mu - (\lambda + \gamma) D \sigma^2))^2}{2\sigma^2} \right) dx = 1$$

since it is an integral of a normal density function over the entire support.

Taking first-order derivative with respective to $D$, we can get the optimal expected demand $D^e$ which must satisfy the following

$$(\lambda + \gamma) (p^e - \mu) + (\lambda + \gamma)^2 \sigma^2 D^e = 0$$

Therefore

$$D^e = \frac{\mu - p^e}{(\lambda + \gamma) \sigma^2}$$

QED.
### Table 1

**Data Summary: SHSE, A-Share Index**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Whole sample:</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan 02, 2001-Dec 31, 2002</td>
<td>-0.0911846</td>
<td>1.45812</td>
<td>0.903045</td>
<td>11.5865</td>
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<tr>
<td><strong>Subsample 1</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan 02, 2001-Jun 05, 2001</td>
<td>0.062151</td>
<td>0.91516</td>
<td>-1.3587</td>
<td>5.8218</td>
</tr>
<tr>
<td><strong>Subsample 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jun 06, 2001-Jun 21, 2002</td>
<td>-0.14218</td>
<td>1.7239</td>
<td>0.6704</td>
<td>8.2056</td>
</tr>
<tr>
<td><strong>Subsample 3</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jun 24, 2001-Dec 31, 2002</td>
<td>-0.106236</td>
<td>1.20743</td>
<td>2.89931</td>
<td>24.6976</td>
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<tr>
<td><strong>Model (Timmermann, 2000)</strong></td>
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<td></td>
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<td>1.45468</td>
<td>72.9481</td>
<td>7.12026</td>
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</tbody>
</table>

The A-Share Index at Shanghai Stock Exchange is examined from January 2, 2001 to December 31, 2002. There are three sub-samples: the first one is from January 2, 2001 to June 5, 2001, the second one is from June 6, 2001 to June 21, 2002 and the third one is from June 24, 2002 to December 31, 2002. These are three windows before, during and after the policy was effective. The statistics of sub-samples see sustained declining price, increased volatility, skewness and kurtosis, suggesting that the market has been locked in the decreasing trend in spite of positive policy adjustments. The moments of the regime-switching model based on the method by Timmermann (2000) shows that they are almost the same as mean and variance from the data of the whole sample, but do not well fit higher moments.
The following regime-switching model is chosen to fit return of the SHSE A-Share index from January 2, 2001 to December 31, 2002.

\[ y_t = \mu_{s_t} + \sigma_{s_t} \varepsilon_t \quad \varepsilon_t \sim NID(0,1) \quad s_t = 1, 2 \]

where \( y_t \) is log difference of the closing prices of the Shanghai Stock Exchange A share index. \( \mu_{s_t} \) is mean return in one of two states denoted by \( s_t \). \( \sigma_{s_t} \) is standard deviation of return in one of two states. \( \varepsilon_t \) is an error term which follows normal independent distribution with zero mean and unit variance. The transition probability between two states \( p_{ij} \) gives the probability that state \( i \) will be followed by state \( j \). Note that \( \mu_1 = 7.65 \) and \( \mu_2 = -0.158 \), which suggest that price movement is asymmetric in the different regimes. Also note that \( \sigma_1^2 = 2.25 \) and \( \sigma_2^2 = 1.60 \), which suggest that returns are more volatile in the increasing regime. More importantly, \( p_{22} = 0.991 \) is significantly close to 1, suggesting that \( s_t = 2 \) can be regarded as an absorbed state. The implication is that the market has been locked in liquidity black holes which lead to the sustained depression.
### Table 3

**Mean Ratio of state shares in the 11 Portfolios**

<table>
<thead>
<tr>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
<td>std</td>
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<td>Jan 02, 2001-Jun 05, 2001</td>
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</tr>
<tr>
<td>Jun 06, 2001-Jun 21, 2002</td>
<td>0.25598</td>
<td>0.0038937</td>
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<tr>
<td>Jun 24, 2001-Dec 31, 2002</td>
<td>0.34508</td>
<td>0.0019839</td>
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<td></td>
<td>0.42098</td>
<td>0.0019407</td>
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</tr>
<tr>
<td></td>
<td>0.75536</td>
<td>0.00314</td>
</tr>
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</table>

Sample stocks are sorted into eleven dynamic portfolios by their ratios of state shares every trading day. The first portfolio has no state shares. Each of the next ten portfolios includes likely equal number of total stocks excluding those in the first portfolio. If the remaining stocks cannot be equally divided into ten deciles, the last portfolio will have more stocks than nine others.

