IMF Economic Review (2019) 67:349–394
https://doi.org/10.1057/s41308-019-00079-z

RESEARCH ARTICLE

Saving China's Stock Market?

Yi Huang[1,2] · **Jianjun Miao**[3,4,5] · **Pengfei Wang**[6]

Published online: 9 April 2019

Abstract

We estimate the value creation for the stocks purchased by the Chinese government between the period starting with the market crash in mid-June of 2015 and the market recovery in September. We find that the government intervention increased the value of the rescued non-financial firms by RMB 206 billion after netting out the average purchase cost, which is about 1% of the Chinese GDP in 2014. The short-term value creation came from the increased stock demand, the reduced default probabilities, and the increased liquidity. The intervention may come at a long-run cost of creating moral hazard, preventing price discovery, creating more uncertainty, and damaging government credibility.

JEL Classification G14 · G15 · G18

Electronic supplementary material The online version of this article (https://doi.org/10.1057/s41308-019-00079-z) contains supplementary material, which is available to authorized users.

✉ Jianjun Miao
miaoj@bu.edu

Yi Huang
yi.huang@graduateinstitute.ch

Pengfei Wang
pfwang@ust.hk

1 Graduate Institute, Geneva, Maison de la paix, Chemin Eugene-Rigot 2, 1202 Geneva, Switzerland

2 CEPR, Washington, DC, USA

3 Department of Economics, Boston University, 270 Bay State Road, Boston, MA 02215, USA

4 ICFS, Southwestern University of Finance and Economics, Chengdu, China

5 CEMA, Central University of Finance and Economics, Beijing, China

6 Department of Economics, The Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong

1 Introduction

From mid-June to early July of 2015, the Chinese Shanghai Stock Exchange Composite Index (SSECI) plunged by 32%, wiping out more than RMB 18 trillion in share value from its June 12 peak.[1] The value lost was equivalent to about 30% of China's GDP in 2014 and about 20% of the US GDP in 2014. The Shenzhen market, which has more tech companies and is often compared to the US Nasdaq index, was down 41% over the same period.

This large stock market crash produced widespread panic and pushed the Chinese government to implement a range of rescue policies. In addition to halting IPOs, restricting short selling, and restricting share sales by large shareholders, the Chinese government directly or indirectly participated in stock market trading. In particular, the China Securities Finance Corporation Limited (CSF) lent money to 21 brokerages for them to buy stocks in the stock markets.[2] Moreover, the CSF and China Central Huijin Investment Limited (CCH),[3] the so-called national team, also directly purchased stocks of more than 1000 firms starting from July 6, 2015.

In this paper, we study the following questions: Did the government intervention create value? If it created value, where did the value added come from? These questions are important for policymakers and investors, but have not been studied in the academic literature.

To answer these questions, we estimate the costs and benefits of the government's purchases of stocks during the period from July 1 to September 30, 2015. We focus on the national team instead of the brokerages due to data availability. The national team continually purchased stocks starting from July 6, but we do not observe its daily trading behavior. We can only observe the national team's share holdings of the rescued firms from the firms' quarterly balance sheets. From the balance sheets in the second and third quarters of 2015, we can infer the net purchases by the government during that period.

Given the global turbulence in financial markets during the period from July 1 to September 30, it is impossible to estimate the systemic effects of the government intervention. However, it is possible to estimate its effects on the rescued firms in comparison with the non-rescued firms. To compute the intervention's effects on the value of these firms, we do not limit ourselves to the changes in the value of common stocks, but we study the changes in the entire enterprise value by also studying changes in the value of existing debt.

We use the capital asset pricing model (CAPM) of Sharpe (1964) to compute the effects on equity value and use the Merton (1974) model to compute debt value. We find that the abnormal variation in the market value of common equity is RMB 113

[1] Based on the exchange rate on June 30, 2015 (RMB 6.11 per US dollar), the loss is roughly 3 trillion US dollars.

[2] The CSF was established in 2011 to lend to securities brokerages to support margin lending to stock investors.

[3] The CCH is a wholly owned subsidiary of China Investment Corporation, with its own board of directors and board of supervisors. It is an organization by which the Chinese government can act as a shareholder for the big four state-owned banks and some other banks.

billion. To separate the effect of the government purchase from that of other events occurring at the same time, we control for the change in debt value of non-rescued firms. This difference-in-difference approach gives the estimate of the total increase in debt value due to the government purchase. We find that the increase is RMB 3169 billion. Adding up the increase in equity value and debt value, we obtain that the enterprise value of the rescued firms increased by RMB 3282 billion.

This increase might come at a cost to the taxpayers. To estimate this cost, we compute the difference between the purchasing value and the holding value on September 30, 2015. Since the government continually purchased stocks during the period between July 6 and September 30 and since we do not observe its daily trading behavior in the data, we estimate its purchasing cost by computing the product of the government's net share holdings of the rescued firms and the estimated purchase price. We consider three estimates of the purchase price using the average price, the highest price, and the lowest price between July 6 and September 30. We find that the corresponding actual costs are RMB 321.9, 818.6, and − 119.8 billion, respectively. Subtracting these costs, we obtain that the value created by the government purchases is RMB 2960, 2464, and 3402 billion, respectively. This value is between 4 and 6% of China's stock market capitalization on June 30, 2015, and about 5% of China's GDP in 2014.

To control for firm characteristics and the number of shares purchased by the government institutions, we re-estimate value gains based on regressions. Because of the data availability, we have to focus on a subsample of non-financial firms after dropping about 300 firms and find that the value created by the government purchases is RMB 410 billion, compared to the corresponding model-based estimate of RMB 2425 billion for all non-financial firms. After netting out the average cost of purchasing the non-financial firms, we find that the regression-based estimate is about RMB 206 billion, which is less than 1% of China's stock market capitalization on June 30, 2015, and about 1% of China's GDP in 2014.

Where did this created value come from? What issues did the government purchase help to resolve? To answer these questions, we study the cross section of more than 1000 rescued firms. We find that the value creation came from three major sources. First, the government purchase increased the demand for shares and raised equity value (or reduced the loss of equity value), thereby raising investors' confidence. Second, the government purchase reduced default probabilities of the rescued firms and hence raised their debt value. Third, the government purchase raised liquidity of the rescued firms. We compute default probabilities using the Merton model and measure illiquidity using the Amihud index (Amihud 2002). We regress changes in firm value, changes in default probabilities, and changes in illiquidity between June 30 and September 30, 2015, on the shares purchased by the government after including a number of control variables. We find that the coefficients are significant and have the right signs.

Our paper contributes to the literature by providing the first analysis of the costs and benefits of the government purchase during the China's stock market crash in the summer of 2015. Our paper is related to Veronesi and Zingales (2010) who analyze the costs and benefits of the US government intervention (Paulson's plan) during the financial crisis of 2008. Our analysis is different from theirs in that the nature

of the intervention in the two countries is different. The Chinese government directly purchased shares of more than 1000 firms, while the US government provided $125 billion preferred equity infusion in the nine largest US commercial banks joined by a 3-year government guarantee on new unsecured bank debt issues. Our methodology is similar to, but different from theirs. Veronesi and Zingales (2010) use the credit default swap rates to estimate debt value and default probabilities. But the data of these rates are not available in China. Instead, we use the Merton model to estimate debt value and default probabilities. Importantly, since the Chinese government purchased shares of more than 1000 firms, we can conduct cross-sectional regressions to analyze the effects of the government purchase. But Veronesi and Zingales (2010) do not conduct a cross-sectional regression analysis because they have a very small sample size.

Unlike Veronesi and Zingales (2010), who can exploit daily returns and credit default swap rates to conduct a clean event study, we only have quarterly data of government purchases. Thus, we cannot directly examine the effects of a number of other measures taken by the government and its role during the bubble formation period leading to the stock market crash. Moreover, the quantitative analysis is inconclusive in terms of understanding possible longer-term effects of these unprecedented measures, including potential costs and further frictions in the market.

Our paper is also related to Cheng et al. (2000) and Su et al. (2002), who study the effects of the Hong Kong government intervention on the stock market and the futures market during the height of financial crisis in 1998. Similar to the Chinese government intervention, the Hong Kong government directly intervened in the stock market by spending a total of HK $118 billion (or US $15 billion) to purchase the shares of the 33 constituent stocks of the Hang Seng index. In an article published in the Asian Wall street Journal on August 20, 1998, Joseph Yam, the Chief Executive of HKMA stressed that the government intervention was necessary to deter currency manipulators who had repeatedly engaged in a double-play manipulation by shorting the Hong Kong dollar to stir up interest rate in the interbank market, while holding a large shorting position in Hong Kong stock futures to reap profit of the Hang Seng index. The Hong Kong intervention appears to be successful. Cheng et al. (2000) find that the government intervention indeed reduced the profit of speculation in the options and futures in Hong Kong. Su et al. (2002) show evidence that government purchases were successful in supporting and stabilizing the prices of the purchased stocks. None of these two papers apply the Merton method to estimate the impact on debt value.

The HKMA did not disclose detailed information about most of its holdings of Hong Kong firms as it was afraid that this information would assist speculators. Thus, one cannot conduct a complete analysis of the benefit and cost of rescued firms. The stocks acquired in the HKMA's August 1998 market intervention were eventually transferred to a private limited company, the exchange Fund Investment Limited, and were sold back to the public by initial public offering.

The Chinese stock market crash in 2015 has spurred a growing literature to investigate the possible causes and consequences of the crash (see Song and Xiong 2018 for a survey). Many studies have pointed out some regulations and trading restrictions, which are intended as a market stabilizer, have unintended destructive

consequences. Examples include the daily price limits (Chen et al. 2017a), trading suspension (Liu et al. 2017), and circuit breakers (Chen et al. 2016). Others find that leverage plays a crucial role during the market crash. For example, Bian et al. (2017b) find that marginal investors are forced to resell during the market crash and Bian et al. (2017a) find that leveraged investors can cause price downturn contagion. These studies indicate that the plunge of the individual stock prices can generate pecuniary externalities through fire-sale contagion and market-wide liquidity dry-up. Thus, government intervention can create value by partially correcting these pecuniary externalities.

We should emphasize that the government intervention may have long-run costs. For example, it may cause moral hazard, prevent price discovery, create more uncertainty, and damage government credibility. We will provide more discussions on this issue in the concluding section.

The rest of the paper proceeds as follows: Section 2 describes the Chinese stock market crash in the summer of 2015 and the government intervention. Section 3 provides an estimate of the costs and benefits of the government intervention. Section 4 studies the heterogeneous effects of the government intervention by conducting a cross-sectional regression analysis. Section 5 provides a robustness analysis. Section 6 concludes.

2 The Chinese Stock Market Crash and Government Intervention

2.1 A Chronology: 07/01/2014–9/30/2015

In this section, we briefly describe the chronology of the Chinese stock market from July 1, 2014, to September 30, 2015. Since our study focuses on the short-run effects of the government rescue plan implemented in July 2015, we will not discuss the events happened after September 30, 2015. Figure 1 summarizes the chronology.

Since the global financial crisis in 2008, the Chinese stock market was in the bear market until July 2014.[4] Starting from July 1, 2014, to June 12, 2015, the Chinese stock market skyrocketed and the SSECI rose from 2050.38 to 5166.35, a 152% increase. This bull market was due to four factors. First, the third Plenum of the 18th Communist Party of China Conference declared that China would continue to reform. In particular, China would promote a mixed-ownership economy by diversifying the shareholding structure of the state-owned enterprises (SOEs). Since many listed firms are state-owned, this policy boosted the stock market. Second, the Chinese central bank (People's Bank of China, PBC for short) conducted loose monetary policies. In particular, on November 22, 2014, the PBC cut the loan rate by 40 basis points and the deposit rate by 25 basis points for the first time since July 2012. On February 5, 2015, the PBC lowered the required reserve ratio by 50 basis points to 19.5% for the first time since May 2012. On March 1, 2015, the PBC cut

[4] See Allen et al. (2015) for a study on the disconnection between China's economic growth and the stock market performance.

Fig. 1 A chronology of China's stock market

the benchmark interest rate by another 25 basis points. Third, new investors kept flooding into the stock market. Many people with little financial knowledge entered the market with the false belief that they could easily make quick and big money. Optimistic beliefs were prevalent in the market.

Fourth, a bull market was at least welcomed if not favored by regulators. After the financial crisis in 2008, China started unprecedented fiscal stimulus through bank/shadow lending. As a consequence, many state-owned companies and local governments were deeply in debt (Huang et al. 2016; Chen et al. 2017b). The total corporate debt-to-GDP ratio rose to 133%. Facilitating equity finance was considered helpful to address the increasingly pressing debt problem. On May, 2014, the state council published "Several Opinions on Further Facilitating Healthy Development of Capital Markets." One of the important objectives was to accelerate the development of multiple levels of stock markets.

