

Financial crisis and corporate cash holdings: Evidence from East Asian firms

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Abstract

We investigate the long-term effect of the Asian financial crisis on corporate cash holdings in eight East Asian countries. The median cash to assets ratio for the Asian firms almost doubles from 6.7% in 1996 to 12.1% in 2006, and the sudden increase in cash holdings is pervasive regardless of financial constraints. The Asian firms build up cash holdings by decreasing investment activities such as capital expenditures and acquisitions after the crisis. We find that the increase in cash holdings is not explained by changes in firm characteristics but by change in the firm's demand function for cash, which indicates that the crisis has systematically changed the firms' cash holding policies. Specifically, the firms' increased sensitivity to cash flow volatility is one of the main factors to explain the higher level of their cash holdings in the post-crisis period. These findings are partially consistent with the precautionary motive of cash holdings in that financial crisis can make the management policies of firms very conservative even after the economy recovers from the crisis.

JEL classification: G3; G32

Key words: Cash holdings; Asian financial crisis; Cash flow risk

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1. Introduction

The recent financial crisis over the period of 2007-2009 has highlighted once again the importance of firms' demand on liquid assets. For many non-financial firms, external financing becomes too expensive and/or difficult to obtain due to the tight financial markets in a period of crisis. Therefore, the firms tend to make efforts to increase cash holdings to avoid raising external capital such as bank loans, bond offerings, and equity offerings in response to the crisis. According to the Liquidity Management Poll conducted by the American Productivity & Quality Center in March 2009, nine of 10 finance executives report that their companies have taken proactive measures to increase their cash holdings and made their liquidity management a top corporate priority¹.

Although we know that the seemingly recurrent financial crises affect the liquidity management policies of firms over the short-term, there has been little research on how financial crisis fundamentally changes the management policies of the firms. The firms tend to implement financial conservatism and low investment policies over the short-term period after the crisis begins, which can temporarily result in higher corporate cash holdings. Whether financial crisis makes the demand function of the firms for cash shift permanently is the empirical question. We try to answer the question in this research.

Recent studies have investigated how the global financial crisis has changed the short-term management policies of firms. For instance, Duchin, Ozbas, and Sensoy (2010) find that U.S. firms burn through cash holdings during a period of global financial crisis, and post-crisis investment is positively related to cash reserves. Campello, Graham, and Harvey (2010) also find that firms are likely to postpone or cancel investment plans when the capital markets are

¹ eBankings & Payments News, May 7, 2009.

tightened. While these studies have focused on the short-term effect of the crisis, we investigate the long-term effect of the Asian financial crisis on the liquidity management by examining cash holdings of East Asian firms before and after the Asian financial crisis.

Most previous literature on corporate cash holdings tries to explain the cross-sectional variation of the firms' cash holdings. In contrast, Bates, Kahle, and Stulz (2009) focus on the time-series trend of U.S. firms' cash holdings. Similar to Bates et al. (2009), we are interested in time-series differences in cash holdings of East Asian firms, and specially focus on the differences before and after the Asian financial crisis. The Asian financial crisis over the period of 1997-1998 was one of the biggest events for Asian firms in the modern era. The firms experienced unusual exogenous shocks like currency devaluation, high interest rates, and difficulty of raising capital, and a substantial number of firms filed bankruptcy during the crisis. The precautionary motive of cash holdings suggests that firms increase their propensity to save cash following negative macroeconomic shocks, and financially constrained firms increase their cash holdings more than unconstrained firms. However, we do not know whether the crisis has a long-term effect on corporate cash holdings. The Asian financial crisis provides us with a natural experiment to investigate the long-term impact of macroeconomic shocks on the change in the firms' cash holding policies.

Using a sample of 32,174 firm-years representing 5,059 East Asian firms over the period of 1990-2006, we first examine the trend in East Asian firms' cash holdings before and after the Asian financial crisis. The sample firms come from eight East Asian countries including Hong Kong, Indonesia, Malaysia, the Philippines, Singapore, South Korea, Taiwan, and Thailand, which were affected the most by the crisis during the period of 1997-1998. We find that East Asian firms almost double the median cash holdings over the 10-year period after the crisis by

increasing from 6.7% in 1996 to 12.1% in 2006. The median cash ratio slightly decreases in the early 1990s and gradually increases after 1998. We find that there is a structural change in the time-series of the firms' cash holdings around the crisis period, and the change is statistically significant. Even though stock market indexes and gross domestic products (GDP) in most of the Asian countries recovered to the pre-crisis level by the early 2000s, the Asian firms continue to build up cash holdings over the sample period. We also document that the relation between investments and cash ratios are significantly negative, specifically in the post-crisis period, which means that the Asian firms increase cash holdings by spending less money in capital expenditures and merger and acquisition activities. This is consistent with the precautionary motive of cash holdings in that the firms adopt more conservative investment policies after the crisis, which leads to the increase in cash holdings. We also find that the increase in the Asian firms' cash holdings is not related to their payout or financing policies.

Next, we divide the sample into well-established firms before the crisis (pre-existing firms), IPO firms during the crisis (1996-1998), and IPO firms after the crisis (1999-2006). We find that the median cash ratio of pre-existing firms increases from 6.5% in 1996 to 10.1% in 2006 while the median investments ratio for the sub-sample decreases from 6.3% to 3.9% over the same period. This suggests that the increase in cash holdings is not limited to newly listing firms and it is observed in even older and well-established firms. This study focuses on the change in the cash holdings of the pre-existing firms. We examine whether the increase of the firms' cash ratios after the crisis results from changes in firm characteristics. Han and Qiu (2007) find that financially constrained firms increase their cash holdings in response to increases in cash flow volatility. Bates et al. (2009) find that the increase of U.S. firms' cash holdings in the 1990s and 2000s is related to increased risk, lower net working capital, and more

R&D investments. We find that the firm characteristics such as cash flow, growth opportunities, and cash flow volatility are very different in the post-crisis period compared to those in the pre-crisis period. We test whether the different firm characteristics predict the cash ratios after the crisis assuming that the firms' demand function of cash has not changed. We find that the changes in firm characteristics do not explain the Asian firms' higher cash holdings in the post-crisis period.

We then examine whether the increasing precautionary motive after the crisis affects East Asian firms' demand function for cash. Based on regressions that relate the cash ratio to firm characteristics, we identify there was a regime change in how the Asian firms determine their cash holdings after the crisis. We find that the intercepts of the regression models are significantly higher in the post-crisis period, which indicates that some portion of the increase in cash holdings is not explained by the relation between cash ratio and firm characteristics. We also test whether the slope coefficients of the regression models change after the crisis. We find that most of the slope coefficients significantly changes during the post-crisis period. The most striking change is the increase in the coefficient on industry cash flow volatility, which suggests that the firms' increased sensitivity to cash flow risk is one of the main factors to explain the increase in the cash holdings. We interpret this as the firms increase cash holdings to better manage their risk after they experience exogenous shocks of the Asian financial crisis. In brief, these results suggest that the increase in the Asian firms' cash holdings is mainly driven by changes in the firms' demand function for cash holdings.

The literature on precautionary motive of cash holdings suggests that financially constrained firms increase their cash ratios more than unconstrained firms after the

macroeconomics shocks². We find that large, dividend-paying, or low-leveraged firms (financially unconstrained firms) tend to have higher cash ratios than financially constrained firms over the sample period. We also find that the unconstrained firms maintain much higher investment rates in the pre-crisis period and react more severely to the increasing precautionary motive to build up cash by reducing investments in response to the Asian financial crisis. These results are not consistent with the precautionary motive of cash holdings.

