Rational Panics, Absorbing Regime Switching And Stock Market Crashes: Empirical Evidence From The State-Share Paradox[1]

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ABSTRACT

A government policy regarding the reduction of state shares in state-owned enterprises (SOE) triggered a crash in the Chinese stock market. The sustained depression even after policy adjustments constitutes a puzzle—the so called "state-share paradox." The empirical evidence shows that the sustained depression is supported by a regime switching model with an absorbing state. The theoretical explanation developed in this paper arises from the concept of rational panics, which generates an inverted-S actual demand curve and gives rise to potential multiple equilibria. Rational panics hypothesis in this paper suggests that the dual pricing system and the quota on the overall stock supply represent major policy failures.

Keywords: Chinese Stock Market, Market Crash, and Inverted-S Demand Curve.

(JEL G18, E65, O16)

1 Introduction

The phenomenon of crashes has long puzzled both participants and observers of stock markets. The challenge is to explain sharp price drops triggered by relatively important new events. Moreover, the stock market can remain low for a substantial amount of time without immediately bouncing back. Empirically, this is consistent with regime switching with an absorbing state. Theoretically, a recent approach interprets crashes as alternating realizations of multiple equilibria.

The Chinese stock markets have seen much more crashes than those in the mature markets. A government policy regarding the reduction of state shares in state-owned enterprises (SOE) triggered a crash in the Chinese stock market. The sustained depression even after policy adjustments constitutes a puzzle—the so called "state-share paradox".

The rest of the paper is organized as follows: institutional background are discussed 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 market return. Section 4 investigates a theoretical hypothesis to explain the empirical evidence. An inverted-S demand curve is constructed. Multiple equilibria and the resulting large drop in prices arise from government intervention. It also discusses different attempted policy changes and their implications for understanding policy traps. Section 5 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

Right from the start, the Chinese stock market adopted a strict 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 social capital. The actual management method used to control issue volume after 1993 was through the Chinese 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 enterprises and key enterprises, 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 16 March 2000, the CSRC announced the abolishment of the quota system and began moving in the direction of a listing approval system. Yet, while the government terminated the use of explicit quotas, asymmetric information between the state and the public about the supply of total stock shares remained as an implicit limit.

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 can not 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. Over the last few years, using various methods, attempts have been made to reduce the number 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 (SEOs). 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, broadening share ownership or improving corporate efficiency.

Unfortunately, the forced inflow of lower-value state shares sold on the market diluted the price of publicly-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 continued into October. The closing indexes of the Shanghai and the Shenzhen securities exchanges tumbled 32% and 37% respectively by October 22, 2001 (Figure 1).

On October 23, 2001, the CSRC announced the suspension of measures to reduce the holdings of state shares. The closing indexes increased 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% 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 up 10%. 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".

3 Empirical Evidence

Figure 1 depicts that the closing prices of the Shanghai A share index fluctuated from January 2, 2001 to March 5, 2003, based on the news of policy changes. The salient features of this crash are as follows: (1) The sharp price changes are triggered by important news; (2) The market jumped down discontinuously but did not jump down immediately as the negative news was announced; (3) Price movement is asymmetric: upward jumps are more significant than downward jumps after policy adjustments were made; (4) The market has been locked in the same kind of decreasing trend in spite of positive news.

Most financial studies involve returns, instead of prices index. Figure 2 shows time plots of daily log returns of shanghai stock market. The following regime switching model is chosen to fit return data:

$$y_t = \mu_{s_t} + \varepsilon_t \qquad \varepsilon_t \sim NID\left(0, \sigma^2_{s_t}\right) \qquad s_t = 1, 2$$

The estimated result is shown in table 1.

Note that the transition probability p_{ij} gives the probability that state i will be followed by state j. p_{11} is significantly close to 0 while p_{22} is significantly close to 1. Thus $s_t = 2$ can be regarded as an absorbed state. Also note that $\mu_2 = -0.1\%$. 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 $\mu_1 = 7\%$ while $\mu_2 = -0.1\%$. 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. Indeed, policy adjustments triggered large upward jumps, but momentum of the upward drive was quickly sapped and it followed a longer process with relatively small jumps to return to depressed levels.

how to explain the largest jump which is downward jump corresponding to original policy announcement? We may take a further look at section 4.2.