A steady healthy bull market clearly would help corporations to raise equity from the stock market. Indeed, equity financing grew more than 60 percent in 2014. And in the first 6 months of 2015, the total equity finance was 18 percent higher than that in 2014. The most important official newspaper, People's Daily, declared on April 10, 2015, that 4000 index points were merely the start of a bull and encouraged investors to place their trust, and savings, in the stock market. However, unlike before, the bull market was fueled by margin financing, which was only authorized in 2011. As the stock market kept rising, the demand for margin financing rose. Many brokerages violated the government regulation by loosening the lending standard. In a series of studies,[5] Miao, Wang, and their coauthors show that leveraged borrowing

[5] See Miao and Wang (2012, 2014, 2015, 2018), Miao et al. (2015a) and Miao et al. (2015b).

can generate a stock market bubble and the collapse of bubbles will cause a financial crisis and an economic recession. In fact, many market observers warned that a stock market bubble already formed in May 2016.

The China Securities Regulatory Committee (CSRC) became concerned about the rapid increase in margin financing and started investigating brokerages in December 2014. Three major brokerages were forbidden to open new margin accounts for 3 months. This caused many investors to turn to fund-matching companies, which provided unregulated margin loans to traders. These companies permitted much lower entry barrier and much higher leverage. Another form of unregulated leverage was through umbrella trusts. An umbrella-trust investor effectively obtained financing from the retail savers who bought wealth management products at banks.[6] Umbrella-trust companies acted as financing vehicles that charged high fees by offering larger leverage ratios than regulated brokerages.

As the banking sector was channeling money into the stock market by unregulated umbrella-trust companies, the CSRC was worried about the risk involved. In particular, the collapse of a stock market bubble could create massive margin liquidation, which would damage banks' balance sheets, leading to a financial crisis. To avoid this risk, the CSRC issued a very strong regulation order on June 13, 2015, that banned all security companies from providing facility for off-market or shadow margin lending, which was estimated to be in the range of RMB 500–1600 billion. To the surprise of the government, the SSECI lost 13.1% between June 15 and June 19, the largest weekly loss since 2008. Investors panicked and the market continued to drop. On June 26, the SSECI plummeted by 7.3% and 2312 among the 2,763 total publicly listed stocks fell by 10%, hitting the lower limit.[7] Investors with a leverage ratio of 10 at fund-matching companies first went bust. Their portfolios were liquidated, expediting the fall of stock prices. The forced liquidation spread to umbrella trusts, which allowed a leverage ratio of 3, and then to the margin accounts in regulated brokerages, which allowed a maximal leverage ratio of 2. This generated a liquidity spiral as described in Markus and Lasse (2009).

On June 26 the PBC cut the interest rate for the fourth time by 25 basis points and the required reserve ratio by 50 basis points. The stock market briefly rebounded a little. But between June 29 and July 3, 2015, the SSECI lost another 12.27% in five trading days. Within just 3 weeks, the SSECI lost 28.6%. On July 4 (Saturday), Premier Li Keqiang held a State Council Meeting by convening 21 major brokerages, 25 mutual fund companies, and major regulators. Right after the meeting, 21 brokerages announced a joint RMB 120 billion purchase plan to purchase blue-chip ETFs and alleged not to sell them when the SSECI was below 4500 points. On July 5, the CSRC announced that IPOs of 28 companies would be suspended and the PBC would provide financing for the CSF. On the night of

[6] See Acharya et al. (2016) for a study on the wealth management products in China.

[7] Under the CSRC regulations, any listed stock must be traded at prices within a lower limit and an upper limit in any trading day. The lower (upper) limit is the price level 10% below (above) the close price in the previous trading day.

July 5, the CCH announced that it had purchased ETFs in the past few days and would continue to purchase in the stock market.

On Monday, July 6, the SSECI opened up 7.8% higher than the previous close, but then declined again with only 2.41% up at the close. More than 900 stocks, which accounted for 42% of total stocks, dropped by 10%, and closed at the daily lower limit. The CSF was reported to start buying big blue chips in the afternoon session.

On July 7, the SSECI lost 1.3% and on July 8, the SSECI lost another 5.9%, with about one-third of all listed companies suspending trading and 915 of remaining stocks closing at the daily lower limit. From June 15 to July 8, the SSECI lost 32.1%. Retail investors lost a lot of money and the balance sheets of the brokerages and state-owned banks were in danger. Investors were in panic and a financial crisis might be imminent.

At this critical moment, the Chinese government reached a consensus on rescuing the stock market. A number of measures were taken:

- The PBC announced officially that it would provide liquidity to the CSF.
- The State-owned Assets Supervision and Administration Commission required SOEs not to sell stocks.
- The CCH pledged it would not sell shares.
- The CSF announced it would provide RMB 260 billion margin loans to finance stock purchases by the 21 brokerages.
- The CSRC banned large shareholders with 5% of holdings or above from selling stocks in the next 6 months.
- China Banking Regulatory Commission allowed more flexible mortgage terms of share-secured loans.
- The China Insurance Regulatory Commission relaxed insurance companies' restriction in holding stocks.
- The China Financial Futures Exchanges increased the margin requirement of the CSI 500 index futures further from 20 to 30%.
- The CSRC and the Ministry of Public Security initiated joint investigation on rules-breaking short sellers and rumor makers.

On July 9, the market rebounded and the SSECI gained 5.8%. The market temporarily stabilized until August 11 when the PBC unexpectedly weakened the RMB, lowering its official exchange rate by almost 2%. Although the PBC stated that it was a move toward the market determination of the exchange rate, many interpreted that the devaluation reflected the PBC's increasing concern of the weak economy. The stock market responded by losing 28.33% from August 12 to August 26. On August 25, the PBC cut the interest rate by 0.25%. There were no other measures announced to further stabilize the stock market by the Chinese government. It was widely believed that this might be due to the fact that the Chinese government was tied by intervening in the foreign exchange market. It is possible that the national team purchased stocks during this period, but this information is not available in the public data.

2.2 Summary Information About Purchased Stocks

After a dramatic drop in the stock market in mid-June 2015, the Chinese government started purchasing stocks from the first week of July. The purchases were conducted primarily through two state-owned investment companies, the CSF and the CCH.[8] In our sample, we first collect all the information about the top ten largest shareholders of all Chinese stocks and then manually match the names of the CSF and the CCH with the list of shareholders from companies' quarterly reports between Q2 and Q3 of 2015. We define our sample to include the stocks which were purchased by the government and match them with their balance sheets, market prices, market returns, and fundamental performance information.

We find that, by the end of September 2015, the CSF and the CCH together invested in 1365 stocks in the Chinese stock market, which accounted for about 50% of the total number of stocks in the stock market. There were 494 stocks purchased by both the CSF and the CCH. Out of the total number of invested stocks, 41% were in the Shanghai main board, 18% were in the Shenzhen market, 26% were in the small and medium board (SMB), and 15% were in the growth enterprise board (GEB). Only the CCH purchased stocks from the GEB and SMB, in a total of 544 firms. Based on the market prices on September 30, 2015, the CCH and the CSF invested in more than 77% in the Shanghai main board, 14% in the Shenzhen market, 6% in the SMB, and 3% in the GEB. More than 60% of the purchased stocks were concentrated on the stocks that accounted for more than RMB 50 billion in market capitalization. The CSF purchased more than 66% of stocks with the capitalization over RMB 50 billion, while the CCH held only 43% stocks with a similar size.

Panel A of Table 1 shows that the market capitalization of the stocks purchased by the CSF accounted for 61% of the total market capitalization on June 30, 2015. The corresponding share for the CCH was 65%, and the market capitalization of all stocks purchased by both the CSF and CCH accounted for 74% of the total market capitalization.

Panel B of Table 1 reports the balance sheet information about the purchased stocks. After the government intervention, the balance sheets of the purchased stocks improved with an increasing return to assets (ROA), return to equity (ROE), and a slightly decreasing leverage (debt/assets) ratio. Specifically, the average ROA and ROE increased from 3.01 to 4.39% and from 2.87 to 4.93%, respectively, while the leverage ratio remained almost unchanged at 45%. In contrast, the average market-to-book (M/B) ratio declined from 5.32 to 3.55.

Panel C of Table 1 presents the industry-wise allocation at the end of September 2015. The CSF and the CCH invested more than 30% and 25%, respectively, in

[8] There are other investment vehicles funded by the China Securities Finance Corporation, a stock market stabilization fund, as well as the Wutongshu investment platform, the equity fund owned by the central bank of China. We did not include stocks purchased by those investment vehicles and shadow funds due to data limitations. Therefore, the purchased stocks included in our sample might underestimate the total amount of the rescue plan.

Table 1 Main information about purchased stocks

6/30/2015	No. of stocks purchased	No. of all stocks	Purchased/ total no. of stocks (%)	Market cap of purchased stocks (billion)	Total market cap (billion)	Purchased/ total market cap (%)
Panel A: Purchased stock information						
CSF	742	2830	26.22	39,682	64,685	61.00
CCH	1117	2830	39.51	41,966	64,685	65.00
Total	1365	2830	48.23	47,917	64,685	74.00
	Total asset (billion)	Total liabilities (billion)	ROA (%)	ROE (%)	Leverage	M/B
Panel B: Balance sheet data						
6/30/2015						
CSF	155,316	135,602	2.79	3.57	0.52	3.76
CCH	138,118	119,398	3.15	3.14	0.43	5.89
Total	159,249	138,047	3.01	2.87	0.45	5.32
9/30/2015						
CSF	156,512	136,271	3.99	4.28	0.52	2.45
CCH	139,178	119,994	4.55	5.31	0.43	3.91
Total	160,486	138,705	4.39	4.93	0.45	3.55
9/30/2015		CSF		CCH		Total
		Market cap share (%)		Market cap share (%)		Market cap share (%)
Panel C: Industry allocation						
Banking		22.50		10.50		18.50
Nonbanking financial		14.10		13.50		13.90
Mining		5.40		3.30		4.70
Chemical industry		3.40		4.60		3.80
Pharmaceutical biotechnology		3.40		6.50		4.40
Transportation		5.30		4.00		4.80
Real estate		4.60		4.90		4.70
Building decoration		5.20		4.50		5.00
Equipment		3.50		5.10		4.10
Utilities		4.70		3.10		4.20
Car		3.00		3.10		3.00
Computer		1.20		4.20		2.20
Food and drink		3.20		2.70		3.00
Nonferrous metal		3.00		3.00		3.00
Electronic		1.40		3.70		2.20
Electrical equipment		1.80		3.50		2.40
Media		1.90		2.80		2.20
Defense industry		3.00		2.90		2.90
Commercial trade		1.20		2.50		1.70
Household appliances		2.10		2.40		2.20

Table 1 (continued)

9/30/2015	CSF Market cap share (%)	CCH Market cap share (%)	Total Market cap share (%)
Steel	2.10	1.50	1.90
Communication	1.30	1.70	1.50
Building materials	0.80	1.50	1.00
Textile and apparel	0.50	1.60	0.80
Agriculture, forestry, animal husbandry and fisheries	0.50	1.50	0.80
Light manufacturing	0.30	0.60	0.40
Others	0.30	0.60	0.40
Leisure services	0.30	0.50	0.30
Total	100.00	100.00	100.00

Panel A reports the number and market capitalization of purchased stocks in terms of market prices on June 30, 2015. Panel B reports the balance sheet information about the purchased stocks. Panel C reports the stock's industry allocation. The purchase information is collected from the ownership structure of all Chinese stocks on their quarterly financial statements on June 30 and September 30, 2015

(a) CSF: China Securities Finance Corporation; CCH: China Central Huijin Investment Corporation.

(b) Both CSF and CCH invested in the same 494 stocks.

(c) Sources: Bloomberg, WIND and CSRC

banking and nonbanking stocks. The remaining investments were distributed among various industries ranging from 7 to less than 1%. In terms of the market capitalization on September 30, banking and nonbanking financial stocks contributed to about 25% of the total invested stocks by the SCF and the CCH. This indicates that the government purchased mainly stocks in the financial sector.

3 Gains/Costs of the Government Intervention

In this section, we estimate the gains or costs of the government intervention by an event study analysis. An event study cannot measure the impact of government intervention on the overall stock market because of concomitant shocks and other policy measures. Thus, we use the difference-in-difference method to estimate only the differential impact of the government intervention on the rescued stocks compared to the rest of the market. Following Veronesi and Zingales (2010), we calculate the change in the entire firm value between 2015Q2 and 2015Q3 by considering both equity and debt and then estimate the net gains after deducting the actual cost of the intervention.