The trend in cash holdings of East Asian firms over the sample period is very different from that of the firms in developed countries over the same period. Bates et al. (2009) document a secular increase in the cash holdings of U.S. firms from 1980 to 2006 while Iskandar-Datta and Jia (2010) find a similar trend for the firms in other G-7 countries, except for Japan. The firms' increase in cash holdings in the developed countries is mostly explained by changes in firm characteristics in the 1990s and 2000s. In contrast, we find that East Asian firms start to build up cash only after the Asian financial crisis, and their increase in cash holdings is explained by changes in their demand function for cash. These results suggest that the Asian financial crisis has a long-term effect on the firms' liquidity management policies. In general, our findings are partially consistent with the precautionary motive of cash holdings in that Asian firms become more conservative in investing and cash holding policies after they experience macroeconomic shocks.

Our results are also consistent with some commentators' concerns about the conservative management of Asian firms. Media and government officials have argued that the conservative financial policies after the crisis would make the Asian firms lose their competitive edge in international competition. For instance, *Maeil Business Newspaper* states that Korean companies have been warned that they face possible difficulties in competing against chief

² For instance, refer to Almeida, Campello, and Weisbach (2004) for this argument.

international corporations in the future, due to their overly conservative management styles, according to Bank of Korea's "Business Achievements of Major Corporations by Industries" report.³

The rest of the paper proceeds as follows. Section 2 discusses related literature while Section 3 explains the sample selection and the data. Section 4 describes the empirical findings, and Section 5 concludes the paper.

2. Related literature

Recent studies show that macroeconomic conditions could be an important determinant of firms' cash-holding behavior. Duchin et al. (2010) and Campello et al. (2010) document that the firms have changed their investments and cash holding policies in a short term, responding to the global financial crisis of 2007-2009. Baum, Caglayan, Ozkan, and Talavera (2005) find that the cross-sectional dispersion of corporate cash holdings narrows as increased macroeconomic uncertainty hinders managers' ability to accurately evaluate firms' specific information. Compared to these studies, we investigate the long-term effect of Asian financial crisis of 1997-1998 on the cash holdings of East Asian firms.

Previous research focuses on the cross sectional determinants of cash. The literature develops models of optimal cash holdings based on various motives, and explains the cross-sectional variation in the firms' cash holdings, mainly using U.S. data. Earlier literature develops models of optimal demands for cash based on transaction costs. From the perspective of the transactional motive, the main benefit of cash holdings is that a firm can save transaction costs by using cash to make payments without having to liquidate assets. A firm holds more cash when it incurs higher transaction costs to convert a non-cash asset into cash whereas it holds

³ "BOK: Korean Firms too conservative", by Dong-eun Lee, Maeil Business Newspaper, October 3, 2006

less cash when an opportunity cost of money is higher. For instance, Miller and Orr (1966) show that brokerage costs could induce firms to hold more liquid assets. There are economies of scale with transaction costs, so that large firms hold less cash. Mulligan (1997) finds that large firms hold less cash as a percentage of sales than small firms consistent with transaction motive.

The precautionary motive is generally accepted as the primary drivers of cash policy. A firm builds up cash to cope with future adverse shocks or to hedge against the risk of future cash shortfalls when access to capital markets is costly. Kim, Mauer, and Sherman (1998) develop a model in which the optimal amount of cash holdings is determined by a tradeoff between the low return earned on liquid assets and the benefit of minimizing the need for costly external financing. Opler, Pinkowitz, Stulz, and Williamson (1999) also develop a model of optimal corporate cash holdings. The main benefit of cash holdings in their model is that a firm can reduce the underinvestment problem by maintaining sufficient cash levels while the cost of cash holdings is a lower return earned on cash holdings compared to investing in other opportunities. They find that riskier firms or firms with better investment opportunities hold more cash in their empirical tests, which is consistent with precautionary motive. Almeida, Campello, and Weisbach (2004) develop a model in which financial constraints are related to a firm's propensity to save cash out of cash inflows (cash flow sensitivity of cash). They show that financially constrained firms' cash flow sensitivity increases during recessions, while unconstrained firms' cash flow sensitivity is unaffected by business cycles. This suggests that financially constrained firms should respond more severely to the Asian financial crisis compared to unconstrained firms.

The increasing precautionary motive of East Asian firms after Asian financial crisis might change their demand function for cash. The firm managers would manage their businesses

more conservatively and hold more cash after experiencing adverse shocks. We test whether increases in Asian firms' cash holdings after the crisis are explained by the change in their demand function for cash. We specifically think that firm managers would be more sensitive to risk after the crisis, and test whether the Asian firms' sensitivity to cash flow risk has changed in the post-crisis period.

Firms can increase their cash holdings due to changes in firm characteristics even though their demand function for cash has not changed. Han and Qiu (2007) find that financially constrained firms increase their cash holdings in response to increases in cash flow volatility while unconstrained firms show no systematic relation between cash holdings and cash flow volatility. After the Asian financial crisis, Asian firms tend to experience higher cash flow risk and higher stock return volatility due to more severe competition with foreign competitors and macroeconomic uncertainty. This suggests that Asian firms increase their cash holdings in response to higher cash flow risk and lower growth opportunities in the post-crisis period. Assuming that the demand function for cash remains unchanged after the crisis, we test whether the changes in firm characteristics explain the increase in the firms' cash holdings.

Previous literature also finds that agency problem is an important determinant of cash holdings. Jensen (1986) argues that agency conflicts between shareholders and managers are most severe when firms have large free cash flows. Managers can spend cash for their own interests at the expense of shareholders if they have free cash flows. Cross-country evidence is consistent with agency costs of free cash flows in that greater shareholder rights are associated with lower cash holdings. Dittmar, Mahrt-Smith, and Servaes (2003) investigate 11,000 firms from 45 countries, and find that firms in countries with poor shareholder protection hold more cash. They also find that the determinants of cash holdings like investment opportunities and

asymmetric information are less important when shareholder protection is poor, and firms hold more cash when access to funds is easier. Ozkan and Ozkan (2004) find that cash holdings fall as managerial ownership increases up to 24%, rise as managerial ownership increase to 64%, and fall again above 64% in U.K. firms. They also find that cash holdings of firms are positively related to cash flows and growth opportunities, and are associated with lower levels of bank debt and leverage. Using international data, Kalcheva and Lins (2007) find that outside shareholders apply a valuation discount to high cash balances carried by firms whose managers are also expected to be entrenched. Due to the data limitation, we do not test whether agency problems have affected the increases in the Asian firms' cash holdings.

Harford (1999) and Harford, Mansi, and Maxwell (2008) study how agency problems affect the use of internal funds. To be consistent with the agency costs theory, Harford (1999) finds that cash-rich firms in the U.S. are more likely to make diversifying acquisitions and those acquisitions by cash-rich firms are value-decreasing. Building on the research, Harford et al. (2008) find that firms with weaker corporate governance dissipate their cash reserves more quickly and the firms spend the cash primarily on acquisitions. Dittmar and Mahrt-Smith (2007) also find that firms with poor corporate governance dissipate cash quickly in ways that significantly reduce operating performance. However, Mikkelsen and Partch (2003) find that operating performance of high cash firms in the U.S. is comparable to or greater than the performance of firms matched by size and industry, and high cash firms grow faster, undertake higher levels of investment, and have higher ratios of market-to-book value of assets. They also find that governance characteristics do not explain the variation in performance among firms with large cash holdings.