For dynamic or static portfolios based on other methods, the results are similar.
Table 4

<table>
<thead>
<tr>
<th>Mean Returns of the 11 Portfolios</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
</tr>
<tr>
<td>Subsample 1: Jan 02, 2001-Jun 05, 2001</td>
</tr>
<tr>
<td>1</td>
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<td>2</td>
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<td>10</td>
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<td>11</td>
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<tr>
<td>Subsample 2: Jun 06, 2001-Jun 21, 2002</td>
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<td>Subsample 3: Jun 24, 2001-Dec 31, 2002</td>
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<td>9</td>
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<td>10</td>
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<tr>
<td>11</td>
</tr>
</tbody>
</table>

Sample stocks are sorted into eleven dynamic portfolios by their ratios of state shares every trading day. The first portfolio has no state shares and the next ten portfolios are formed as of equal number of stocks. The mean returns turn negative in the last two sub-samples, with increased volatility, skewness and kurtosis.

For dynamic or static portfolios based on other methods, the results are similar.
Table 5

Correlation of 11 Portfolios

<table>
<thead>
<tr>
<th>Subsample</th>
<th>Subsample 1</th>
<th>Subsample 2</th>
<th>Subsample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.94673</td>
<td>0.98522</td>
<td>0.98379</td>
</tr>
<tr>
<td>Std</td>
<td>0.0095077</td>
<td>0.002754</td>
<td>0.0042923</td>
</tr>
</tbody>
</table>

55 pairwise correlations among eleven portfolios are computed for each sub-sample. The average of pairwise correlations is computed by

$$\bar{\rho} = \frac{1}{55} \sum_{i=1}^{10} \sum_{j=i+1}^{11} \rho_{ij},$$

that is, mean of correlations of each sub-sample is calculated as the equally-weighted average of pairwise correlations of 11 portfolios.

Both Friedman and ANOVA tests report that the means of correlations are different among three subsamples by comparing three correlations vectorized from the lower triangle of the 11×11 correlation matrices. Further test by multiple comparison test shows that the means of pairwise correlations in subsample 2 and subsample 3 are not statistically different and they are significantly different from mean of correlations in subsample 1.

For dynamic or static portfolios based on other methods, the results are similar.
### Table 6

Cross-section Analysis I: individual stocks

<table>
<thead>
<tr>
<th></th>
<th>Panel A</th>
<th></th>
<th>Panel B</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average coefficient</td>
<td>FM t-Stat</td>
<td>Average coefficient</td>
<td>FM t-Stat</td>
</tr>
<tr>
<td>$c_0$</td>
<td>-0.0011596</td>
<td>-0.071695</td>
<td>-0.11439</td>
<td>0.021241</td>
</tr>
<tr>
<td>$c_1$</td>
<td>0.00024898</td>
<td>0.00024898</td>
<td>0.024072</td>
<td>0.076846</td>
</tr>
<tr>
<td>$c_2$</td>
<td>-0.12337</td>
<td></td>
<td>-0.12337</td>
<td>-0.09338</td>
</tr>
<tr>
<td>Adjusted R^2</td>
<td>0.001082</td>
<td>0.0008684</td>
<td>0.044254</td>
<td></td>
</tr>
</tbody>
</table>

Panel A: on every trading day, we regress returns of trading stocks (707 stocks listed on Dec, 31, 2002) on ratios of state shares of individual stocks:

$$ r_{it} = c_0 + c_1 r_{it} + c_2 r_{it} + \epsilon $$

where $y_{it}$ is the return of stock $i$ at trading day $t$, and $r_{it}$ is the ratio of state shares relative to total shares of stock $i$ at trading day $t$. $n_t$ denotes the number of stock at trading day $t$ and varies from 553 to 698 during the sample period. There are totally 477 trading days from January 2, 2001, to December 31, 2002. The t-statistics in Fama and MacBeth (1973) is reported, suggesting the regression coefficient of ratios of individual stocks is statistically zero.