3.1 The Merton Model

Veronesi and Zingales (2010) use the credit default swap (CDS) rates data to estimate debt value and default probabilities. Since these data for Chinese stocks are not

available, we have to use a different approach. As a starting point, we adopt the Merton (1974) model to estimate firm value and default probabilities. We then compute debt value as firm value minus equity value.

Now, we briefly introduce the Merton (1974) model. Suppose that firm value V follows a geometric Brownian motion process

$$dV/V = \mu dt + \sigma_V dW, \tag{1}$$

where μ is the expected continuously compounded return on V, σ_V is the volatility of firm value, and W is a Wiener process. Suppose that debt is a discount bond with face value F and maturity T. If firm value is lower than F at the maturity date, then the firm defaults and debt holders get V, but equity holders get nothing. Thus, equity can be viewed as a call option on the underlying firm value with the strike price F and the time-to-maturity T. Its value can be derived by the Black–Scholes formula:

$$\begin{aligned} E &= V\mathcal{N}(d_1) - e^{-rT}F\mathcal{N}(d_2), \\ d_1 &= \frac{\ln(V/F) + \left(r + 0.5\sigma_V^2\right)T}{\sigma_V\sqrt{T}}, \\ d_2 &= d_1 - \sigma_V\sqrt{T}, \end{aligned} \tag{2}$$

where E is equity value, r is the risk-free rate, and $\mathcal{N}$ denotes the standard cumulative normal distribution function.

By Ito's lemma, equity volatility satisfies

$$\sigma_E = \frac{V}{E}\mathcal{N}(d_1)\sigma_V. \tag{3}$$

We then use the values of r, T, E, and σ_E as input to solve for two variables V and σ_V using two Eqs. (2) and (3). After obtaining this solution, we can compute expected default probability under the risk-neutral measure as

$$EDP = \mathcal{N}(-DD), \tag{4}$$

$$DD = \frac{\ln(V/F) + \left(r - 0.5\sigma_V^2\right)T}{\sigma_V\sqrt{T}}, \tag{5}$$

where DD is often called the (risk-neutral) distance to default. Under the physical measure, we replace r with μ in Eq. (5) to derive the (physical) expected default probability. We choose to compute the risk-neutral default probability instead of the physical default probability for simplicity because we do not need to estimate the unknown parameter μ. Crosbie and Bhon (2003) and Vassalou and Xing (2004) propose a complicated iterative procedure to compute daily V and then estimate μ as the mean of the daily growth of V. Bharath and Tyler (2008) propose a simpler approach.

In our application, we observe stock prices data and can compute equity value E on June 30 and September 30, 2015. We then take a rolling 250-day standard deviation of equity returns to estimate the volatility of equity σ_E. We take the 1-year government bond yield as the risk-free rate r. Following Vassalou and Xing (2004) and Bharath and Tyler (2008), we use the short-term plus one half of the long-term liability of June 30 to represent the face value of debt for non-financial firms. Due to the special liability structure of the financial firms (banks, insurance, and security firms), we use the total book liability on June 30 as the face value of debt. Suppose that the debt has 1 year maturity and set $T = 1$ on June 30. On September 30, T becomes 3/4. Once the values for r, T, E, and σ_E are obtained, we can compute firm value V on June 30 and September 30 as well as the default probabilities on those dates.

To apply the preceding Merton method, we need to know the previous year's information about equity value to estimate equity volatility. Some stocks lack this information due to either new listings or mergers and acquisitions. For this reason, we exclude those stocks from our sample. We then have a smaller sample of 2650 stocks, among which 1316 stocks were purchased by the national team and the remaining stocks were not purchased.

Table 2 presents the computed market values of all financial and non-financial firms in our sample on June 30 and September 30. Note that the CSF and the CCH both invested in the same 483 stocks, which were mainly financial and large market capitalization firms. We have to be careful about double counting when computing values.

Panel A of Table 2 shows that the CSF purchased 680 non-financial firms. The value of these firms increased by 3.8%, and the increase in value was RMB 1086 billion. The CCH purchased 1041 non-financial firms, and these firms lost value of RMB 708 billion. The loss was 2.2% of June 30 value. The CSF and the CCH both purchased 449 non-financial firms. These firms gained value of RMB 1,282 billion and the gain was 5.3%. In aggregate, the total rescued stocks lost 2.4% of firm value worth RMB 904 billion. There were 1329 non-financial stocks not purchased by either the CSF or the CCH. These firms lost 13.5% of value worth RMB 2352 billion.

Panel B of Table 2 presents the corresponding numbers for financial stocks. The CSF and the CCH purchased 40 and 38 financial stocks, respectively. There were 34 financial stocks purchased by both the CSF and the CCH. There were 5 financial stocks not purchased by either the CSF or the CCH. These firms lost 19.6% of value worth RMB 246 billion. By contrast, the total rescued financial firms lost 2.1% of value worth RMB 2598 billion.

3.2 Change in Debt Value

Next we estimate debt value by subtracting equity value from firm value. Equity value is computed as the market capitalization, i.e., the stock market price multiplied by the total outstanding shares. Table 3 presents computed equity value.

Panel A of Table 3 shows that the purchased non-financial stocks lost about 30.9% of their equity value worth RMB 9495 billion. The non-purchased stocks lost a

Table 2 Estimated firm value

Date	Number	Firm value (billion)	Firm value (billion)	Firm value change (billion)	Firm value change per stock (billion)	Firm value change (%)
	06/30–09/30	06/30	09/30	06/30–09/30	06/30–09/30	06/30–09/30 (%)
Panel A: Non-financial stocks						
CSF	680	28,814	29,900	1086	1.6	3.80
CCH	1041	32,678	31,969	− 708	− 0.7	− 2.20
Both CSF and CCH	449	24,177	25,459	1282	2.9	5.30
Total purchased stocks	1272	37,315	36,411	− 904	− 0.7	− 2.40
Total not purchased stocks	1329	17,446	15,094	− 2,352	− 1.8	− 13.50
Total stocks	2601	54,761	51,505	− 3,256	− 1.3	− 5.90
Panel B: Financial stocks only						
CSF	40	124,229	121,797	− 2,432	− 60.8	− 2.00
CCH	38	108,084	105,763	− 2,321	− 61.1	− 2.10
Both CSF and CCH	34	106,665	104,512	− 2,154	− 63.3	− 2.00
Total purchased stocks	44	125,648	123,049	− 2,598	− 59.1	− 2.10
Total not purchased stocks	5	1257	1011	− 246	− 49.2	− 19.60
Total stocks	49	126,904	124,060	− 2,845	− 58.1	− 2.20

Panels A and B report the market value of non-financial and financial firms, respectively, estimated using the Merton model

smaller percentage of 24.8% of equity value worth RMB 3800 billion. Panel B shows the corresponding results for financial stocks. The total purchased financial stocks lost 26.1% of equity value worth RMB 2586 billion. By contrast, the total non-purchased stocks lost a much larger percentage of 46.9% of equity value worth RMB 231 billion.

In summary, Table 3 shows that the rescued financial stocks lost a much smaller percentage of equity value compared to the non-rescued financial stocks, but the opposite is true for the non-financial stocks.

Table 4 presents the estimated debt value. Panel A shows that debt value of the rescued non-financial firms increased by about more than 100%, while debt value of the non-rescued non-financial firms also increased, but by a much smaller magnitude. Panel B shows that debt value of the rescued financial firms barely changed, but debt value of the non-rescued financial firms lost about 2%.

Since debt value changed for both rescued and non-rescued firms during the period from June 30 to September 30 and since there were many market events happened during this period, we isolate the effect of the government intervention by using non-rescued firms as a control. For each rescued stock, we use non-rescued stocks in the same industry as a control. The adjusted change in debt value of the rescued stock is computed as

$$\text{adjusted}\Delta(\text{debt}) = \Delta(\text{debt}) - \text{debt}_{06/30} * \frac{\Delta(\text{debtn})}{\text{debtn}_{06/30}},$$

where debtn denotes debt value of all non-rescued firms in the same industry of the rescued firm. Since the government purchased many stocks in various industries, we have to take industry effects into account. We use the industry classification presented in Panel C of Table 1.

Panel A of Table 4 shows that the adjusted debt value change is about 40% of the raw change for all purchased non-financial stocks, which is RMB 3252 billion. By contrast, Panel B shows that the adjusted debt value change decreases significantly from RMB − 12 billion to RMB − 83 billion for the rescued financial firms. This means that debt value of the rescued non-financial firms benefitted much more significantly than that of the rescued financial firms.

3.3 Change in Equity Value

Table 3 shows that the market value of equity plummeted from June 30 to September 30, 2015 for both rescued and non-rescued firms. This could be due to a number of market events happened in this period. To estimate the effects of the government intervention, we have to control for these market events. As is standard in the finance literature, we use the CAPM model summarized by the following equations:

Table 3 Equity value

Unit: Billion	Number	Market cap	Market cap	Market cap change	Market cap change per stock	Market cap change (%)
Date	06/30–09/30	06/30	09/30	06/30–09/30	06/30–09/30	06/30–09/30 (%)
Panel A: Non-financial stocks						
CSF	680	23,248	15,887	− 7,362	− 10.8	− 31.70
CCH	1041	26,983	18,776	− 8,207	− 7.9	− 30.40
Both CSF and CCH	449	19,531	13,457	− 6,073	− 13.5	− 31.10
Total purchased stocks	1272	30,700	21,205	− 9,495	− 7.5	-30.90
Total not purchased stocks	1329	15,292	11,492	− 3,800	− 2.9	− 24.80
Total stocks	2601	45,992	32,697	− 13,295	− 5.1	− 28.90
Panel B: Financial stocks						
CSF	40	9493	7067	− 2,426	− 60.7	− 25.60
CCH	38	8586	6278	− 2,308	− 60.7	− 26.90
Both CSF and CCH	34	8187	6038	− 2,148	− 63.2	− 26.20
Total purchased stocks	44	9892	7306	− 2,586	− 58.8	− 26.10
Total not purchased stocks	5	493	262	− 231	− 46.3	− 46.90
Total stocks	49	10,385	7568	− 2,817	− 57.5	− 27.10

Panels A and B report equity value for non-financial and financial stocks, respectively. Equity value is equal to market capitalization computed as the market price multiplied by the number of outstanding shares

Table 4 Estimated debt value

Unit: Billion	Number	Debt value	Debt value	Debt value change	Adjusted debt value change	Adjusted debt value change (%)
Date	06/30–09/30	06/30	09/30	06/30–09/30	06/30–09/30	06/30–09/30
Panel A: Non-financial stocks						
CSF	680	5566	14,014	8448	3659	65.74
CCH	1041	5695	13,194	7499	3114	54.68
Both CSF and CCH	449	4646	12,002	7356	3521	75.79
Total purchased stocks	1272	6615	15,206	8591	3252	49.16
Total not purchased stocks	1329	2154	3602	1448	1448	67.22
Total stocks	2601	8769	18,808	10,039	4700	53.60
Panel B: Financial stocks						
CSF	40	114,736	114,731	− 5	− 69	− 0.06
CCH	38	99,498	99,486	− 12	− 71	− 0.07
Both CSF and CCH	34	98,479	98,473	− 5	− 58	− 0.06
Total purchased stocks	44	115,755	115,743	− 12	− 83	− 0.07
Total not purchased stocks	5	764	749	− 15	− 15	− 1.96
Total stocks	49	116,519	116,492	− 27	− 98	− 0.08

Panels A and B report estimated debt value for non-financial and financial stocks, respectively. Debt value is equal to firm value minus equity value from Tables 2 and 3. "Adjusted debt value change" is equal to the industry aggregate of the estimated debt value change of purchased stocks, adjusted for the debt value change of not purchased stocks in the same industry

$$\begin{aligned}
\text{Equity Value Gain} &= \text{MKTCAP} * \text{Abnormal Return},\\
\text{Abnormal Return} &= \text{Raw Return} - \widehat{\beta} * R_{\text{m}},\\
\text{Raw Return} &= \frac{\text{Stock Price}_{09/30} - \text{Stock Price}_{06/30}}{\text{Stock Price}_{06/30}},\\
R_{\text{m}} &= \frac{\text{Market Index}_{09/30} - \text{Market Index}_{06/30}}{\text{Market Index}_{06/30}},
\end{aligned}$$

where MKTCAP is the market capitalization on June 30, 2015, the betas are estimated from daily stock prices during the period from January 1, 2014, to June 29, 2015. We use the SSECI as the market index.

Panel A of Table 5 shows that even though the raw returns dropped much more for the rescued non-financial stocks than for the non-rescued non-financial stocks, the abnormal returns dropped much less. All abnormal returns are negative and range from − 1% to − 4%. By contrast, Panel B of Table 5 shows that the abnormal returns on purchased financial stocks are positive and are about 6% to 7%. The abnormal returns on non-rescued financial stocks are about − 47%. This means that financial stocks benefitted from the government intervention much more than non-financial stocks.