Finally, it seems that the regime switching model cannot cover all stylized facts of the crash. There is no information why market did not jump down immediately as the negative news was announced.

4 Rational Panics Hypothesis

In this section, an explanation will be developed to be consistent with institutional background and empirical evidence. The explanation arises from the concept of rational panics, in which expected demand and supply turn out to be interdependent. This innovation generates an inverted-S actual demand curve and gives rise to potential multiple equilibria. The hypothesis in this section suggests that the dual pricing system and the quota on the overall stock supply represent major policy failures.

4.1 An Inverted-S Demand Curve

The demand curve for a good is typically downward sloping with respect to price of that good. Recall that derivation of the demand curve is based on a representative consumer who works out the quantities demanded by maximizing his utility, taking prices as given. This assumption becomes unrealistic if the consumer does not, in fact, take the offering price for granted.

In the Chinese 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 state acquires state-owned shares at book value—say, one dollar; however, the market price of the public shares offered to contemporaneous public investors is much higher than book value—say, five dollars. 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 dollars of the total five million dollars (one million shares, valued at five dollars each) would be taken by the government. The SOE thereby only receives 4.5 million dollars on a five-million-dollar offering. Ultimately, because of remittances to the government, the SOE only realizes a portion—here, 90%–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. However, it is important to

note that in reality the aggregate supply of public shares is unchanged at one million 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 dollars. 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 publicly-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 can be illustrated in a static model. Define a demand function $D(p^e, r)$, where D is aggregate demand, p^e is defined as the price expected by public 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 $p^e(D, r)$ is continuously differentiable with respect to r, then $\frac{\partial p^e}{\partial r} < 0$. Note that, for each $r \in [0, 1]$, we can draw a demand curve $D = D(p^e, r)$. We shall call each such curve a "quasi-demand curve" or "r-demand curve". Figure 2 illustrates a family of r-demand curves, assuming usual downward sloping. The textbook demand curve is the relation between and r with $D(p^e, 0)$, which is shown as in Figure 2. We can see that the demand curve shifts left as r increases, implying that the expected price decreases for a fixed quantity $\hat{D}$, $p^e(\hat{D}, r') < p^e(\hat{D}, r) < p^e(\hat{D}, 0)$ if $r' > r > 0$.

Our goal is to construct the "actual aggregate demand curve" from the r-demand curves. This will depend on interaction between demand and supply. Let us suppose that the aggregate supply for stock is the usual upward sloping function of offering price p, denoted by $S(p)$. As mentioned before, the aggregate supply of state shares remains unchanged. As shown in figure 3, the supply curve intersects each r-demand curve. Once state shares are sold, the expected price of investors is lower than the price offered by SOE. Define the ratio between two prices as a strictly decreasing function of r,

$$\frac{p^e}{p} = f(r), \frac{\partial f}{\partial r} < 0$$

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 investors is AB and the offering price of SOE 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 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 investors expect the price to

be p^e, then their demand would be point B, such that their rational panic is 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 0-demand curve (that is the r-demand curve without sale of state shares) to the left of the supply curve. This is because at any such point, the expected price of investors exceeds the offering price. This implies that at these points there are no panics, only manias.

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 investors and SOE. The divergence increases as the expected proportion of state shares sold increases. This model differs from the models of Gennotte and Leland (1990) and Barlevy and Veronesi (2003), in which inverted-S demand curves were derived using asymmetric information and misinterpretation among heterogeneous investors

4.2 Government Intervention and Multiple Equilibria

Suppose $S(p)$ in figure 3 represents the supply for the stock. E represents the only point of equilibrium. The equilibrium price at point E is p^*. It should be emphasized that the inverted-S demand curve is derived based on upward sloping (expected) supply curve. However, the actual aggregate supply curve of public shares is vertical, since there is an implicit overall quota controlled by the CSRC.

Figure 4 shows the government-implemented aggregate supply curve is vertical. Observe that if the supply curve is perfectly inelastic and quantity was originally at F, there are three levels of demand that would satisfy rational panics: H, I, and G, as shown in figure 4(a). Among these points, H and G are stable equilibrium points while I is unstable one. Suppose the demand that actually occurs is at H before the crash.