While most previous literature focuses on cross-sectional differences in corporate cash holdings, Bates et al. (2009) investigate the time-series variation in cash ratios and net debt of the U.S. firms over the period of 1980-2006. They find that the average cash to assets ratio gradually increases over the sample period. They also document that the increase is concentrated among non-dividend-paying firms and is explained by changes in firm characteristics. Iskandar-Datta and Jia (2010) extend Bates et al.'s (2009) research to the firms in G-7 countries and find that the secular trend in corporate cash holdings is observed in other developed countries, except for Japan. Barger, Lehn, and Zutter (2007) also find that U.S. firms have significantly reduced their R&D and capital expenditures, but significantly increased their cash holdings since the Sarbanes-Oxley Act of 2002 compared with their U.K. counterparts. Similar to this line of research, we investigate the trend in cash holdings of East Asian firms and specifically focus on the change in the post-crisis period.

For the research on Asian firms' cash holdings, Rajan and Zingales (1995) present descriptive statistics showing that Japanese firms hold more cash than other firms in G-7 countries. Pinkowitz and Williamson (2001) investigate why Japanese firms hold twice as much cash holdings as U.S. and German firms. They argue that the large cash holdings in Japan are explained by the strong bank power, and the cash holdings decrease as the bank power weakens. However, there is little research about the increase in East Asian firms' cash holdings after the Asian financial crisis.

3. Sample and data

We construct our sample of firms from Thomson Financial's *Worldscope* database for the period 1990-2006. We restrict our sample to firms that are incorporated in the eight East Asian

countries including Hong Kong, Indonesia, Malaysia, the Philippines, Singapore, South Korea, Taiwan, and Thailand, which were affected the most by the Asian financial crisis during the period of 1997-1998. We collect most of accounting data beginning in 1990 because *Worldscope* includes data of only a few firms in some countries for the 1980s. Because we calculate the standard deviation of earnings before interest and taxes (EBIT)/assets for each firm-year using five-year data, the data goes back to 1986 for some firms. We obtain the stock return data from *Datastream*. We exclude financial firms with SIC codes of 6000-6999 because they may carry cash to meet the regulations of the industry or individual country. Our final sample consists of 32,174 firm-years representing 5,059 unique firms. Of these firms, most of the firms (1,136 firms, 22.5%) are incorporated in Taiwan and the least (121 firms, 2.4%) are incorporated in the Philippines.

We report descriptive statistics on each variable used in our tests in Table 1. The table reports the number of firm-years (N), mean, median, maximum, minimum, and standard deviation (Std) for each variable. Cash ratio is the ratio of cash and short-term investments to the book value of total assets. The mean (median) cash ratio is 14.0% (9.8%) with a standard deviation of 13.2%, which is lower than U.S. firms with cash ratios of higher than 20% in the 2000s. Leverage is the ratio of total debt to the book value of total assets and the mean leverage is 25.6%. The mean noncash net working capital to assets ratio (NWC/assets), which is the ratio of net working capital minus cash and short-term investments to the book value of total assets, is 3.2% with a standard deviation of 18.4%.

[Insert Table 1 about here]

To measure the investments of each firm-year, we add capital expenditures and acquisitions. The mean ratio of investments to assets is 6.7% with a standard deviation of 7.4%.

Market-to-book ratio is calculated as the sum of total debt and the market value of equity, divided by the book value of total assets. The mean market to book ratio of assets is 1.122 with a standard deviation of 1.041. Firm size is measured as a natural log of the book value of total assets (\$ in thousands), which is translated to U.S. dollars using year-ending exchange rates. The mean firm size is 11.62 (\$152 million) with a standard deviation of 1.52. Dividend/assets is the ratio of cash dividend paid to the book value of total assets for only 22,497 dividend-paying firm-years (69.92% of 32,174 firm-years). The mean (median) dividend payout is 2.8% (1.6%) with a standard deviation of 3.4%. Equity issuance/assets is the ratio of equity sales to the book value of total assets. The mean (median) equity issuance ratio is 2.4% (0.0%) with a standard deviation of 7.5%. To measure the cash flow of each firm year, we use the ratio of EBIT to the book value of the assets⁴. The mean EBIT/assets is 7.2% while the median is 6.1%.

We use standard deviation of EBIT/assets (STD of EBIT) and industry average of STD of EBIT (industry sigma) to measure the risk of each firm-year. The STD of EBIT is calculated using the ratios of EBIT to the book value of total assets over the previous five years. We then calculate the average risk of each industry, which is termed as industry sigma. We classify the sample firms into 66 industries using the two-digit SIC codes. The industry sigma is the average of STD of EBIT/assets for each industry in the same country and year. The mean STD of EBIT/assets is 0.036 and the mean industry sigma is 0.036 as well. We also measure sales growth as the geometric mean of the growth rate of sales over the previous two years. The mean sales growth is 13.8% while the median is 10.2%.

4. Empirical findings

⁴ Unlike previous literature, this study uses EBIT instead of operating cash flow due to data limitation from *Worldscope*.

4.1. How much has the firms' cash holdings increased after the Asian financial crisis?

We first examine changes in cash holdings of the East Asian firms after the Asian financial crisis. Table 2 reports the number of firm-years and the mean and median ratios of cash, leverage, and equity issuance, payouts to stockholders, and investments to assets year by year.

[Insert Table 2 about here]

Table 2 shows that the trend in the mean cash ratio of the Asian firms has been very stable around 11.0% from 1990 to 1996, and it starts to increase after the Asian financial crisis of 1997-1998. The mean cash ratio increases from 11.0% to 16.0% in 2006. The changes in the median cash ratios for the sample are more dramatic. The firms' median cash holdings increase from 6.7% in 1996 to 12.1% in 2006, which almost doubles over the 10-year period. We use the Chow test to investigate a structural change after the crisis period (1997-1998) in the time-series of cash ratios. The test result is statistically significant with a p-value of less than 0.01, which indicates that the time-series pattern of Asian firms' cash ratios in the post-crisis period are different compared to that in the pre-crisis period.

In comparison, Bates et al. (2009) find that American firms increase cash holdings gradually to 23.2% in 2006 from 10.5% in 1980. While American firms have accumulated cash since the 1980s, East Asian firms suddenly begin increasing cash holdings after the Asian financial crisis. In Figure 1, we compare the mean cash ratios for East Asian firms vs. U.S. firms over the period of 1990-2006⁵. The Asian firms' cash holdings remain slightly over 10% before the Asian financial crisis while the American firms gradually increase cash ratios. The difference in the mean cash ratios between the two samples increases from 1.7% in 1990 to 7.6% in 1997. Figure 1 shows that the Asian firms increase their cash holdings sharply over the period

⁵ We obtain the data on cash ratios for U.S. non-financial firms from Compustat.

of 1999-2003. The difference in the mean cash ratios decreases to 4.8% in 2002 and it slightly increases after 2002.