Combining Panels A and B shows that there was more than RMB 113 billion gain in equity value of total purchased stocks during the period from June 30 to September 30, 2015. Equity value of the stocks purchased by the CSF and the CCH increased by RMB 475 and 275 billion, respectively.

3.4 Actual Cost of the Stock Purchases

Both CSF and CCH bought stocks in July and August of 2015. We compute the purchasing cost using the following equation:

$$\text{Cost of Stock Purchase} = \text{Purchased Shares} * \text{Price Per Share}.$$

The information about the exact purchasing dates and the purchasing prices is not available from public sources. We can find the information about large shareholders and their shareholdings from a firm's balance sheets in Q2 and Q3 of 2015. We can estimate the purchased shares of all rescued firms as the shareholdings of the CSF and the CCH in Q3 minus their shareholdings in Q2. We use three ways to estimate the price per share: the average price between June 30 and September 30, 2015, the highest price in this period, and the lowest price in this period.

The purchasing cost is not the actual cost because both the CSF and the CCH owned the purchased stocks and might obtain capital gains/losses over time. We have to subtract the market value of the purchased stocks on September 30 to obtain the actual cost incurred in the period from June 30 to September 30.

Table 6 shows that the total costs of stock purchases by the CSF and the CCH range from RMB 770.5 to 1708.8 billion. The CSF purchased fewer stocks, but the

Table 5 Value gain of common equity of purchased stocks

Unit: Billion	Number	Market cap	Estimated beta	Raw return (%)	Abnormal return (%)	Equity value gain	Equity value gain per stock (billion)
Date	06/30–09/30	06/30	09/30	06/30–09/30	06/30–09/30	06/30–09/30	06/30–09/30
Panel A: Non-financial stocks							
CSF	680	23,248	1.03	− 31.7	− 2.1	− 480	− 0.7
CCH	1041	26,983	1	− 30.4	− 1.9	− 479	− 0.5
Both CSF and CCH	449	19,531	1.06	− 31.1	− 0.8	− 132	− 0.3
Total purchased stocks	1272	30,700	0.99	− 30.9	− 2.7	− 827	− 0.7
Total not purchased stocks	1329	15,292	0.73	− 24.8	− 3.9	− 603	− 0.5
Total stocks	2601	45,992	0.9	− 28.9	− 3.1	− 1430	− 0.5
Panel B: Financial stocks only							
CSF	40	9493	1.14	− 25.6	7.1	955	23.9
CCH	38	8586	1.15	− 26.9	6	754	19.8
Both CSF and CCH	34	8187	1.14	− 26.2	6.4	769	22.6
Total purchased stocks	44	9892	1.14	− 26.1	6.6	940	21.4
Total not purchased stocks	5	493	0.58	− 46.9	− 30.5	− 150	− 30
Total stocks	49	10,385	1.12	− 27.1	4.9	790	16.1

Panel A reports the non-financial stocks' information, while Panel B reports the financial stocks' information. The market capitalization is the price per share on 06/30/2015 multiplied by the number of shares outstanding. The estimated beta is based on the average daily return between 01/01/2014 and 06/29/2015. The abnormal return equals raw return—estimated beta multiplied by the market return. "Equity value gain" is the product of the market capitalization (June 30) multiplied by the abnormal return

Table 6 Actual cost of government purchase plan

Unit: Billion	Number of purchased stocks	Costs of stock purchase (average)	Costs of stock purchase (highest)	Costs of stock purchase (lowest)	Market value of shareholdings by government	Actual cost of stock purchase (average)	Actual cost of stock purchase (highest)	Actual cost of stock purchase (lowest)
Date	06/30–09/30	06/30–09/30	06/30–09/30	06/30–09/30	09/30	06/30–09/30	06/30–09/30	06/30–09/30
CSF	720	758.12	1000.13	521.5	599.2	158.9	400.9	− 77.8
CCH	1079	454.08	708.67	249	291	163.1	417.7	− 42.1
Total	1316	1212.2	1708.8	770.5	890.2	321.9	818.6	− 119.8

The cost of stock purchase is equal to the purchased shares multiplied by the estimated purchase prices. The average, highest, and lowest costs of stock purchase are based on the average, highest, lowest prices of common equity between 06/30/2015 and 09/30/2015. "Market value of shareholdings by government" is the value of the shareholdings of the government purchased stocks on 09/30/2015. The "actual cost of stock purchase" is the difference between the cost of stock purchase and the market value of shareholdings by the government

(a) China Securities Finance Corporation (CSF) and China Central Huijin Investment (CCH).

(b) Both CSF and CCH invest in same 483 stocks.

(c) Purchase prices of market value are based on the average, highest and lowest prices between June 30 and Sep. 30, 2015

(d) Sources: Bloomberg, WIND and CSRC

purchasing costs were higher. The market value of purchased stocks by the CSF on September 30 was RMB 599.2 billion, compared to RMB 291 billion for the CCH. Subtracting the market value on September 30, we obtain the total actual costs of stock purchases by both the CSF and the CCH, RMB 321.9 (average price), 818.6 (highest price), and − 119.8 (lowest price). Thus, if the CSF and the CCH purchased stocks at the lowest prices, they made paper profits from capital gains in equity. But if they purchased stocks at the average or higher prices, they had a paper capital loss at the expense of taxpayers.

3.5 Net Gains of the Government Purchase Plan

We are ready to compute the net costs and benefits of the stock purchase plan using the following equation:

$$\text{Net gains} = \text{Adjusted change in debt value} + \text{Change in equity value} - \text{Actual cost}.$$

Using the estimates obtained in Tables 4, 5, and 6, we obtain the net gains for financial and non-financial firms in Table 7. From the two panels, we observe the following: (1) Based on the average price, the purchased financial and non-financial stocks benefitted by about RMB 740 billion and 2221 billion, respectively. (2) The net gains came mostly from the adjusted increase in debt value for non-financial firms. (3) The net gains of both financial and non-financial stocks purchased by the CSF were larger than those purchased by the CCH.

The difference in results across financial firms and non-financial firms may be driven by two factors. First, unlike non-financial firms, financial firms always enjoy an implicit guarantee in China, a Chinese version of the too-big-to-fail. Thus, the impact of reducing default probabilities for financial firms is much weaker. Second, financial firms are typically investors of the stock market through many channels. But the government restricted their trading activities, which reduced their stock holdings liquidity. This regulation on stock trading reduced their asset values.

Table 8 presents the aggregate of Panels A and B of Table 7. This table shows that the net gains of all stocks purchased by the CSF are between RMB 3664 and 4143 billion based on different estimates of the purchase cost. The net gains of all stocks purchased by the CCH are between RMB 2900 and 3,360 billion. The net gains of all stocks purchased by both the CSF and the CCH are between RMB 3584 and 4194 billion. The total net gains of all purchased stocks are between RMB 2464 and 3,402 billion.

So far we have computed the net gains using the CAPM and Merton models without controlling for firm characteristics. In the next section, we re-estimate the net gains using a regression analysis. The regressions in Table 13 presented later estimate the effect of the number of shares purchased by the government on the percentage change in firm value and debt value after controlling for firm characteristics for a subsample of non-financial firms. We then compute the gains from the intervention by multiplying the number of shares bought by the government with estimates in Table 13. A similar method applies to equity value and debt value. We find that firm value and debt value increase by RMB 410.32 and 886.49 billion, respectively,

Table 7 Net gains of the government purchase plan

Unit: Billion	Number of purchased stocks	Debt value change	Common equity gain	Actual cost (average)	Actual cost (highest)	Actual cost (lowest)	Net gain (average)	Net gain (highest)	Net gain (lowest)
Panel A: Non-financial stocks									
CSF	680	3659	− 480	97.2	254.3	− 47.5	3082	2925	3226
CCH	1041	3114	− 479	107	286.2	− 32.8	2528	2349	2668
Both CSF and CCH	449	3521	− 132	125	327	− 61.7	3264	3062	3451
Total purchased stocks	1272	3252	− 827	204.2	540.5	− 80.3	2221	1884	2505
Panel B: Financial stocks only									
CSF	40	− 69	955	61.7	146.6	− 30.3	824	739	916
CCH	38	− 71	754	56	131.5	− 9.3	627	551	692
Both CSF and CCH	34	− 58	769	78.6	189.3	− 31.8	633	522	743
Total purchased stocks	44	− 83	940	117.7	278.1	− 39.5	740	579	897

Panel A reports the non-financial stocks' net gains, while Panel B reports the financial stocks' net gains. The value gain of the debt equals the adjusted debt value change, which comes from Table 4. The value gain of common equity comes from Table 5. The actual cost of the government purchase plan comes from Table 6. The net gain is the sum of the value gains from common equity and adjusted debt value minus actual costs

(a) China Securities Finance Corporation (CSF) and China Central Huijin Investment (CCH)

(b) Both CSF and CCH invest in same 483 stocks

(c) Purchase prices of market value are based on the average, highest, and lowest prices between June 30 and September 30, 2015

(d) Sources: Bloomberg, WIND and CSRC

Table 8 Total net gain of purchased stocks

Unit: Billion	Number of purchased stocks	Adjusted debt value gain	Common equity gain	Actual costs (average)	Actual costs (highest)	Actual costs (lowest)
CSF	720	3590	475	158.9	400.9	− 77.8
CCH	1079	3043	275	163	417.7	− 42.1
Both CSF and CCH	483	3463	637	203.6	516.3	− 93.5
Total purchased stocks	1316	3169	113	321.9	818.6	− 119.8
	Net gain (average)	Net gain (highest)	Net gain (lowest)	Net gain per stock (average)	Net gain per stock (highest)	Net gain per stock (lowest)
CSF	3906	3664	4143	5.4	5.1	5.8
CCH	3115	2900	3360	2.9	2.7	3.1
Both CSF and CCH	3897	3584	4194	8.1	7.4	8.7
Total purchased stocks	2960	2464	3402	2.2	1.9	2.6

This table reports the aggregate of Panels A and B of Table 7

(a) China Securities Finance Corporation (CSF) and China Central Huijin Investment (CCH)

(b) Both CSF and CCH invest in same 483 stocks

(c) Purchase prices of market value are based on the average, highest, and lowest prices between June 30 and September 30, 2015

(d) Sources: Bloomberg, WIND and CSRC

but equity value decreases by RMB 476.17 billion, for all non-financial firms in our sample. After subtracting the average purchase cost of RMB 204.2 billion (see Table 7 Panel A), we find that the net firm value gain is RMB 206.12 billion. This number is much smaller than our previous estimate of RMB 2960 billion using the CAPM and Merton models after netting out the average purchase cost (see the last row of Table 8).

There are two reasons that the estimate based on regressions is much smaller. First, the regression analysis only applies to a subsample of non-financial firms after dropping about 300 firms due to the data availability as explained in the next section, while the estimate based on the CAPM and Merton models applies to a much larger sample of both financial and non-financial firms. Second, by just focusing on non-financial firms to compute net gains using the CAPM and Merton models, we find that the gain after netting out the average purchase cost is RMB 2425 billion (see Table 7 Panel A), which is still much larger than our regression-based estimate. This is because the model-based estimate does not control for firm characteristics. Moreover, our regressions use a smaller sample by dropping about 300 firms to obtain all control variables.

4 Sources of Value Creation

In the previous section, we have shown that the government purchase plan created value. This section addresses the following questions: What kind of firms was more likely to be saved? Where did the value creation come from? Since the government purchased shares of more than 1000 firms, we have a fairly large sample for a cross-sectional regression analysis. We begin by describing the data.

4.1 Data Description

We consider all stocks listed in the Shanghai and Shenzhen stock exchanges using Wind and CSMAR financial statement data matched with the stock purchase information by the CSF and the CCH. We exclude financial firms and newly listed firms from the sample in our regression analysis.[9] As shown in Table 4B, only 5 financial stocks (out of 49) were not purchased. There are not enough control groups for us to identify the government purchase effects.

Panel A of Table 9 presents the variables used in our regression analysis. Accounting variables such as return on assets (ROA), market-to-book ratio (M/B), leverage (LEV), cash flow (CF), and dividend yield (DIV) are taken from firms' balance sheets in 2015Q2. We also include dummy variables such as sales (which equals 1 if sales are above the median and 0 otherwise), GOVD (which equals 1 if a stock was purchased by the government between July 6, 2015, and September 30, 2015), export (which equals 1 if a company had foreign sales in 2015Q1, otherwise

[9] Financial firms have totally different balance sheets and profit sources compared with non-financial firms. Taking banks as an example, a majority of assets of banks are the loans lent to non-financial firms.