In figure 4(b) the government announces the policy regarding the reduction of state shares. While, this does not change the aggregate supply, the actual aggregate demand curve shifts left because the panic is more severe than when the state shares were actually sold. Although the worsening panic is not earthshaking, based on the amount of state shares reduced, but it is enough to eventually shift demand a fractional amount further to the left of the aggregate supply 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 demand curve getting closer to, but not yet reaching the critical point E, which is tangent to the vertical supply line. Once this point was passed in July 2001, the market "catastrophe" occurred. At that point, a new low-price equilibrium, L, is 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 5(a), none of these so-

lutions have been successful. A potential small rightward shift of the demand curve, gained through the suspension of the policy will lead to a small increase in the equilibrium price. Discounting of the price of state shares might lead the upper branch of the demand curve to intersect the supply curve. The permanent removal of the policy might bounce the demand curve back to the original demand level. Indeed, 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, which is locally 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. 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 local 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 5(b), one way for an upward jump in prices to be achieved is through a large shift to the left of the supply line, such that the lower branch of the demand curve passes another critical tangential point, E'. This could be done through the reduction of the implicit quota on public shares. However, if the supply curve moves too far to the left, additional privatization of SOE's will become more difficult. Fewer enterprises will be transformed and reform will slow.

A similar effect could be achieved through a large shift to the right of the demand curve. This solution might be accomplished through the infusion of large quantities of government funds. 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, both large shifts would be difficult to induce.

The smarter solution might 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.

Another solution might be an attempt to increase the slope of the supply curve in accordance with investor expectations. In terms of policy, this implies the elimination of the implicit quota system, greater transparency of aggregate supply, and an increased symmetry of information between the government and the investor.

5 Conclusions

The model developed in this paper explains the crash of the Chinese stock market. Empirically, the regime switching model with an absorbing state can characterize the paradox partially–which can explain sustained depression but cannot explain delayed crash mechanism. Theoretically, rational panics hypothesis is proposed and the crash is explained in terms of irregular demand and supply curves—an inverted-S demand curve and a vertical supply. These irregularities are blamed on the dual pricing system and the quota on overall stock supply, which represent major policy failures and are the key to explain the state-share paradox. The policy implications of this modeling suggest a removal of these types of irregular pricing schemes.

It is important to point out that this modeling technique can be developed into a more general theoretical framework. One implication is that the integration of dual-pricing market systems into unique-pricing markets tends to be followed by booms and crashes. Other applications could include currency area, financial liberalizations/contagions, and openness of market during international trade.

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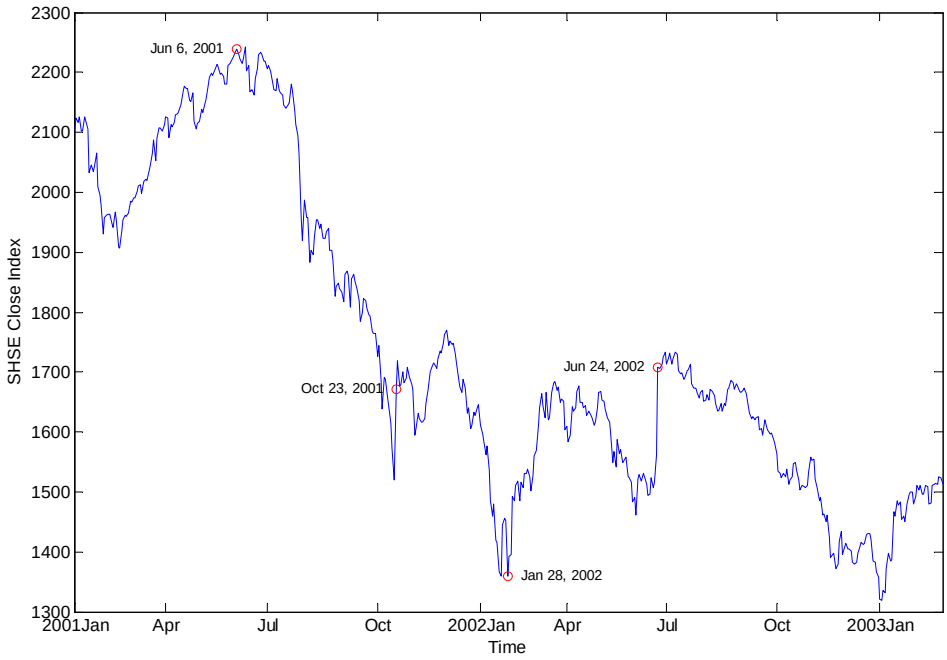
Table 1: Empirical Result of Regime Switching Model