[Insert Figure 1 about here]

The increase in Asian firms' cash holdings should affect their financial, investment, or payout policies after the crisis. To investigate these possibilities, we also report the trends of leverage, equity issuance/assets, investments/assets, and payouts/assets year by year in Table 2. The mean (median) leverage ratio slightly increases from 27.7% (26.2%) in 1990 to 31.4% (31.5%) in 1996, and gradually decreases to 20.9% (18.6%) in 2006 after the crisis. The mean ratio of equity issuance to assets decreases from 3.1% in 1996 to 1.7% in 2006. These indicate that Asian firms' accumulation of cash after the crisis is not driven by external financing. The firms can also increase cash holdings by reducing payouts to shareholders. We measure the payouts to shareholders as the ratio of cash dividends plus share repurchase amounts to the book value of assets each year. The Asian firms' payout ratios decrease during the crisis but increases after 1999. The mean payout ratio is 1.8% in 1996 while it is 2.6% in 2006. This indicates that Asian firms have not built up cash holding by reducing payouts to shareholders after the crisis. We then investigate the trend of the firms' capital expenditures and acquisitions and find a sudden change in investments after the crisis. The Asian firms decrease the mean (median) ratio of investments to assets almost half to 5.6% (3.5%) in 2003 from 9.0% (6.4%) in 1996, and slightly increase the ratios over the period of 2003-2006. These results indicate that the sudden increase in Asian firms' cash holdings after the crisis is related to the decrease in investments.

In untabulated tests, we divide the eight countries into two groups, Hong Kong, Singapore, South Korea, and Taiwan vs. Indonesia, Malaysia, the Philippines, and Thailand. The former countries are more developed and more quickly recovered from the Asian financial crisis,

compared to the latter countries. We find that firms in the former countries increase cash holdings more in the post-crisis period than those in the latter countries. The firms in Hong Kong, Singapore, South Korea, and Taiwan seem to have more leeway to save cash from internal cash flows after the crisis compared to those in the other four countries.

To further investigate the relation between cash holdings and investments, we estimate the equations of cash holdings and investments. However, the estimation is complicated by the possibility that the levels of both cash holdings and investments can be simultaneously determined by some factors like profitability and investment opportunities. For instance, firms with more profitable investment opportunities invest more and possibly require more cash holdings to take advantage of the investment opportunities. To account for the simultaneous determination of cash holdings and investments, we estimate the system of cash holding and investment models. This setup allows us to examine the effect of investments on cash holdings and the effect of cash holdings on investments.

Following Opler et al. (1999), we model cash ratio as a function of NWC, investments, EBIT, market-to-book ratio, firm size, leverage, dividend dummy, and industry cash flow volatility (industry sigma). We use the ratio of EBIT to assets instead of cash flow to assets due to limited data on depreciation and amortization expenses from *Worldscope*. We also model investments as a function of EBIT, market-to-book ratio, cash holdings, and sales growth, following Lang, Ofek, and Stulz (1996). We run the regressions for the whole-period sample (1990-2006), the pre-crisis sample (1990-1996), and the post-crisis sample (1999-2006), and report the results in Table 3.

[Insert Table 3 about here]

In the cash ratio equation for the whole-period sample, the result indicates that a firm's non-cash net working capital and leverage are negatively related to its cash ratio while the firm's cash flow (EBIT), market-to-book ratio, size, and the cash dividend payment are positively related to its cash ratio. The coefficient on investments/assets is -0.847 with a p-value of less than 0.01, which means that the firm's cash ratio is lower when it invests more on capital expenditures and acquisitions. In the investments/assets equation, the result indicates that a firm's growth opportunities, measured by market-to-book ratio and sales growth, are positively related to its investments while the coefficient on EBIT/assets is marginally significant. The coefficient on cash ratio is significantly positive, which is consistent with Denis and Sibilkov's (2009) findings.

Comparing the regression results for the pre-crisis sample to those for the post-crisis sample, we find that the coefficient on investments/assets is not significant in the pre-crisis period (-0.531), but is negatively significant in the post-crisis period (-1.383). This is consistent with the time-series pattern reported in Table 2 that the increase in Asian firms' cash holdings after the crisis is related to the decrease in their investments. The results in Table 2 & 3 suggest that East Asian firms build up cash holdings by reducing their investing activities on capital expenditures and M&As.

4.2. Do changes in firm characteristics explain the increase in Asian firms' cash holdings?

In the previous sub-section, we find that East Asian firms dramatically increase their cash holdings and decrease investments after the Asian financial crisis. There is a possibility that firms increase cash holdings after the crisis because their characteristics have changed. Fama and French (2004) find that the composition of firms has recently changed due to an influx of

newly listed firms. These new firms tend to be small and have more growth opportunities and higher cash flow risk. It can be argued that the increase of the sample firms' cash holdings after the crisis might be related to the different composition of firms. To test this possibility, we divide our sample into well-established firms before the crisis (pre-existing firms), firms that went public during the crisis (1996-1998), and firms that went public after the crisis (1999-2006). We report the number of firms and the median cash ratios and investments/assets ratios of each sub-sample year by year in Table 4.

[Insert Table 4 about here]

Pre-existing firms increase the median cash ratio from 6.5% in 1996 to 10.1% in 2006 while they reduce the median investments ratio from 6.3% to 3.9% over the same period. This is inconsistent with Bates et al.'s (2009) finding that cash holdings do not increase for older, established U.S. firms. IPO firms during the crisis also increase the median cash ratio from 8.1% in 1996 to 12.2% in 2006 while they decrease the median investments ratio from 7.5% to 4.0%. The number of firms for the sub-sample of IPO firms after the crisis sharply increases due to a surge in IPO activity in the 2000s. The mean and median cash ratios of the IPO firms after the crisis are higher than those of other sub-sample firms. These firms might have more cash because of the recent IPO and follow-on equity offerings. The median investments ratio for IPO firms after the crisis has fluctuated around 4.0% over the 2000s, which is not higher than those of other sub-sample firms. The results in Table 4 indicate that the increase in the Asian firms' cash holdings is not solely driven by the characteristics of newly listed firms. To further investigate the reason of why Asian firms' have increased cash holdings after the crisis, we limit the rest of our analyses to the sub-sample of pre-existing firms which consists of 13,964 firm-years representing 1,301 unique firms.

There is a possibility that firms increase cash holdings after the crisis because their characteristics have changed. Asian firms have experienced dramatic changes in their business operating environment mainly due to globalization and technology innovations after the Asian financial crisis. We test whether the firm characteristics are different in the pre- vs. post-crisis period (1990-1996 vs. 1999-2006). We compare the mean and median firm characteristics of the two periods and report the results in Table 5. All the variables significantly change after the crisis. The mean (median) leverage decreases from 29.4% (28.6%) to 28.5% (27.1%). The mean noncash NWC/assets decrease from 0.5% to -0.4% while the median ratios have negative values. The mean (median) ratio of investments to assets significantly decreases from 9.1% (6.4%) to 5.0% (3.3%), which is consistent with the result reported in Table 4. The cash flow (EBIT/assets) also decreases significantly in the post-crisis period, which means that the increase in cash holdings is not driven by the increase in internal cash flows. The mean growth opportunities, market-to-book ratio, decrease from 1.434 to 0.901. Firm size gets larger since some small firms tend not to survive in the post-crisis period. The proportion of dividend-paying firms has decreased from 85.37% to 68.69%. The cash flow risk (Std of EBIT and industry sigma) significantly increases from 2.9% to 3.6% after the crisis. Previous literature indicates that decreases in leverage, non-cash net working capital, cash flow, market-to-book have negative effects on cash holdings. Decrease in investments and increase in cash flow risk are positively related to cash holdings. Firm size and dividend payment are used to measure financial constraints in the literature. According to precautionary motive, larger firm size in the post-crisis period should have a negative effect on cash holdings while smaller portion of dividend-paying firms have a positive effect. Therefore, the changes in firm characteristics after the crisis might have offsetting effects on the level of cash holdings.