Panel B: only for the subset of stocks that listed before year 2001 (562 stocks), we regress the returns of trading stocks on the ratios after controlling the stocks’ beta coefficients:

$$ r_{it} = c_0 + c_1 \cdot r_{it} + c_2 \cdot \beta_{it} + c_3 \cdot \beta_{it} + \epsilon $$

Following Scholes and Williams (1977), we estimate 3 betas for every stock corresponding to the 3 sub-samples. Each beta does not change over each sub-sample. The regression coefficient of ratios of individual stocks is still statistically zero after controlling for individual stocks' beta coefficients.

From the results of panel A and B, returns of individual stocks are unrelated with their ratios of state shares and thus the crash is likely to be homogeneous across different stocks.
Table 7

Cross-section Analysis II: 11 Portfolios

<table>
<thead>
<tr>
<th></th>
<th>$c_0$</th>
<th>$c_1$</th>
<th>$c_2$</th>
<th>$c_3$</th>
<th>Adjusted R-sqare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel A: $y_p^{(1)} - y_p^{(2)} = c_0 + c_1 r_p^{(1)} + e_p$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimated value</td>
<td>0.23176</td>
<td>-0.011333</td>
<td></td>
<td></td>
<td>-0.10324</td>
</tr>
<tr>
<td>p-value</td>
<td>2.56119e-006</td>
<td>0.805603</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panel B: $y_p^{(1)} - y_p^{(2)} = c_0 + c_1 \cdot r_p^{(1)} + c_2 \cdot (r_p^{(1)} - r_p^{(2)}) + c_3 \cdot (\beta_p^{(1)} - \beta_p^{(2)}) + e_p$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimated value</td>
<td>-0.13037</td>
<td>-0.29644</td>
<td>-0.31738</td>
<td>-0.43509</td>
<td>0.23677</td>
</tr>
<tr>
<td>p-value</td>
<td>0.026878</td>
<td>0.07601</td>
<td>0.12205</td>
<td>0.21743</td>
<td></td>
</tr>
</tbody>
</table>

Panel A: Sample stocks on the run are sorted by their ratios of state shares every trading day. The first portfolio has no state shares. The next ten portfolios are formed as 10% of the number of stocks, which makes the number of stocks most likely to be equal for each portfolio on every trading day. We regress the differences of the mean returns between the first two subsamples on the mean ratios of state shares in first subsample. There is no evidence that those portfolios with heavy state shares dropped more.

Panel B: Stocks listed before year 2001 are sorted in to eleven static portfolios by their ratios of state shares on June 6, 2001. The first portfolio includes 102 stocks without state shares on June 6, 2001. The next ten portfolios each have equal 46 stocks. The stocks for each portfolio do not change over the entire sample period. $y_p^{(i)}$ and $r_p^{(i)}$ are respectively the mean return and mean ratio of state shares of portfolio $p$ in $i$ -th subsample period, $\beta_p^{(i)}$ estimated by Scholes and Williams (1977), is the portfolio beta for $i$ -th subsample period. We regress return differences of static portfolios between subsample 1 and subsample 2 on mean ratios of state shares in subsample 1, ratio changes of state shares between subsample 1 and subsample 2, controlling for portfolios' beta coefficients. Again, there is no evidence that those portfolios with heavy state shares dropped more.
Sample period: Jan 01, 1997 to Dec 31, 2003. The Shanghai Share A Index and S&P 500 stands for stock markets of China and USA respectively. There are more crashes (if a daily price drops more than -5%) in Chinese stock market (13 times) than US market (3 times).
The quarterly GDPs of China show strong seasonality, however, the growth momentum persists.
Sample period: Jan 2001-Dec 2002. On Jun 6, 2001, the policy was announced. On Oct 23, 2001, the policy was suspended. On Jan 26, 2002, the policy was resumed. On Jun 24, 2002, the policy was permanently terminated.
Figure 4