Parameter	Estimated Value	Standard Error
μ_1	7.09	1.17
μ_2	-0.136	0.0555
σ_1^2	2.97	2.21
σ_2^2	1.59	0.156
p_{11}	1.05e-010	0.119
p_{22}	0.989	0.00492

FIGURE 1

The closing index of the Shanghai securities exchange, January 2001-March 2003



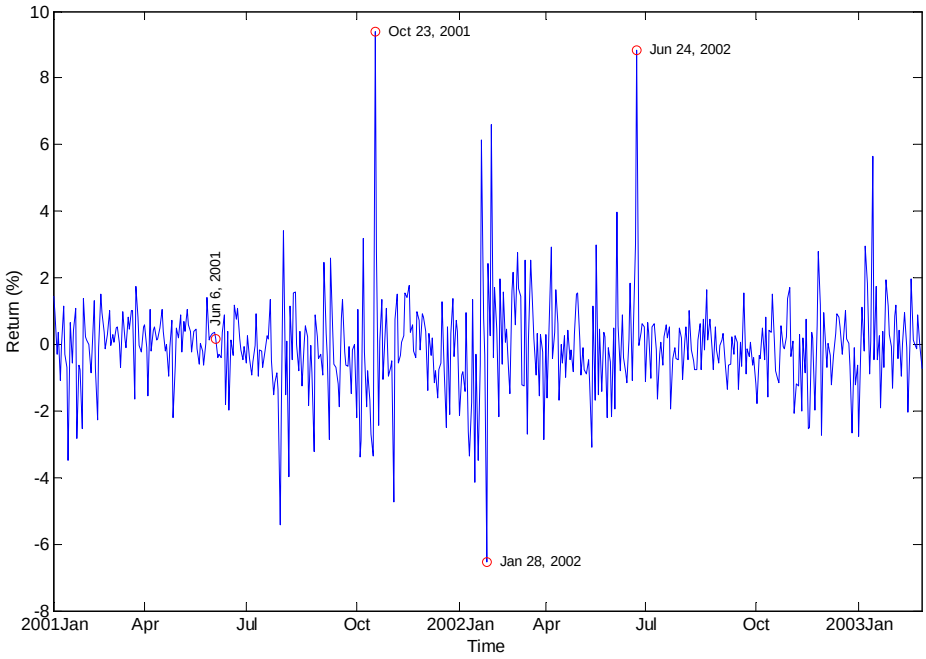