0), BC (which equals 1 if a company is a blue chip, otherwise 0), and SOE (which equals 1 if the actual controller of a company is a state-owned enterprise, otherwise 0). The variable GOV is defined as the ratio of the number of a firm's shares purchased by the government to the firm's total outstanding shares between July 6, 2015, and September 30, 2015, multiplied by 100.

The variable DLL is defined as the number of days when a firm's stock price hit the lower limit during the crash period from June 6 to July 5, 2015. More than 84% of all stocks listed in Shanghai and Shenzhen Exchanges hit the lower limit for at least 1 day during the crash period. By contrast, only 34% of all stocks hit the lower limit for at least 1 day during the period from January 1 to June 5, 2015.

During the crash period, many firms suspended their stock trading as a self-protection measure. The variable SuspBe is defined as the number of suspension days before the government intervention between June 6, 2015, and July 5, 2015. The variable Suspension measures the suspension days of a firm's stock during the intervention period between July 7, 2017, and September 30, 2017.

Firm value, debt value, and default probabilities are computed using the Merton model described in Sect. 3.1. We then define the variables, FVC (firm value change), DVC (debt value change), and DPC (default probability change), as the changes of those values between June 30, 2015, and September 30, 2015.

Following Amihud (2002) and Brogaard et al. (2016), we use the Amihud index to measure illiquidity. The Amihud index is defined as the absolute value of daily stock returns divided by daily trading volume, multiplied by 10^6. This index captures the idea that, for a given amount of trading, illiquid stocks should experience a larger price change. A higher value of the Amihud index corresponds to lower liquidity. We use the variable LIQ to measure a firm's average illiquidity between July 1, 2015, and September 30, 2015, defined as the average Amihud index during that period.

As CSRC banned large shareholders with 5% of holdings or above from selling stocks for the next 6 months since July 8, 2015, ownership concentration will hence likely be an important factor. Following Morck et al. (1988), we use the variable CCT defined as the sum of squares of shares greater than 5% as a measure of ownership concentration.

To consider the effect of firms' size, we use a dummy variable Sales, which equals 1 if the firm's total sale on December 31, 2014, is above the median and 0 otherwise.

Panel B of Table 9 reports summary statistics of the variables discussed above for the sample period between June 30 and September 2015. There are several extreme values among the observations in the sample. To exclude outliers, we winsorize both the top and bottom 1% for our empirical analysis. Overall, we have more than 2500 observations in the regression analysis. The control variables used in our baseline regression analysis are based on the balance sheet information in 2014Q4. As a robustness check in Sect. 5, we will use the balance sheet information in 2015Q1.

Table 9 Variable description, sources, and summary statistics

Name	Variable	Description	Source
Panel A: Variable description, sources			
GOV	Government purchase share	Shares purchased by government/total outstanding shares * 100	Wind
GOVD	Government purchase dummy	Dummy variable equals 1 if government purchased the stock, otherwise 0.	Wind
GFV	Firm value growth	Change of log(firm value)	Author's calculation
GDV	Debt value growth	Change of log(debt value)	Author's calculation
DPC	Default probability change	100 * Change of expected default probability estimated by KMW model.	Author's calculation
LIQ	Amihud index	Average of Amihud index between July 1 and September 30, 2015, where Amihud index is the absolute value stock return/trading volume *1 billion.	CSMAR
DLL	Limit down	Number of trading days classified by CSRC limit down stock during 2015.6.6–2015.7.5. Limit down is defined as − 10% return.	Wind
SuspBe	Suspension before	Dummy variable equals 1 if a firm has suspended during 2015.06.06–2015.07.05, 0 otherwise.	Wind
Suspension	Suspension during	1 if suspension days during 2015.07.07–2015.09.30 greater than median, 0 otherwise.	Wind
GOV2	GOV^2	Square of GOV.	Wind
CCT	Ownership concentration	Sum of squares of shares greater than 5%.	CSMAR
ROA	Return of assets	Net income/total assets * 100	Wind

Table 9 (continued)

Name	Variable	Description	Source
Sales	Sales	Dummy variable equals 1 if sales are above the median, 0 otherwise.	CSMAR
M/B	M/B ratio	Market/book value of equity	Wind
LEV	Leverage	Total liabilities/total assets	Wind
CF	Cash flow	Net operating cash flow/total assets	Wind
DIV	Dividend ratio	Dividend/price * 100	CSMAR
Export	Export	Dummy variable equals 1 if a firm had foreign sales in 2015Q1, otherwise 0.	Wind
BC	Blue chip	Dummy variable equals 1 if a firm is a blue-chip share, otherwise 0.	Wind
SOE	State-owned enterprise	Dummy variable equals 1 if the actual controller of a firm is the state-owned enterprise, otherwise 0.	Wind
CAR	Cumulative abnormal return	100 * Cumulative abnormal return over index return around the announcement date of third-quarter financial statements of 2015.	Wind

Variables	Obs	Mean	Std	Min	P25	Median	P75	Max
Panel B: Summary statistics								
GOV	2583	0.961	1.410	0.000	0.000	0.000	1.374	6.892
GOVD	2589	0.488	0.500	0	0	0	1	1
DPC	2589	− 0.655	5.627	− 10.617	− 4.946	− 0.441	3.458	10.235
LIQ	2098	0.669	0.652	0.052	0.224	0.454	0.841	2.631
DLL	2589	3.279	2.143	0	2	3	5	12
SuspBe	2589	0.241	0.428	0	0	0	0	1

Table 9 (continued)

Variables	Obs	Mean	Std	Min	P25	Median	P75	Max
Suspension	2589	0.481	0.500	0	0	0	1	1
GOV2	2583	2.911	5.632	0	0	0	1.888	47.505
CCT	2589	0.154	0.102	0.026	0.070	0.131	0.217	0.385
ROA	2589	0.042	0.212	− 4.000	0.013	0.036	0.070	8.441
Sales	2588	0.500	0.500	0	0	0.5	1	1
M/B	2275	0.839	0.802	0.001	0.350	0.575	1.000	6.688
LEV	2589	0.441	0.202	0.114	0.274	0.433	0.606	0.799
CF	2589	0.043	0.093	− 1.938	0.001	0.041	0.089	0.684
DIV	2442	0.105	0.186	0.000	0.000	0.050	0.130	4.374
Export	2589	0.462	0.499	0	0	0	1	1
BC	2589	0.067	0.250	0	0	0	0	1
SOE	2587	0.308	0.462	0	0	0	1	1

Panel A reports variable definition and sources and Panel B reports the summary statistics of variables. Firm value, debt value, default probability information are estimated from quarterly balance sheet between June 30 and September 30, 2015; other financial variables shown in this table are from the annual report of year 2014. In the robustness checks, we also use balance sheet information from the second quarter of 2015

4.2 What Kind of Firms was More Likely to Be Saved?

As Table 1 shows, the Chinese government purchased many firms with various characteristics in various industries. What kind of firms was more likely to be saved? To answer this question, we study a probit model specified below:

$$\Pr(\text{GOV } D = 1) = b_0 + \sum_{n=1}^{k} b_n X_n + \varepsilon,$$

where the vector X includes variables related to firm characteristics, the number of days when the stock hit the lower limit during the crash period, the ownership dummy, ownership concentration, the relative size of firm, and the export dummy. It is natural that the government is more likely to save a firm with better fundamentals. Since many firms hit the lower limit during the crash period, the market liquidity dried up. A simple way to raise liquidity is to purchase stocks on the lower limits so that their prices move out of the lower limits. Thus, we should expect that the government is more likely to purchase a stock if it stayed at the lower limit more often. Finally, the reason why we add the export dummy is that during the period under consideration, China experienced a devaluation of its currency, the RMB. This may affect the market value of exporting firms significantly.

We present the regression results in Table 10. As seen in columns 1 to 4, there is a very strong and significant positive correlation between the probability of being purchased by the government and firm characteristics including CCT, ROA, sales, market-to-book ratio, dividend yield, SOE dummy, and blue-chip dummy. These results hold true both with and without industry fixed effects specifications. In particular, the higher the ROA or the higher the dividend yield, the more likely a firm is included in the government purchase plan. Being a SOE or a blue-chip firm also increases the likelihood of being included in the government purchase plan. A firm with a larger market-to-book ratio is less likely to be included in the government purchase plan. These regression results indicate that the government is more likely to purchase value stocks, blue-chip stocks, high-dividend-yield stocks, and stocks of profitable firms, SOEs, and large firms. Moreover, we find that government is more likely to buy stocks that stay at the lower limits or have higher ownership concentration. Interestingly, there is no statistical relationship between the export status and the probability of being purchased by the government. This result is consistent with the official announcements that the government did not intervene in the stock market in response to the currency devaluation in August 2015.

Since two government agencies, CSF and CCH, purchased different stocks, there are three different outcomes for a particular stock: no purchase, purchased by one agency, and purchased by both agencies. It is natural to run the following ordered probit regression,

$$\Pr(\text{GOV } D = 0, 1, 2) = b_0 + \sum_{n=1}^{k} b_n X_n + \varepsilon,$$

Table 10 Government purchase choice model

	Probit (1)	Probit (2)	Oprobit (3)	Oprobit (4)
DLL	0.065***	0.073***	0.039***	0.047***
	(0.013)	(0.014)	(0.012)	(0.013)
CCT	1.427***	1.417***	1.546***	1.499***
	(0.289)	(0.299)	(0.256)	(0.263)
ROA	1.865***	1.818***	1.613***	1.573***
	(0.593)	(0.607)	(0.542)	(0.556)
Sales	0.518***	0.491***	0.589***	0.570***
	(0.069)	(0.071)	(0.061)	(0.063)
Export	0.059	0.056	0.046	0.068
	(0.056)	(0.064)	(0.050)	(0.058)
M/B	0.178***	0.206***	0.158***	0.190***
	(0.049)	(0.055)	(0.045)	(0.051)
SOE	0.125*	0.114*	0.288***	0.271***
	(0.064)	(0.067)	(0.059)	(0.061)
BC	0.679***	0.720***	0.690***	0.723***
	(0.131)	(0.133)	(0.106)	(0.108)
LEV	− 0.763***	− 0.724***	− 0.548***	− 0.535***
	(0.194)	(0.201)	(0.179)	(0.185)
CF	− 0.418	− 0.339	− 0.306	− 0.137
	(0.400)	(0.426)	(0.373)	(0.392)
DIV	0.570**	0.626***	0.469***	0.538***
	(0.227)	(0.232)	(0.175)	(0.184)
Constant cut1			0.815***	0.748***
			(0.099)	(0.169)
Constant cut2			1.833***	1.791***
			(0.102)	(0.171)
Constant	− 0.747***	− 0.669***		
	(0.106)	(0.189)		
Industry FE	NO	YES	NO	YES
R^2	0.0962	0.111	0.0999	0.116
N	2272	2272	2272	2272

This table presents results of the government choice model. Columns 1 and 2 use a probit model for estimation, where the dependent variable equals 0 if no government purchase, 1 if government made a purchase. Columns 3 and 4 use an ordered probit model for estimation, where the dependent variable equals 0 if no government purchase, 1 if only one of CSF and CCH made a purchase, 2 if both CSF and CCH purchased. All variables are defined in Table 9. All firm-level variables are based on the balance sheet information at Q4 2014. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 11 Robustness check: government choice model

	Probit (1)	Probit (2)	Oprobit (3)	Oprobit (4)
SuspBe	− 0.913***	− 0.924***	− 0.839***	− 0.839***
	(0.071)	(0.072)	(0.071)	(0.072)
CCT	1.411***	1.408***	1.545***	1.500***
	(0.292)	(0.303)	(0.256)	(0.264)
ROA	1.329**	1.281**	1.298**	1.248**
	(0.568)	(0.577)	(0.517)	(0.532)
Sales	0.491***	0.459***	0.574***	0.548***
	(0.070)	(0.072)	(0.062)	(0.064)
Export	0.091	0.074	0.072	0.084
	(0.057)	(0.065)	(0.051)	(0.059)
M/B	0.160***	0.177***	0.144***	0.167***
	(0.050)	(0.056)	(0.045)	(0.051)
SOE	0.008	0.007	0.194***	0.184***
	(0.066)	(0.068)	(0.060)	(0.062)
BC	0.621***	0.657***	0.649***	0.674***
	(0.131)	(0.133)	(0.104)	(0.107)
LEV	− 0.748***	− 0.700***	− 0.506***	− 0.489***
	(0.199)	(0.205)	(0.183)	(0.188)
CF	− 0.359	− 0.315	− 0.265	− 0.131
	(0.405)	(0.424)	(0.381)	(0.391)
DIV	0.421*	0.480**	0.369**	0.438**
	(0.226)	(0.230)	(0.172)	(0.181)
Constant cut1			0.452***	0.403**
			(0.084)	(0.161)
Constant cut2			1.517***	1.492***
			(0.085)	(0.162)
Constant	− 0.235**	− 0.194		
	(0.096)	(0.184)		
Industry FE	NO	YES	NO	YES
R^2	0.147	0.161	0.135	0.150
N	2272	2272	2272	2272

This table presents robustness results of the government choice model where suspension dummy substitutes for down limit days in Table 10. Columns 1 and 2 use a probit model for estimation, where the dependent variable equals 0 if no government purchase, 1 if government made a purchase. Columns 3 and 4 use an ordered probit model for estimation, where the dependent variable equals 0 if no government purchase, 1 if only one of CSF and CCH made a purchase, 2 if both CSF and CCH purchased. All firm and industry characteristics in Tables 10, 11, and 12 are included. All variables are defined in Table 9. All firm-level variables are based on the balance sheet information at Q4 2014. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

where GOV $D = i$ if i government agency purchased the firm's stock for $i = 0, 1, 2$. From columns 3 and 4 of Table 10, we find that the ordered probit model yields similar positive relationships between government purchases and firm characteristics such as ownership concentration, SOE ownership, ROA, sales, dividend yield, leverage, and the number of trading dates of the limit down. But the estimated coefficients are slightly different.