[Insert Table 5 about here]

To further investigate whether changes in firm characteristics explain the increase of cash holdings in the post-crisis period, we estimate the modified Opler et al.'s (1999) model for the pre-crisis period using Fama-MacBeth's (1973) regression. Then, we compute how actual cash holdings differ from cash holdings predicted by that model in the post-crisis period. This method is used in Bates et al.'s (2009) paper.

The Fama-McBeth estimates of the modified Opler et al.'s model for the pre-crisis period are as follows:

$$\begin{aligned} \text{Cash ratio} = & 0.140 + 0.172 \text{ Industry Sigma} - 0.001 \text{ Market-to-book ratio} - \\ & 0.0004 \text{ Firm size} + 0.342 \text{ EBIT/assets} - 0.205 \text{ NWC/assets} - 0.327 \\ & \text{Investments/assets} - 0.166 \text{ Leverage} + 0.184 \text{ Dividends/assets} + 0.237 \text{ Equity} \\ & \text{issuance/assets} + 0.129 \text{ Increase in total debt/assets} \end{aligned}$$

The coefficients on market-to-book ratio and firm size are not significantly different from zero. The coefficient on dividends/assets is positive, which is not consistent with previous literature. All other coefficients have the same signs as those in Bates et al. (2009).

Table 6 reports the mean predicted cash ratios and the mean differences between actual cash ratios and predicted cash ratios in the post-crisis period for the whole sample, small and large firms, and non-dividend and dividend paying firms. When we measure the predicted cash ratios using Fama-MacBeth's regression, we assume that the firms' demand function for cash has not changed, or the coefficients on all the variables remain the same even after the Asian financial crisis. If changes in firm characteristics explain the increase of the firms' cash holdings after the crisis, we expect that the mean differences between actual cash ratios and predicted cash ratios are zero. The predicted cash ratio for the whole sample over the period of 1999-2006 is 9.8% to 10.6%. The mean differences between the actual cash ratios and the predicted cash ratios are significantly positive with p-values of less than 0.01 and the difference gets bigger as

time goes on. The mean difference is 0.9% in 1999 and it increases to 2.4% in 2006. The result suggests that the Fama-MacBeth's regression underestimates the cash ratio, and the increase of the firms' cash holdings in the post-crisis period is not explained by changes in firm characteristics. We do the same tests for small and large firms and for non-dividend-paying and dividend-paying firms. The results show that the mean actual minus predicted cash ratios are not qualitatively different regardless of firm size and dividend payments.

[Insert Table 6 about here]

The findings in Table 5 and 6 are sharply different from Bates et al's (2009) results. They find that the increase of U.S. firms' cash holdings in the 1990s and 2000s is related to changes in risk, net working capital, and R&D investments. We find that the Asian firms' characteristics are very different in the post-crisis period. However, our results suggest that the increase of the Asian firms' cash holdings after the crisis is not explained by the changes in firm characteristics.

4.3. Has the demand function of Asian firms for cash holdings changed after the crisis?

The analyses in the previous sub-section consider how changes in firm characteristics influence cash holdings. To identify increases in cash holdings that are not explained by the changes in firm characteristics, we now extend the analyses by allowing for an intercept change and coefficient changes in cash holdings equations after the Asian financial crisis.

We again use the Opler et al.'s (1999) model for cash holdings as a baseline regression specification. Since our sample is a time-series and cross-sectional data (panel data), we run ordinary least square (OLS) with clustered standard errors, Fama-MacBeth, and fixed effects

regressions, and present the results in the left five columns of Table 7⁶. Following Bates et al. (2009), we use cash ratio and log (cash/net assets⁷) as dependent variables in the OLS regressions. We also use changes in the variables rather than levels as a dependent variable in the OLS regression. We include a dummy variable as an independent variable in the OLS regressions to permit intercept shifts in the post-crisis period (1999-2006).

[Insert Table 7 about here]

In Model 1, we use cash ratios as dependent variables in the OLS regression. We expect that noncash net working capital to assets ratio (NWC/assets) and cash ratio have a negative relation because noncash net working capital can be a substitute for cash. The coefficient on NWC/assets is -0.118 with a p-value of less than 0.01 as expected. The significantly negative relation remains regardless of model specifications. The coefficient on investments/assets is statistically negative at a 1% significance level, which is consistent with the finding presented in Table 3. We expect that firms with higher cash flows hoard more cash. We find that EBIT/assets and cash ratios have a significantly positive relation as expected. These results are consistent with Opler et al.'s (1999) findings. The precautionary motive of cash holdings suggests that firms with higher growth opportunities have higher cash holdings since it is costlier for these firms to obtain external financing. The coefficient on market-to-book ratio is 0.012 with a p-value of less than 0.01, which is consistent with the results in Kim et al. (1998) and Opler et al. (1999). We expect a negative relation between firm size and cash ratio since there are economies of scale to holding cash. The coefficient on firm size is not statistically significant in Model 1. We also expect a negative relation between leverage and cash ratio because firms use cash to make interest payments or repay the principal on debt. The

⁶ Refer to Peterson (2009) for regressions on panel data.

⁷ Net assets are measured as the book value of total assets minus cash.

coefficients on leverage are significantly negative as expected, which is also consistent with the results in Kim et al. (1998) and Opler et al. (1999). Finally, we expect a negative relation between dividend payment and cash ratio since cash dividends consume cash. The coefficient on a dividend dummy variable in Model 1 is significantly positive, which is not consistent with the findings in previous literature.

We use $\log(\text{cash}/\text{net assets})$ as a dependent variable in Model 2 and we use changes in all variables rather than levels in Model 3. We include the lagged change in cash and the lagged level of cash as independent variables to allow for partial adjustment of the cash ratio to equilibrium level in Model 3. Most of the coefficients and significance of firm characteristics remain unaltered in Model 2 and 3, compared to Model 1. The coefficients on firm size are significantly positive in Model 2 and 3, which indicates that firm size is positively related to changes in cash holdings. The coefficient on industry sigma is not significant in Model 3.

To investigate whether there is a regime change after the Asian financial crisis for the firms' demand for cash, we include a post-crisis dummy variable in Model 1 to 3. The dummy variable takes a value of 1 if a firm-year is in the period of 1999-2006 and 0 otherwise. We expect that the dummy variable has a positive and significant coefficient if the cash ratio increases after the crisis for exogenous reasons unrelated to firm characteristics. The coefficient on the dummy variable is 0.006 with a p-value of less than 0.01 in Model 1 while the coefficient is 0.144 in Model 2. The coefficient is 0.003 with a p-value of 0.03 in Model 3. These results suggest that there is a significant upward shift in demand for cash in the post-crisis period.