FIGURE 2

A family of expected demand curve of public shares

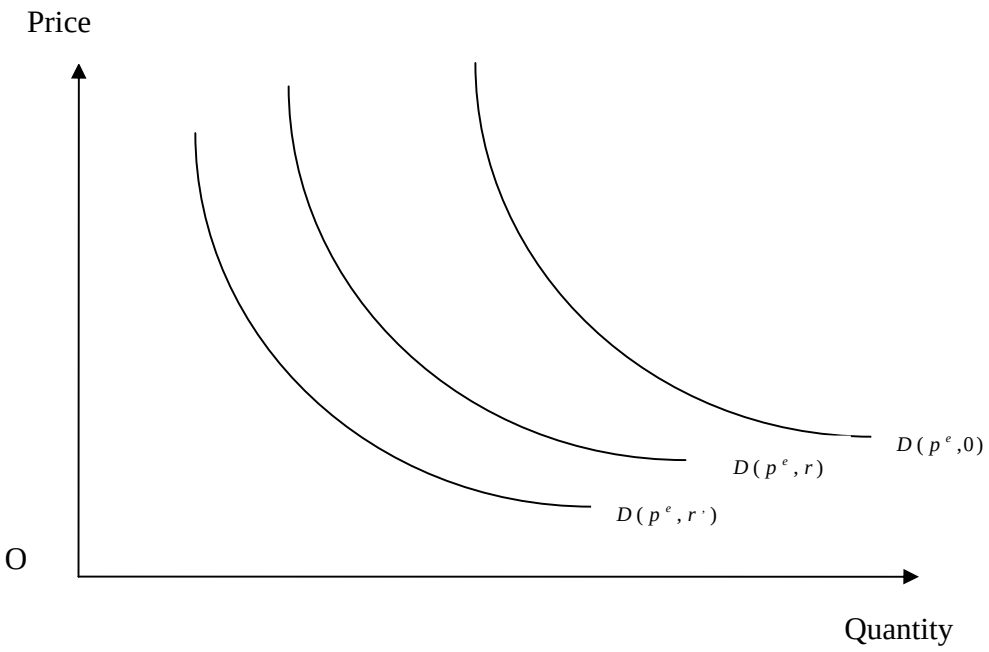


FIGURE 3

An inverted-S actual demand curve of public shares

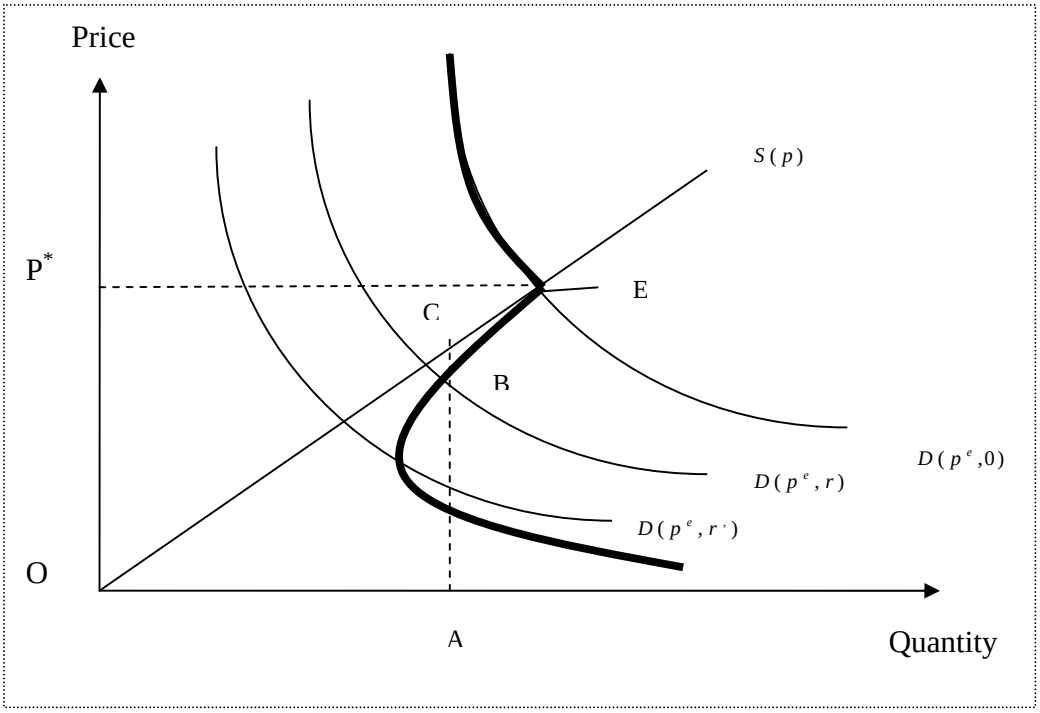
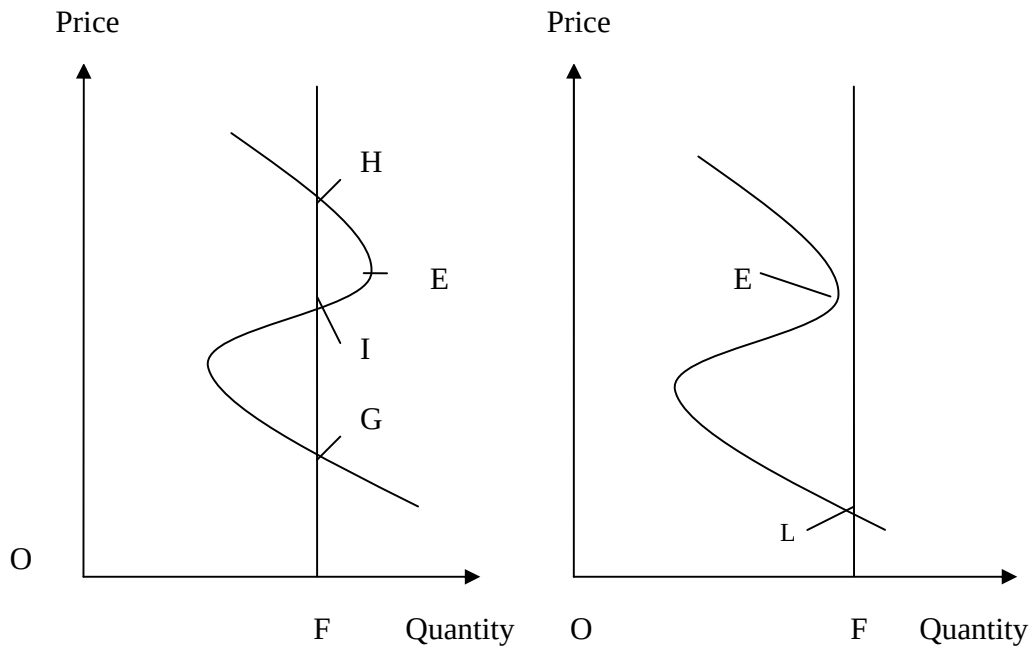