We also consider a robustness check by considering SuspBe as a different control variable. Obviously the government cannot purchase a firm's stock if the firm has suspended their stock trading. Since the full-blown government intervention did not start until July 5, 2017, we hence only consider suspension before July 5, 2017. Table 11 shows that the regression yields similar results. As conjectured, the probability of being purchased by the government is reduced if the firm suspended trading relatively more than other firms. The coefficients of other control variables reported in Table 11 are very similar to those in Table 10. Our conclusion that which stocks are more likely to be purchased by the government is hence robust to different specifications.

It is also interesting to understand what factors determine how much the government purchased. We hence run the following regression

$$\text{GOV} = b_0 + \sum_{n=1}^{k} b_n X_n + \varepsilon,$$

where GOV is defined as the percentage of shares purchased by government. As in the probit model, we introduce the same set of control variables X related to firm characteristics. From Table 12, we can see that the government purchased more blue-chip stocks, SOEs stocks, or stocks with relatively larger size (measured by relative sales). Not surprisingly, the number of suspension days before government intervention reduces government purchases, as suspension prevents any transactions. Unlike the probit model, ROA, the market-to-book ratio, ownership concentration, and leverage are not significant determinants for the amount of the government purchases.

4.3 Public Responses to Government Purchases

How did public investors respond to the government purchases? Even though the government announced that it purchased stocks in July, the public did not know which stocks were purchased and when they were purchased, unless the public had insider information. However, insider trading is illegal. Pubic investors can know which stocks were purchased by investigating the firms' third-quarter earning reports in October. Thus, we use the earnings announcement date as the exact time when the public investors were informed about the status of government purchases.

To see how stock prices responded to the earnings announcements, we first calculate the cumulative excess returns (CAR) after adjusting the market returns (measured by SSECI or SCI 300) using the CAPM within $(-2, +2)$ or $(-3, +3)$ window of the official announcement date. We then run the following regression

Table 12 Government purchase choice model

	OLS	OLS	OLS
SuspBe	− 0.671***	− 0.630***	− 0.611***
	(0.056)	(0.055)	(0.056)
CCT	0.894***	0.312	0.322
	(0.299)	(0.296)	(0.297)
ROA	0.528	0.157	0.051
	(0.322)	(0.163)	(0.147)
Sales	0.778***	0.677***	0.654***
	(0.063)	(0.063)	(0.065)
Export	0.051	0.082	0.094
	(0.056)	(0.055)	(0.061)
M/B	0.034	0.103*	0.153**
	(0.053)	(0.058)	(0.062)
SOE	0.276***	0.324***	0.318***
	(0.070)	(0.068)	(0.070)
BC		1.064***	1.063***
		(0.137)	(0.138)
LEV		− 0.538***	− 0.544***
		(0.171)	(0.173)
CF		− 0.172	0.060
		(0.338)	(0.341)
DIV		0.661***	0.685***
		(0.196)	(0.209)
Constant	0.495***	0.648***	0.445**
	(0.063)	(0.083)	(0.210)
Industry FE	YES	YES	YES
R^2	0.174	0.224	0.240
N	2272	2272	2272

This table shows the results of the government choice model using OLS. The dependent variable is GOV. All variables are defined in Table 9. All firm-level variables are based on the balance sheet information at Q4 2014

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

$$\mathrm{CAR}_i = a + \beta \mathrm{GOV}_i + \mathrm{Controls}_i + \epsilon_i,$$

where GOV_i is 1 if firm i is purchased by the government and 0 otherwise. The control variables are firm-specific variables such as the book-to-market ratio, ROA, and SOEs dummy. We find the coefficient on GOV_i is slightly negative but not significant, suggesting that public investors did not respond much to government purchases.[10] Our finding is consistent with Chi et al. (2017). It is probably due to the

[10] The result is available upon request.

Table 13 The impact on value creation

	Firm value growth (GFV)			Debt value growth (GDV)		
	(1)	(2)	(3)	(4)	(5)	(6)
GOV	0.017***	0.017***	0.009**	0.182***	0.157***	0.125***
	(0.004)	(0.003)	(0.004)	(0.022)	(0.021)	(0.022)
CCT	0.259***	0.240***	0.163***	0.242	0.540	0.049
	(0.049)	(0.048)	(0.050)	(0.338)	(0.341)	(0.360)
ROA	0.045***	0.173***	0.153***	− 0.121	0.934***	1.077***
	(0.011)	(0.045)	(0.033)	(0.433)	(0.257)	(0.388)
Sales	0.222***	0.132***	0.124***	1.793***	1.265***	1.238***
	(0.011)	(0.013)	(0.013)	(0.080)	(0.086)	(0.088)
Suspension	0.041***	0.040***	0.039***	0.344***	0.233***	0.231***
	(0.011)	(0.011)	(0.011)	(0.077)	(0.079)	(0.079)
Export		0.003	0.020*		0.088	0.185**
		(0.010)	(0.011)		(0.070)	(0.080)
M/B		0.070***	0.070***		− 0.167***	− 0.164***
		(0.007)	(0.008)		(0.044)	(0.047)
LEV		0.275***	0.285***		2.223***	2.350***
		(0.036)	(0.038)		(0.254)	(0.260)
SOE		− 0.013	− 0.014		0.171**	0.116
		(0.011)	(0.011)		(0.075)	(0.076)
BC			0.056***			0.216*
			(0.018)			(0.110)
CF			− 0.018			− 0.832
			(0.068)			(0.522)
DIV			0.096***			0.329
			(0.034)			(0.201)
Constant	− 0.463***	− 0.594***	− 0.595***	− 1.368***	− 1.974***	-1.957***
	(0.012)	(0.016)	(0.018)	(0.096)	(0.134)	(0.142)
Industry FE	NO	NO	YES	NO	NO	YES
Adj. R^2	0.201	0.298	0.318	0.258	0.270	0.289
N	2582	2272	2272	2292	2079	2079

This table presents the regressions to estimate the correlation between the government purchase plan and value creation, which includes firm and industry characteristics. All variables are defined in Table 9. All firm-level variables are based on the balance sheet information at Q4 2014. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

fact the major intervention was in July and 3 months have past in October. The investors might believe that prices had already absorbed the impact of government purchases. For example, it is possible that institutional investors may have private information about government purchases through firm managers. The arrest of the so-called Chinese Warren Buffet Xu Xiang and many others later for insider trading on November 2017 suggests that there is indeed an insider trading problem.

4.4 Did Purchasing More Shares Create More Values?

Intuitively, if the government purchases more stocks, it will raise more demand for stocks and hence raise more equity value and more liquidity. Tables 3 and 5 show that although equity value fell significantly during the period from June 30 to September 30, 2015, the fall would have been even more significant without government purchases. To examine whether value creation would be higher if the government purchased more stocks, we run the following cross-sectional regression:

$$\text{Value Creation} = b_0 + \sum_{n=1}^{k} b_n X_n + \varepsilon.$$

Table 13 summarizes the results. The dependent variable, value creation, represents either the change in log firm value or in log debt value between June 30 and September 30, 2015. The key explanatory variable is GOV, the ratio of the shares purchased by the government to the total outstanding shares. For the various specifications considered, the control variables include industry fixed effects, export status, SOE dummy, blue-chip dummy, and other variables commonly used in the literature such as ROA, M/B, leverage, cash flow, and dividend yield. We also add the variable CCT to control for the effect of ownership concentration and the variable Sales to control for the size effect.

We find a significant positive relationship between the number of shares purchased by the government and the value creation, after including many control variables. This result holds true for various specifications considered in columns 1 through 6. Moreover, ROA, dividend yield, and leverage as well as the blue-chip, export dummies, and sale dummy have a positive correlation with the value creation. But M/B is negatively related to the value creation. This indicates that fundamentals matter for value creation.

The new regulation by CSRC that forbids large shareholders with 5% or more of the ownership to sell their holdings in the next month may also have a large impact on the stock market. There are two opposite effects. First, it reduces the selling pressure from these pessimistic large shareholders and hence tends to stabilize stock prices. However, this policy may prevent some optimistic shareholders to increase their holdings as they may need to resell their shares in the future for possible liquidity management. Hence, the overall impact depends on which effect dominates. To investigate the overall impact, we add variable CCT to the regression. The coefficient on CCT under all different specifications is significant and sizable. This suggests that the first effect dominates the second.

Similarly suspending trading may have two opposite effects on the stock prices. On the one hand, it can protect firms' stock prices from panic selling. But on the other hand, it may signal weaker fundamentals, creating a greater selling pressure once the stock resumes trading. Again we find that the first effect dominates. Suspending trading has a significant impact on value creation. Each suspension trading day on average generates about 5.78% increases in firm value. But we need to take the gain very cautiously. Liu et al. (2017) find that such suspending of trading

generates a large selling pressure on other firm stocks. Our reduced-form regression cannot compute this valuation destruction on other firms and hence overestimate the benefit of suspending.

When we gradually add more control variables from columns 1 to 3 for the regressions on the change in firm value, the slope of GOV gradually decreases, but is still significant, and R-squared gradually increases. A similar result holds true for the regressions on the change in debt value. In columns 4 and 6 we find that the slope of GOV is 0.182 and 0.125, respectively, when we include all control variables. The interpretation based on our definition of GOV in Table 9 is that a one percentage point increase in the ratio of the number of shares purchased by the government to the total outstanding shares will raise firm value by 0.9% and debt value by 12.5%.

The positive and significant relationship between the government purchase and the value creation documented above is consistent with the aggregate evidence of the government purchase plan reported in Sect. 3.

Although it is difficult to draw a causality link between government purchases and value creation, as they are both affected by firm fundamentals. We have tried to address this issue by controlling many firms' characteristics. But there could still exist some omitted variable problems. Ideally if we can observe the exact time of government purchases, we can employ a difference-in-difference method to establish a causal relationship. Unfortunately these data are not available. A closer examination of Tables 10 and 13, however, suggests that government purchases indeed increase stock prices above what can be explained by firm fundamentals. Notice that while variables like ROA, CCT, M/B have positive effects on firms' value creation, they are not significant determinants of government purchases.

Since a majority of purchased stocks are SOEs, the value creation may reflect some other direct public support that firms may receive. Arguably direct pubic support will favor more publicly owned firms. The coefficient on SOE can hence tell whether this is indeed the case. We find that the coefficients of SOE in columns 3 and 6 are not significant. This suggests that the value creation is not due to other direct support from the government.

4.5 Impact on Default Probabilities, Liquidity, and Investor Confidence

In the previous subsection, we have shown that if the government purchased more shares, it would create more value. This could be due to the abnormal returns of equity generated by the increased demand for stocks. In this section, we examine three additional channels: reduced default probabilities, increased liquidity, and increased confidence.