Since our sample is panel data, we also estimate a Fama-MacBeth regression and a fixed effect regression and report the results in Model 4 and 5, respectively. The coefficient on a dividend dummy variable is not significant in Model 4. Other coefficients are not qualitatively

different from those in Model 1. These results show that the relation between cash ratios and firm characteristics is generally consistent across the models we estimate in Table 7.

Differences in the intercepts could result from changes in the relation between cash ratios and firm characteristics. To investigate this possibility, we estimate a model that allows for changes in both the intercept and slope coefficients and report the results of Model 6 in the last two columns of Table 7. Model 6 replicates Model 1, but with dummy variables for the post-crisis period (1999-2006) that interact with all independent variables. The coefficients on the interaction variables with net working capital, market-to-book ratio, firm size, leverage, dividend payment, and industry cash flow volatility (industry sigma) are statistically significant, which indicates that there are changes in the relation between corporate cash holdings and the variables in the post-crisis period. Most strikingly, the coefficient on industry sigma increases from 0.062 in the pre-crisis period to 0.771 ($0.062+0.709$) in the post-crisis period, which indicates that the Asian firms become more sensitive to cash flow risk after the crisis. This suggests that the Asian firms have built up cash as a buffer against the cash flow risk after the crisis. . The intercept is more positive in the post-crisis period. The intercept increases by 0.055 in the post-crisis period, which indicates that 5.5% of the increase in cash holdings is not explained by the relation between firm characteristics and cash ratios, and the proportion can be considered a pure unexplained shift in precautionary demand of cash.

The results in Table 7 show that the change in the East Asian firms' demand function for cash explains the higher cash ratios after the Asian financial crisis. The intercept increases and most of the slope coefficients change in the post-crisis period. Specifically, the results suggest that Asian firms' increased sensitivity to cash flow risk is related to the higher level of their cash holdings after the crisis.

In Table 4, we find that the cash ratio of a pre-existing firm with median characteristics increases by 3.6% (from 6.5% in 1996 to 10.1% in 2006). We also find in Table 5 that the changes in firm characteristics do not affect the cash ratio in aggregate. Assuming that industry sigma of 0.029 in 1996 remains unchanged, the cash ratio increases by 2.7% ($0.029 \times$ the coefficient of 0.709 from Table 7) due to the firm's increased sensitivity to cash flow risk in the post-crisis period. The increase in industry sigma (from 0.029 in 1996 to 0.035 in 2006) increases the cash ratio by 0.04% (0.006×0.709). The firm's market-to-book ratio decreases by 0.246 (from 1.024 in 1996 to 0.778 in 2006). The decrease in market-to-book decreases investments ratio by 0.001 ($0.246 \times$ the coefficient of 0.004 from Table 3), which leads to the increase in the cash ratio by 0.003% ($-0.001 \times$ the coefficient of -0.026 from Table 7). The reduction in market-to-book directly increases the cash ratio by about 0.2% (from Table 7). The investments ratio decreases from 6.3% in 1996 to 3.9% in 2006, which leads to the increase in the cash ratio by 0.06% ($-0.024 \times$ the coefficient of -0.026 from Table 7). The results show that about 75% of the increase in the cash ratio (2.7%/3.6%) is ascribed to the firm's increased sensitivity to cash flow risk and other effects are relatively small. We argue that the increased sensitivity to risk represents a firm's increasing precautionary motive in the post-crisis period, which mainly explains the sudden increase in cash holdings.

4.4 Is the increase in cash holdings limited to financially constrained firms?

The literature on precautionary motive of cash holdings suggests that financially constrained firms increase their cash ratios more than unconstrained firms after the macroeconomics shocks [for instance, Opler et al. (1999), Han and Qiu (2007), and Almeida et al. (2004)]. To further test whether the increase in cash holdings after the Asian financial crisis is limited to financially

constrained firms, we classify the pre-existing firms into financially constrained firms and unconstrained firms using firm size, dividend payment, and leverage, following Altı (2003)⁸. A sample firm-year is classified as a small firm if its total assets belong to the bottom 30% of total assets of the sample firms as of the end of 1996. A sample firm-year is also classified as a highly-leveraged firm if its leverage ratio belongs to the top 30% of the leverage ratios of the sample firms. Small firms, non-dividend-paying firms, and highly-leveraged firms are considered financially constrained firms.

The median cash ratios and investments ratios for the financially constrained and unconstrained firms are reported over the sample period in Panel A of Table 8. We first find that financially unconstrained firms have slightly higher cash ratios than constrained firms before the crisis regardless of how we classify the firms. Both financially constrained and unconstrained firms increase cash ratios after the Asian financial crisis. Small firms (non-dividend-paying firms) have the median cash ratio of 9.7% (6.4%) in 2006 while large firms (dividend-paying firms) have the median cash ratio of 10.3% (11.1%) in the same year. High-leveraged (low-leveraged) firms have the median cash ratios of 6.9% (11.2%) in 2006. This is not consistent with the precautionary motive of cash holdings, which suggests that financially constrained firms tend to have more cash holdings due to costly external financing. Both financially constrained and unconstrained firms have generally decreased investments ratios after the crisis. The median cash ratios of non-dividend-paying firms decrease 3.8% in 1996 to 2.6% in 2006 while those of dividend-paying firms decrease 6.7% to 4.2% over the same period.

[Insert Table 8 about here]

⁸ Almeida et al. (2004) use five criteria including dividend payout ratio, firm size, bond ratings, commercial paper ratings, and KZ index (Kaplan and Zingales, 1997) to classify the firms into financially constrained vs. unconstrained firms. Due to data limitation, we cannot use bond ratings and commercial paper ratings to classify the firms.

To formally test the difference in changes of cash ratios and investment ratios for financially constrained vs. unconstrained firms, we use difference-in-difference tests and report the results in Panel B of Table 8. Panel B reports the median changes in cash ratios and investment ratios and results for the difference-in-difference tests. Changes in cash ratios and investment ratios are measured as the differences in those ratios between 2006 and 1996 for each firm. The median changes show that the Asian firms increase cash ratios and decrease investment ratios over the test period regardless of financial constraints. We find that there is no statistical difference in changes in the median cash ratios and investment ratios for small vs. large firms. We also document that dividend-paying firms significantly increase the median cash ratios and decrease the median investment ratios more than non-dividend-paying firms (2.1% vs. 0.2% and -2.5% vs. -0.7%). When we divide the sample across financial constraints using leverage, we do not find any difference. These results are inconsistent with the precautionary motive of cash holdings, which suggests that financially constrained firms increase cash holdings more than unconstrained firms after macroeconomic shocks. If there is any difference in changes in cash ratios and investment ratios after the Asian financial crisis, our results show that unconstrained firms has increased cash ratios more than constrained firms by spending less money on capital expenditures or acquisitions. These results indicate that non-dividend-paying firms do not have the resources to increase cash as much as they would like. The financially constrained firms already invest less and have less room to adjust downward while the unconstrained firm maintains much higher investment rates in the pre-crisis period and react more severely to the incentive to build up cash in response to the economic uncertainty.