FIGURE 4

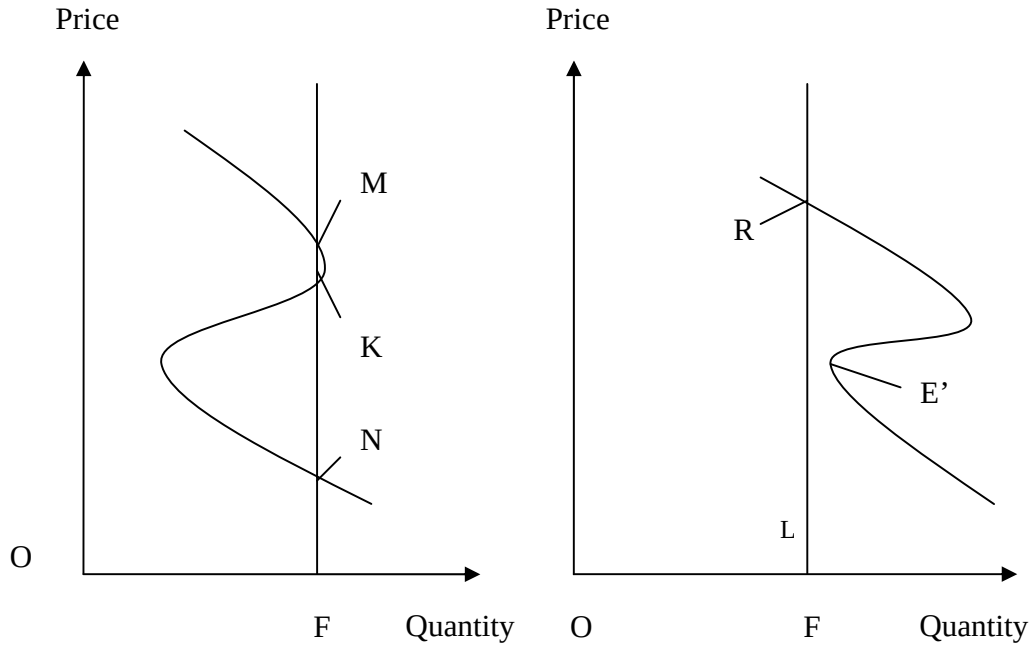
The state-share paradox



(a) Before the crash (b) The crash

FIGURE 5

Solutions to the paradox



(a) After the crash (b) Theoretical Recovery