As shown in Sect. 3, we can compute the expected default probabilities using the Merton (1974) model. We then compute the change in default probabilities between June 30 and September 30, 2015 for each stock. We use the Amihud index to describe illiquidity for each stock. We then run the following cross-sectional regressions:

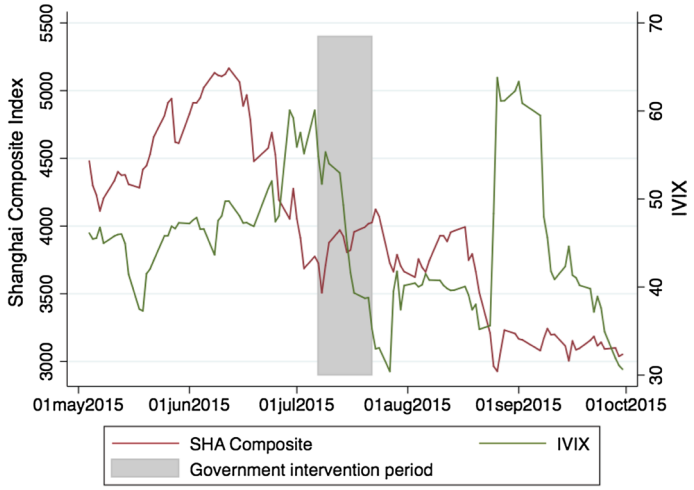
Table 14 The impact on default probabilities and liquidity

	Default probability change (DPC)			Liquidity (LIQ)		
	(1)	(2)	(3)	(4)	(5)	(6)
GOV	− 0.412***	− 0.397***	− 0.369***	− 0.130***	− 0.111***	− 0.095***
	(0.089)	(0.082)	(0.084)	(0.007)	(0.007)	(0.007)
CCT	1.506	0.685	− 0.026	0.609***	0.726***	0.833***
	(1.130)	(1.153)	(1.191)	(0.116)	(0.118)	(0.121)
ROA	− 2.353	− 3.106***	− 2.806***	− 1.023***	− 1.430***	− 1.382***
	(1.535)	(0.739)	(0.782)	(0.211)	(0.217)	(0.239)
Sales	1.525***	− 0.605**	− 0.610**	− 0.313***	− 0.291***	− 0.291***
	(0.233)	(0.274)	(0.285)	(0.028)	(0.034)	(0.033)
Suspension	0.141	0.505**	0.536**	0.073**	0.087***	0.099***
	(0.230)	(0.247)	(0.250)	(0.029)	(0.030)	(0.030)
Export		− 0.975***	− 1.102***		0.008	− 0.030
		(0.228)	(0.253)		(0.025)	(0.029)
M/B		1.225***	1.020***		− 0.057***	− 0.057***
		(0.193)	(0.204)		(0.017)	(0.019)
LEV		7.403***	7.351***		0.181*	0.188*
		(0.752)	(0.798)		(0.095)	(0.096)
SOE		0.497*	0.402		− 0.054**	− 0.037
		(0.280)	(0.287)		(0.027)	(0.028)
BC			− 0.123			− 0.194***
			(0.474)			(0.030)
CF			0.443			0.386**
			(1.462)			(0.187)
DIV			0.200			0.079
			(0.595)			(0.048)
Constant	− 1.224***	− 4.166***	− 3.853***	0.895***	0.808***	0.765***
	(0.267)	(0.383)	(0.408)	(0.031)	(0.041)	(0.042)
Industry FE	NO	NO	YES	NO	NO	YES
Adj. R^2	0.0274	0.166	0.174	0.217	0.241	0.271
N	2582	2272	2272	2092	1825	1825

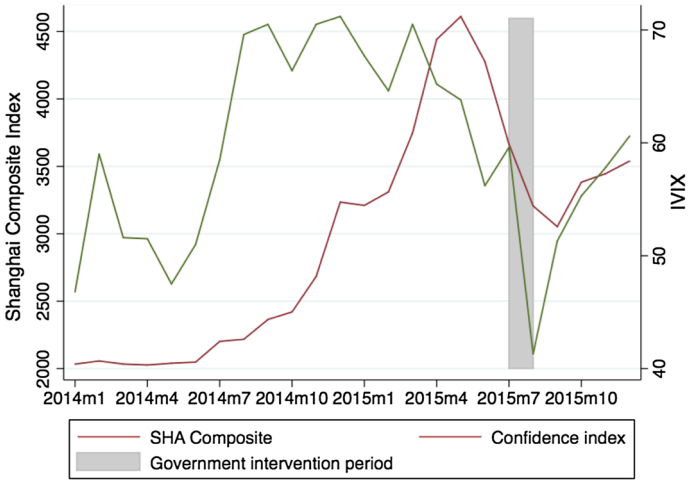
This table presents the regressions to estimate the impact of the government purchase plans on default probability change and liquidity separately, which includes firm and industry characteristics. All variables are defined in Table 9. All firm-level variables are based on the balance sheet information at Q4 2014. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

$$\mathrm{DPC} = a_0 + a_1 \mathrm{GOV} + \sum_{n=1}^{k} a_n X_n + \varepsilon,$$

$$\mathrm{LIQ} = a_0 + a_1 \mathrm{GOV} + \sum_{n=1}^{k} a_n X_n + \varepsilon.$$



Panel A: Shanghai Composite and IVIX



Panel B: Shanghai Composite and Confidence Index

Fig. 2 Market index and investors' confidence index

Table 14 reports the regression results. Columns 1–3 of Table 14 show that there is a significant negative relationship between the change in default probabilities and the number of shares purchased by the government across various specifications. This implies that an increase in the number of shares purchased by the government tends to reduce the firm's default probability. The slope of GOV varies from − 0.369 to − 0.413 with different control variables. In column 3 the slope of GOV is − 0.369 when we include all control variables. The interpretation is that a one percentage increase in the ratio of the number of shares purchased by the government to the total outstanding shares will reduce the default probabilities by 0.37%.

Table 15 Robustness check: alternative controls

	GFV (1)	GDV (2)	DPC (3)	LIQ (4)
GOV	0.007**	0.120***	− 0.421***	− 0.105***
	(0.003)	(0.023)	(0.080)	(0.007)
CCT	0.158***	− 0.256	0.982	0.783***
	(0.047)	(0.351)	(1.068)	(0.121)
ROA	0.015***	0.049***	− 0.152***	− 0.011
	(0.002)	(0.018)	(0.049)	(0.006)
Sales	0.113***	1.324***	− 0.413	− 0.365***
	(0.013)	(0.087)	(0.274)	(0.036)
Suspension	0.048***	0.385***	0.387*	0.078***
	(0.010)	(0.076)	(0.222)	(0.030)
Export	0.011	0.174**	− 1.192***	− 0.033
	(0.011)	(0.078)	(0.227)	(0.028)
M/B	− 0.010***	− 0.039***	− 0.130***	− 0.005
	(0.002)	(0.011)	(0.028)	(0.005)
LEV	0.423***	2.453***	8.925***	0.214**
	(0.033)	(0.217)	(0.677)	(0.085)
SOE	− 0.002	0.156**	0.209	− 0.073**
	(0.011)	(0.075)	(0.273)	(0.029)
BC	0.042**	0.129	− 0.155	− 0.205***
	(0.017)	(0.119)	(0.450)	(0.029)
CF	0.096	− 0.540	− 0.640	0.117
	(0.131)	(0.964)	(2.698)	(0.346)
DIV	0.011	0.035	0.412	− 0.021
	(0.011)	(0.075)	(0.282)	(0.027)
Constant	− 0.548***	− 2.129***	− 2.569***	0.855***
	(0.020)	(0.155)	(0.429)	(0.052)
Industry FE	YES	YES	YES	YES
Adj. R^2	0.313	0.347	0.173	0.251
N	2579	2289	2579	2091

This table presents the regressions to estimate the impact of the government purchase plan on value creation, default probability change and liquidity with alternative controls. All variables are defined in Table 9. All firm-level variables are based on the balance sheet information in 2015Q2. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

In columns 4 through 6, we find that there is a significant negative relationship between the Amihud index, our proxy for illiquidity (LIQ), and GOV across various specifications. This implies that an increase in the number of shares purchased by the government relative to total outstanding shares tends to increase the liquidity of stocks.

The other possible channel for the government intervention is from the increased investor's confidence. Bacchetta et al. (2012) and Benhabib et al. (2015) show that asset prices may enter self-fulfilling sentiment-driven equilibria. In the self-fulfilling

sentiment-driven equilibria, the asset price plunges, while its volatility shoots up. Government intervention may create additional value by pulling the economy away from the self-fulfilling equilibrium trap. To see this possibility, we consider two investor confidence indexes. The first one is a fear index like VIX in the USA. IVIX is the implied volatility of Shangzheng 50 ETF option. The first panel of Fig. 2 shows an obvious negative movement between IVIX and the Shanghai Composite Index. The second is a direct investor confidence survey index complied by China Securities Investor Protection Fund Corporation Limited. The second panel of Fig. 2 shows that the investor confidence clearly dropped during the crash period and rebounded back when the stock price increased.

5 Robustness

5.1 Alternative Control Variables

In the regressions reported in Tables 10, 11, 12, and 14, we use firm characteristics collected from the balance sheets in 2014Q4 as the control variables. As a robustness check, we now consider the balance sheet variables in 2015Q2 as the new control variables.

Table 15 reports the results. We find that our result, that value creation is positively related to GOV, is robust to using alternative measures of control variables. The magnitudes of the slope of GOV are similar for all variables that we are interested in. The slope of GOV changes from 0.009 to 0.007 for firm value growth (GFV), from 0.125 to 0.120 for debt value growth (GDV), from -0.369 to 0.421 for the change in default probabilities (DPC), and from − 0.095 to − 0.105 for illiquidity (LIQ). This difference might be due to the relatively small sample in our cross-sectional regressions.

Tables 14 and 15 show that the negative relationship between GOV and default probabilities and the positive relationship between GOV and liquidity are robust to alternative measures of control variables. Moreover, the slope of GOV is significant across various specifications and the magnitudes of the slope are quite similar in Tables 14 and 15.

5.2 Nonlinear Effects

It is reasonable to suspect a nonlinear effect of the government intervention on firms' default and liquidity. To see this possibility, we augment the regressions in Table 14 by adding a square term of GOV. Column 1 of Table 16 shows that the coefficient of GOV^2 on the change in default probabilities DPC is 0.214, while the coefficient on GOV changes from − 0.369 to − 1.199. Although both coefficients are statistically significant, the relative size suggests that the first-order term dominates. As a result, the adjusted *R*-square barely changes to 0.174 from 0.177. In other words, the regression does suggest some declining effect of the government intervention. However, it is not economically significant. Similarly when adding

Table 16 Robustness check: nonlinearity

	DPC (1)	LIQ (2)	DPC (3)	LIQ (4)
GOV	− 1.199***	− 0.176***	− 1.396***	− 0.197***
	(0.286)	(0.026)	(0.258)	(0.026)
GOV^2	0.214***	0.020***	0.253***	0.023***
	(0.072)	(0.006)	(0.065)	(0.006)
CCT	0.375	0.879***	1.380	0.827***
	(1.197)	(0.122)	(1.069)	(0.122)
ROA	− 2.761***	− 1.376***	− 0.157***	− 0.011*
	(0.779)	(0.238)	(0.049)	(0.006)
Sales	− 0.599**	− 0.289***	− 0.390	− 0.362***
	(0.285)	(0.033)	(0.273)	(0.036)
Suspension	0.410	0.088***	0.265	0.068**
	(0.251)	(0.030)	(0.222)	(0.030)
Export	− 1.099***	− 0.030	− 1.202***	− 0.034
	(0.253)	(0.028)	(0.227)	(0.028)
M/B	0.996***	− 0.059***	− 0.131***	− 0.005
	(0.207)	(0.019)	(0.028)	(0.005)
LEV	7.311***	0.182*	8.844***	0.203**
	(0.797)	(0.096)	(0.674)	(0.084)
SOE	0.309	− 0.049*	0.107	− 0.085***
	(0.288)	(0.028)	(0.274)	(0.029)
BC	− 0.208	− 0.203***	− 0.246	− 0.214***
	(0.475)	(0.029)	(0.451)	(0.028)
CF	0.433	0.389**	− 0.584	0.130
	(1.463)	(0.187)	(2.700)	(0.346)
DIV	0.165	0.077	0.400	− 0.020
	(0.597)	(0.048)	(0.282)	(0.027)
Constant	− 3.597***	0.792***	− 2.285***	0.886***
	(0.413)	(0.043)	(0.433)	(0.053)
Industry FE	YES	YES	YES	YES
Adj. R^2	0.177	0.273	0.178	0.255
N	2272	1825	2579	2091

This table presents the nonlinear regressions to estimate the correlation between the government purchase plan and corresponding dependent variables by including GOV^2 as an explanatory variable. All variables are defined in Table 9. All firm-level variables in columns 1 and 2 are based on the balance sheet information at Q4 2014; and those in columns 3 and 4 are based on the balance sheet information at Q2 2015. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

GOV^2 to the regression of measured liquidity as in column 2, its coefficient is 0.02, which is again statistically significant but economically not important. The adjusted R-square increases slightly from 0.271 to 0.273. We hence conclude that a linear