To investigate whether the factors to explain the increase in cash holdings are different between financially constrained vs. unconstrained firms, we repeat the regression analyses we do

in Model 6 of Table 7 for the two sub-samples. Again, we add dummy variables for the post-crisis period (1999-2006) that interact with all independent variables to the Opler's (1999) model. We report the results of OLS regressions with clustered errors on cash ratios in Table 9. Financially constrained firms are non-dividend-paying firms while unconstrained firms are dividend-paying firms. The results show that the coefficients on industry sigma are significantly more positive in the post-crisis for the subsamples of both financially constrained and unconstrained firms, meaning that the firms are more sensitive to cash flow risk after the crisis regardless of financial constraints. The coefficient on the interaction term of post-crisis dummy and investments ratio is -0.06 with p-value of 0.07 for unconstrained firms while that is not significant for financially constrained firms. In addition, the intercept for the subsample of unconstrained firms increases by 0.095 in the post-crisis period while that for the subsample of constrained firms does not statistically increase. These results are consistent with the findings in Table 8 in that unconstrained firms have more leeway to reduce investments and increase cash holdings compared to financially constrained firms. These results are inconsistent with Almeida et al.'s (2004) argument that financially constrained firms should increase their propensity to retain cash following negative macroeconomic shocks while unconstrained firms should not.

[Insert Table 9 about here]

Baum et al. (2005) find that the cross-sectional dispersion of corporate cash holdings narrows as macroeconomic uncertainty increases. We find that the standard deviation of cash ratios for pre-existing firms is 11.66% in the pre-crisis period while it is 10.98% in the post-crisis period. The slight decrease in the dispersion of cash ratios is indirectly consistent with Baum et al.'s (2005) argument.

5. Conclusion

We examine how the Asian financial crisis affects the long-term liquidity management policies of Asian firms by investigating their cash holdings before and after the crisis. Using the sample firms from eight East Asian countries over the period of 1990-2006, we find that the median cash ratio remains stable in the early 1990s and suddenly increases after the crisis of 1997-1998. Specifically, the East Asian firms increase the median cash holdings from 6.7% in 1996 to 12.1% in 2006. The Asian firms increase cash holdings by decreasing investment activities such as capital expenditures or M&As. We also find that the increase in cash holdings is not explained by changes in firm characteristics by change in the firms' demand function for cash. Specifically, the firms' increased sensitivity to cash flow risk in the post-crisis period is one of the main factors to explain the increase of their cash holdings.

Our results show that the financial crisis has systematically changed the cash holding policies of the firms and has a long-term effect. The findings are consistent with the precautionary motive of cash holdings in that the Asian firms become more conservative in investing and cash holding policies after they experience macroeconomic shocks. The precautionary motive of cash holdings also indicate that financially constrained firms should be more sensitive to cash flow risk. Our results show that there is no much difference in the changes in cash holding after the crisis for financially constrained vs. unconstrained firms. Therefore, our results are partially consistent with precautionary motive documented in previous literature such as Kim et al. (1998), Opler et al. (1999), and Almeida et al. (2004).

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Table 1: Descriptive statistics

Variable	N	Mean	Median	Maximum	Minimum	Std
Cash ratio	32174	0.140	0.098	0.684	0.001	0.132
Leverage	32174	0.256	0.233	1.274	0.000	0.207
NWC/assets	31740	0.032	0.028	0.486	-1.340	0.184
Investments/assets	32174	0.067	0.042	0.401	0.000	0.074
Market-to-book ratio	32174	1.122	0.828	9.285	0.176	1.041
Firm size	32174	11.623	11.487	15.717	7.652	1.518
Dividend/assets	22497	0.028	0.016	0.195	0.000	0.034
Equity issuance/assets	32174	0.024	0.000	0.555	0.000	0.075
EBIT/assets	32139	0.072	0.061	0.300	-0.544	0.070
Std of EBIT	23465	0.036	0.028	0.171	0.004	0.029
Industry sigma	32068	0.036	0.036	0.116	0.004	0.009
Sales growth	23534	0.138	0.102	1.775	-0.644	0.267

The panel data on 32,174 firm-years representing 5,059 sample firms in eight East Asian countries are collected from Thomson Financial's *Worldscope*. The table reports the number of firm-years (N), mean, median, maximum, minimum, and standard deviation (Std) for each variable. N is the number of non-missing observations of each variable. Cash ratio is the ratio of cash and short-term investments to the book value of total assets. Leverage is the ratio of total debt to the book value of total assets. NWC/assets is the ratio of net working capital minus cash and short-term investments to the book value of total assets. Investment/assets is measured as the sum of capital expenditures and acquisitions, divided by the book value of total assets. Market-to-book ratio is calculated as the sum of total debt and the market value of equity, divided by the book value of total assets. Firm size is measured as a natural log of the book value of total assets (\$ in thousands), which is translated to U.S. dollars using year-ending currency rates. Dividend/assets is the ratio of cash dividend paid to the book value of total assets for only 22,497 dividend-paying firm-years. Equity issuance/assets is the ratio of equity sales to the book value of total assets. EBIT/assets is the ratio of earnings before interests and taxes (EBIT) to the book value of total assets. Std of EBIT is measured as the standard deviation of EBIT/assets for the previous five years. Industry sigma is the average standard deviation of EBIT/assets of each industry, which is classified by 2-digit SIC codes. Sales growth is the geometric mean of the growth rate of sales over the previous two years. All variables are winsorized at the 1st and 99th percentiles.

Table 2: Cash ratio, leverage, equity issuance, payouts, and investments year by year

Year	N	Cash ratio		Leverage		Equity issuance/assets		Payouts/Assets		Investments/assets	
		Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
1990	270	0.109	0.074	0.277	0.262	0.041	0.000	0.026	0.011	0.092	0.072
1991	473	0.116	0.073	0.268	0.242	0.038	0.000	0.029	0.016	0.099	0.069
1992	592	0.109	0.070	0.272	0.255	0.039	0.000	0.028	0.017	0.104	0.072
1993	689	0.107	0.064	0.285	0.279	0.035	0.000	0.026	0.015	0.090	0.058
1994	865	0.113	0.069	0.287	0.277	0.035	0.000	0.022	0.012	0.087	0.061
1995	1208	0.109	0.068	0.300	0.299	0.028	0.000	0.019	0.011	0.088	0.065
1996	1374	0.110	0.067	0.314	0.315	0.031	0.000	0.018	0.010	0.090	0.064
1997	1499	0.108	0.071	0.350	0.337	0.030	0.000	0.016	0.008	0.084	0.059
1998	1506	0.112	0.072	0.351	0.331	0.021	0.000	0.013	0.003	0.065	0.041
1999	1850	0.125	0.083	0.311	0.287	0.022	0.000	0.013	0.002	0.050	0.031
2000	2287	0.133	0.088	0.284	0.254	0.033	0.000	0.017	0.005	0.061	0.036
2001	2628	0.139	0.097	0.252	0.227	0.020	0.000	0.019	0.007	0.057	0.035
2002	2884	0.147	0.108	0.230	0.205	0.018	0.000	0.020	0.008	0.056	0.034
2003	3124	0.158	0.118	0.222	0.200	0.017	0.000	0.021	0.010	0.056	0.035
2004	3442	0.158	0.118	0.221	0.203	0.023	0.000	0.024	0.011	0.064	0.040
2005	3679	0.160	0.119	0.213	0.190	0.023	0.000	0.026	0.013	0.066	0.043
2006	3804	0.160	0.121	0.209	0.186	0.017	0.000	0.026	0.013	0.063	0.040
Whole sample	32174	0.140	0.098	0.256	0.233	0.024	0.000	0.021	0.009	0.067	0.042

This table reports the annual mean and median value of cash ratio, equity issuance/assets, payouts/assets, and investments/assets. Cash ratio is the ratio of cash and short-term investments to the book value of total assets. Leverage is the ratio of total debt to the book value of total assets. Equity issuance/assets is the ratio of equity sales to the book value of total assets. Payout/assets is measured as the sum of dividends and stock repurchase divided by the book value of total assets. Investment/assets is calculated as the sum of capital expenditures and acquisitions, divided by the book value of total assets.