Estimated density of the market return

With a kernel smoothing method, the estimated density (solid) is different from normal (dashed).
The four trading days in increasing regime with probability 1 are: Oct 23, 2001; Jan 23, Jan 31, and Jun 24, 2002.
Figure 6
The Percentage of State Shares

The upper figure is the histogram of the number of stocks for each percentage of the state shares on Jan 2, 2001. There are 562 listed stocks totally at the beginning of sample period. Among them, 100 stocks without state shares are not shown in the figure.

The lower figure is the histogram of the number of stocks for each percentage of the state shares on Dec 31, 2002. The listed stocks have increased to 707 at the ending of sample period. Among them, 121 stocks without state shares are not shown in the figure.

Generally, the percentage of state shares is between 30% and 80%.
There is a family of expected demand curves, or so-called r-demand curves or quasi-demand curves, assuming downward sloping. $p^e$ is the price expected by long-term investors and $r \in [0, 1]$ is the expected ratio of state shares reduced. The textbook demand curve is one of them which has $r=0$. The r-demand curve shifts left as $r$ increases, implying less liquidity provided by long-term investors.
Figure 8

An inverted-S actual demand curve: intuitive sketch

The actual aggregate demand curve folds over itself, forming an inverted-S shape. It coincides with the part upper than point E of 0-demand curve (that is the r-demand curve without sale of state shares) and also coincides with the part lower than point F of 1-demand curve (that is the r-demand curve with sale of total state shares). The actual demand curve is upward slopping between point E and F. At any such point, rational panics is satisfied in the sense that for quantity OA, AB/AC, the ratio of expected price of long-term and short horizon traders is consistent with expected ratio of state shares reduced, r.
Assume that long-term investors are homogeneous so that there exists a representative investor. The long-term representative investor has a state-share-averse utility, which is a constant absolute risk-aversion (CARA) preference with state-dependent beliefs regarding the unknown wealth loss conditional on the policy aimed at reduction of state shares. We assume that linear forms for expected demand and expect supply. A min function is used to present rational expectation. Under the following values of parameters, 

\( (\mu, \lambda, \sigma, \gamma, a, b) = (6.30, 1.15, 0.426, 0.3, 5.50, 19.7) \),

we can get the above piecewise linear actual demand curve. The shape of this numerical curve demonstrates the existence of the inverted-S demand curve. Note that the price is normalized to unit at point E, the leftward turning point of the actual demand curve.
Figure 10
The state-share paradox

(a) Before the crash
After the policy announcement on June 6, 2001, the supply curve shifts to the right and becomes more inelastic. There are three levels of demand that would intersect with supply curve: H, I, and G, which gives rise to multiple equilibria. The demand that actually occurs is at H before the crash.

(b) The crash
While the actual aggregate supply curve shifts right further to pass the critical point E in July 2001, the market “catastrophe” occurred. At that point, a new low-price equilibrium, L, was established.
Figure 11

Solutions to the paradox

(a) After the crash
The government's restructuring efforts imply the possibility of multiple equilibria (M, K and N). However, because the crash moved the demand level down to the lower equilibrium price N, the government's efforts are insufficient to induce the necessary price jump out of the liquidity black holes. The lower level, stable equilibrium explains why the stock prices remained at a paradoxically low level, even after the policy was removed in June 24, 2002.

(b) Theoretical Recovery
One way for an upward jump in prices to be achieved is through a large shift of the demand curve to the right, so that another critical tangential point F is on the right of the supply curve. This solution would be infeasible as the infusion of large quantities of government funds violates the original intent and might enlarge the liquidity black holes.