Table 17 Robustness check: difference-in-difference on Tobin's Q

Variables	(1) Long term	(2) Long term	(3) Short term	(4) Short term
GOVD	− 1.664**	− 1.596*	− 1.275***	− 1.187***
	(0.833)	(0.830)	(0.168)	(0.156)
Post	− 1.577	− 1.605	− 2.026***	− 1.995***
	(1.185)	(1.160)	(0.174)	(0.163)
DID	1.000	1.004	0.685***	0.654***
	(1.179)	(1.151)	(0.197)	(0.183)
Sale	− 0.003	− 0.002	0.000	0.001
	(0.002)	(0.002)	(0.001)	(0.001)
ROA	− 1.557	− 1.615	0.097***	0.091***
	(1.709)	(1.731)	(0.031)	(0.028)
Blue chip	0.504	0.371	− 1.030***	− 0.708***
	(1.563)	(1.161)	(0.129)	(0.119)
SOE	− 2.830**	− 2.469**	− 1.762***	− 1.244***
	(1.159)	(1.231)	(0.090)	(0.087)
Export	− 1.682**	− 1.348***	− 0.875***	− 0.922***
	(0.688)	(0.360)	(0.096)	(0.100)
Constant	7.739***	7.489***	5.660***	5.435***
	(2.933)	(2.822)	(0.177)	(0.161)
Industry FE	NO	YES	NO	YES
Adj. R^2	0.0165	0.0351	0.186	0.302
N	4255	4253	4140	4138

This table shows the regression results of the function $\text{Tobin}Q_{i,t} = \alpha \text{GOV}\, D_i + \beta \text{Post}_t + \theta \text{DID}_{i,t} + \text{Controls}_{it} + \epsilon_{i,t}$, where $\text{DID}_{i,t} = \text{GOV}\, D_i * \text{Post}_t$. In columns (1) and (2), Post = 0 if 2015Q2, Post = 1 if 2016Q1; in columns (3) and (4), Post = 0 if 2015Q2, Post = 1 if 2015Q3. And columns (2) and (4) present the results with industry fixed effect being controlled

Robust standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

regression is sufficient in our sample. In columns 3 and 4 of Table 16, we consider the balance sheet data in quarter 2 and find similar results.

5.3 Long-Run Price Performance

We use the difference-in-difference approach to estimate the persistence of the price effects of the government intervention. We use Tobin's Q to study the price effect. We measure Tobin's Q using equity value (the market capitalization) divided by the book value of assets. Since we have used equity value as an input to compute debt value, firm value, and default probabilities as described in Sect. 3.1, these variables are nonlinear functions of equity value and hence Tobin's Q. Table 17 reports the results for the sample over 2015Q2 and 2016Q1 and the sample over 2015Q2 and

2015Q3. We use these two samples to study the long- and short-run effects of the government intervention. The variable $\text{GOV}\,D_i$ is a dummy variable which is equal to 1 if the government purchased stock i, and 0 otherwise. The variable Post_t is equal to 0 if t is equal to 2015Q2 and 1 if t is equal to 2016Q1 or 2015Q3. The variable $\text{DID}_{i,t} = \text{GOV}\,D_i * \text{Post}_t$. We find that the coefficient of this variable is significant for the sample over 2015Q2 and 2015Q3, but insignificant for the sample over 2015Q2 and 2016Q1, indicating that the government purchases have a short-run effect, but do not have a significant long-run effect on the firm's Tobin's Q.

6 Conclusions

In this paper, we have estimated the benefits and costs of the government purchase plan. We find that the plan increased the value of a subsample of the rescued nonfinancial firms by about RMB 206 billion after netting out the average purchase cost**,** which is about 1% of the Chinese GDP in 2014. The value creation came from the increased stock demand, the reduced default probabilities, and the increased liquidity.

We have used the Merton (1974) model to estimate the benefits and costs, as a starting point. This model needs strong assumptions such as the geometric Brownian motion process for firm value, the constant interest rate, and the discount defaultable debt. Developing a more complicated model by relaxing some of these assumptions will change our estimates. We hope our analysis can be used as a benchmark to stimulate further research in this direction. Extending the Merton model to take into account the impact of government intervention is an important future research topic.

We should emphasize that our estimates are based on a short-run analysis. Many researchers are concerned about the long-run costs of the Chinese government intervention. First, the massive stock purchases by the government prevented the efficient discovery of the stock prices. The national team is a large player in the stock market, whose transactions can have a large impact on the price movements. As a result, the stock prices may not reflect fundamentals. This may plant the seeds of a future bubble. Also how the government exits from the stock market may create uncertainty in the market for a long time. The Hong Kong government intervention on the stock market and the futures market during the height of financial crisis in 1998 suggest that transparency helps reduce these long-run costs and frictions such as moral hazard by investors and firms.

Second, although the government intervention stabilized the stock market in the short run, its trial-and-error approach may create more uncertainty, which is also a cause of market volatility. Some researchers argue that the Chinese stock market is like a casino whose owner keeps changing the rules to favor the house. The Chinese government appears to be manipulating the rules to favor a bull market and has actually eroded the integrity of the system and cast doubt on the government's ability to manage its financial affairs.

Third, on July 8, 2015, the Chinese regulators imposed a lockup on shareholders owning 5% or more of their companies, prohibiting them from selling for 6 months.

This rule is intended to prevent massive selling in declining markets. With the first wave of lockedup shares coming due in January 2016, just 3 days after the massive plunge, the Chinese stock markets were fearing the worst, triggering another steep decline in February 2016. The Chinese government extended the lock-up until additional rules could be established. Nearly 4 billion shares were set to become tradable again when the lockup expired. The effect of lockups is well understood in mature stock markets; they tend to create latent bearish pressures as the expiration approaches. With an immature market like the Chinese stock market, the effects are much more prominent.

Fourth, the Chinese regulators banned 1-day short selling, which was blamed to be a primary cause of the stock market volatility by the Chinese government. Although this restriction stabilized stock prices for a while, it could lead to greater volatility, since short sellers are more willing to buy during a stock market rout. Without them, there is nothing to slow the decline. It is likely that the short sellers' absence exacerbated the stock market plunge in the summer of 2015 and early 2016. Note that the US stock market's biggest collapse occurred after the Securities and Exchange Commission (SEC) banned short selling.

Fifth, the Chinese government intervention can create a moral hazard problem. If firms believe that the government will rescue them if they default on the margin loans, then they may keep borrowing more without improving the loans' profitability.

Besides the possible long-run costs discussed above, there are many other questions worth further studying. For example, what are the problems of the Chinese trading system? How should one reform this system? Is there a better alternative intervention approach? The cost and benefit estimated in this paper suggest that these are billion-dollar questions. The nature of these questions, however, necessarily calls for a general equilibrium framework beyond our empirical analysis. Such a framework is unequivocally important but also challenging. We hence leave these questions for future research.

References

Acharya, Viral V., Qian Jun, and Zhishu Yang. 2016. In the Shadow of Banks: Wealth Management Products and Bank Risks. Working Paper, SAIF.

Allen, Franklin, Susan C. Shan, Jun Qian, Julie L. Zhu. 2015. Explaining the Disconnection Between China's Economic Growth and Stock Market Performance. Working Paper, SAIF.

Amihud, Yakov. 2002. Illiquidity and Stock Returns: Cross-Section and Time-Series Effects. *Journal of Financial Markets* 5: 31–56.

Bacchetta, Philippe, Tille Cedric, and Eric van Wincoop. 2012. Self-Fulfilling Risk Panics. *American Economic Review* 102 (7): 3674–3700.

Benhabib, Jess, Xuewen Liu, and Pengfei Wang. 2015. Sentiments, Financial Markets, and Macroeconomic Fluctuations. *Journal of Financial Economics* 120 (2): 420–443.

Bharath, Sreedhar, and Shumway Tyler. 2008. Forecasting Default with the Merton Distance to Default Model. *Review of Financial Studies* 21: 1339–1369.

Bian, Jiangze, Zhi Da, Dong Lou, and Hao Zhou. 2017a. Leverage Network and Market Contagion. Working Paper, Tsinghua University.

Bian, Jiangze, Zhiguo He, Kelly Shue, and Hao Zhou. 2017b. Leverage-Induced Fire Sales and Stock Market Crashes. Working Paper, University of Chicago.
Brogaard, Jonathan, Dan Li, and Ying Xia. 2016. Stock Liquidity and Default Risk. *Journal of Financial Economics* 124: 486–502
Brunnermeier, Markus, and Pedersen Lasse. 2009. Market Liquidity and Funding Liquidity. *Review of Financial Studies* 22: 2201–2238.
Chen, Hui, Anton Petukhov, and Jiang Wang. 2016. A Dynamic Model of Circuit Breakers. Working Paper, MIT.
Chen, Ting, Gao Zhenyu, He Jibao, Jiang Wenxi, Xiong Wei. 2017. Daily Price Limits and Destructive Market Behavior. NBER Working Paper.
Chen, Zhuo, He Zhiguo, and Liu Chun. 2017. The Financing of Local Government in China: Stimulus Loan Wanes and Shadow Banking Waxes. Working Paper, University of Chicago.
Cheng, L.T.W., J.K.W. Fung, and K.C. Chan. 2000. Pricing Dynamics of Index Options and Index Futures in Hong Kong Before and During the Asian Financial Crisis. *Journal of Futures Markets* 20: 145–166.
Chi, Yegang, and Xiaoming Li. 2017. Beauties of the Emperor: Investigations of an Opaque Stock Market Bailout. Working Paper, Shanghai Jiaotong University.
Crosbie, Peter, and Jeffrey Bohn. 2003. Modeling default risk. KMV white paper series.
Huang, Yi, Marco Pagano, and Ugo Panizza. 2016. Local Crowding Out in China. Working Paper, Graduate Institute, Geneva.
Liu, Xiaolei, Jiajie Xu, and Ninghua Zhong. 2017. Trading Restrictions as a Channel of Financial Contagion: Evidence From China's Stock Market. Working Paper, Beijing University.
Merton, Robert. 1974. On the Pricing of Corporate Debt: The Risk Structure of Interest Rates. *Journal of Finance* 29: 449–470.
Miao, Jianjun, and Pengfei Wang. 2012. Bubbles and Total Factor Productivity. *American Economic Review* 102: 82–87.
Miao, Jianjun, and Pengfei Wang. 2014. Sectoral Bubbles, Misallocation, and Endogenous Growth. *Journal of Mathematical Economics* 53: 153–163.
Miao, Jianjun, and Pengfei Wang. 2015. Banking Bubbles and Financial Crises. *Journal of Economic Theory* 157: 763–792.
Miao, Jianjun, and Pengfei Wang. 2018. Asset Bubbles and Credit Constraints. *American Economic Review* 108: 2590–2628.
Miao, Jianjun, Pengfei Wang, and Xu Zhiwei. 2015. A Bayesian DSGE Model of Stock Market Bubbles and Business Cycles. *Quantitative Economics* 6: 599–635.
Miao, Jianjun, Pengfei Wang, and Jing Zhou. 2015. Asset Bubbles, Collateral, and Policy Analysis. *Journal of Monetary Economics* 76: S57–S70.
Morck, Randall, Andrei Shleifer, and Robert W Vishny. 1988. Management Ownership and Market Valuation: An Empirical Analysis. *Journal of Financial Economics* 20: 293–315.
Sharpe, F.William. 1964. Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk. *Journal of Finance* 19: 425–442.
Song, Zheng, and Wei Xiong. 2018. Risks in China's Financial System. *Annual Review of Financial Economics* 10: 261–286.
Su, Yuli, Yewmun Yip, and Rickie Wong. 2002. The Impact of Government Intervention on Stock Returns: Evidence From Hong Kong. *International Review of Economics and Finance* 11: 277–297.
Vassalou, Maria, and Yuhang Xing. 2004. Default Risk in Equity Returns. *Journal of Finance* 59: 831–868.
Veronesi, Pietro, and Luigi Zingales. 2010. Paulson's Gift. *Journal of Financial Economics* 3: 339–368.

Yi Huang is an assistant professor at Graduate Institute. He received PhD from London School of Economics. His research interests lie at the intersection of international macroeconomics and finance. He is particularly interested in investigating the determinants of financial activity and economic development in the era of globalization.

Jianjun Miao is Professor of Economics at Boston University, and an Associate Editor of *Economic Theory, Journal of Mathematical Economics, and Macroeconomic Dynamics*. He received his B.S. in Mathematics from the University of Science and Technology of China in 1992 and his PhD in Economics from the University of Rochester in 2003. Professor Miao's main research areas are finance and macroeconomics. He publishes extensively in top economics and finance journals including *American Economic Review, Econometrica, and Journal of Finance*.

Pengfei Wang is professor at Hong Kong University of Science and Technology. He received PhD from Cornell University in 2007. His research fields are macroeconomics, monetary economics, and financial economics