Table 3: Simultaneous equations on cash ratios and investments

	<u>Whole sample period</u> (1990-2006)		<u>Before the crisis</u> (1990-1996)		<u>After the crisis</u> (1999-2006)	
	Cash ratio	Investments/ assets	Cash ratio	Investments/ Assets	Cash ratio	Investments/ Assets
Intercept	0.358 (<0.01)	0.041 (0.07)	-0.175 (0.36)	0.134 (0.05)	0.267 (<0.01)	0.042 (0.04)
NWC/assets	-0.147 (<0.01)		-0.254 (0.05)		-0.170 (<0.01)	
Investments/ assets	-0.847 (<0.01)		-0.531 (0.22)		-1.383 (<0.01)	
EBIT/assets	0.117 (<0.01)	-0.015 (0.09)	0.205 (0.03)	-0.078 (0.14)	0.130 (<0.01)	-0.017 (0.09)
Market-to- book ratio	0.010 (<0.01)	0.003 (<0.01)	0.005 (0.35)	0.001 (0.66)	0.019 (<0.01)	0.004 (<0.01)
Firm size	0.003 (0.17)		0.029 (0.12)		0.014 (<0.01)	
Leverage	-0.137 (<0.01)		-0.050 (0.37)		-0.128 (<0.01)	
Dividend dummy	0.020 (<0.01)		0.021 (0.38)		0.018 (<0.01)	
Industry sigma	0.247 (0.33)		-0.319 (0.50)		0.165 (0.35)	
Cash ratio		0.088 (<0.01)		0.312 (0.03)		0.089 (<0.01)
Sales growth		0.026 (<0.01)		0.019 (<0.01)		0.020 (<0.01)
Year dummy	Yes	Yes	Yes	Yes	Yes	Yes
Firm dummy	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R ²	0.651	0.403	0.417	0.304	0.647	0.476
N	23167	23167	3155	3155	17656	17656

This table exhibits the results of the regressions on cash holdings and investment. Using the simultaneous equations of cash holdings and investments, we run the regressions for the whole-period sample (1990-2006), the pre-crisis sample (1990-1996), and the post-crisis sample (1999-2006). Cash ratio is the ratio of cash and short-term investments to the book value of total assets. Investment/assets is calculated as the sum of capital expenditures and acquisitions, divided by the book value of total assets. NWC/assets is the ratio of net working capital minus cash and short-term investments to the book value of total assets. EBIT/assets is the ratio of earnings before interests and taxes (EBIT) to the book value of total assets. Market-to-book ratio is calculated as the sum of total debt and the market value of equity, divided by the book value of total assets. Firm size is a natural log of the book value of total assets (\$ in thousands), which is translated to U.S. dollars using year-ending currency rates. Leverage is the ratio of total debt to the book value of total assets. Dividend dummy takes a value of 1 if a firm distributes cash dividend in a given year, and otherwise 0. Industry sigma is the average standard deviation of EBIT/assets of each industry,

which is classified by 2-digit SIC codes. Sales growth is the geometric mean of the growth rate of sales over the previous two years. The numbers in parentheses are p-values.

Table 4: Trends of cash ratios and investments for pre-existing firms, IPO firms during, and after the crisis

	Pre-existing firms			IPO during the crisis			IPO after the crisis		
	N	Cash ratio	Investments	N	Cash ratio	Investments	N	Cash ratio	Investments
1990	270	0.074	0.072						
1991	473	0.073	0.069						
1992	592	0.070	0.072						
1993	689	0.064	0.058						
1994	865	0.069	0.061						
1995	1208	0.068	0.065						
1996	1185	0.065	0.063	189	0.081	0.075			
1997	1153	0.066	0.054	346	0.098	0.071			
1998	1083	0.065	0.039	423	0.097	0.048			
1999	1033	0.072	0.028	405	0.103	0.036	412	0.098	0.034
2000	968	0.075	0.031	396	0.105	0.037	923	0.101	0.044
2001	904	0.080	0.030	375	0.108	0.037	856	0.097	0.040
2002	869	0.085	0.030	347	0.120	0.036	830	0.103	0.036
2003	841	0.090	0.031	348	0.122	0.040	802	0.103	0.037
2004	847	0.096	0.037	346	0.113	0.040	774	0.098	0.038
2005	841	0.098	0.040	341	0.118	0.043	755	0.106	0.037
2006	847	0.101	0.039	330	0.122	0.040	751	0.109	0.033

This table shows the number of firms, the median cash ratios and investments (investments/assets ratios) for each sub-sample year by year. We divide our sample into well-established firms before the crisis (pre-existing firms), firms that went public during the crisis (1996-1998), and firms that went public after the crisis (1999-2006). Cash ratio is the ratio of cash and short-term investments to the book value of total assets. Investments/assets is calculated as the sum of capital expenditures and acquisitions, divided by the book value of total assets.

Table 5: Comparison of firm characteristics in the period of pre- vs. post-Asian financial crisis

	Mean		p-value	Median		p-value
	Pre-crisis (1990~1996)	Post-crisis (1999~2006)		Pre-crisis (1990~1996)	Post-crisis (1999~2006)	
Leverage	0.294	0.285	0.02	0.286	0.271	<0.01
NWC/assets	0.005	-0.004	<0.01	-0.006	-0.004	0.81
Investment/assets	0.091	0.050	<0.01	0.064	0.033	<0.01
EBIT/assets	0.079	0.059	<0.01	0.066	0.049	<0.01
Market-to-book ratio	1.434	0.901	<0.01	1.101	0.722	<0.01
Firm size	12.064	12.363	<0.01	12.020	12.305	<0.01
Proportion of dividend paying firms	85.37%	68.69%	<0.01	NA	NA	NA
Std of EBIT	0.029	0.036	<0.01	0.022	0.028	<0.01
Industry sigma	0.029	0.037	<0.01	0.028	0.037	<0.01

This Table shows the mean and median firm characteristics for the two sub-periods: pre-crisis (1990~1996) and post-crisis (1999~2006). Leverage is the ratio of total debt to the book value of total assets. NWC/assets is the ratio of net working capital minus cash and short-term investments to the book value of total assets. Investment/assets is calculated as the sum of capital expenditures and acquisitions, divided by the book value of total assets (Missing values of acquisitions are set as zero). EBIT/assets is the ratio of earnings before interests and taxes (EBIT) to the book value of total assets. Market-to-book ratio is calculated as the sum of total debt and the market value of equity, divided by the book value of total assets. Firm size is a natural log of the book value of total assets (\$ in thousands), which is translated to U.S. dollar\$ using year-ending currency rates. Proportion of dividend paying firms is measured as the number of dividend paying firms divided by the total number of firms. Standard deviation of EBIT (STD of EBIT) is the standard deviation of EBIT for the previous five years. When the previous EBITs are missing in more than three years, STD of EBIT is treated as missing. Also when the average EBIT of the previous five years is negative, STD of EBIT is treated as missing. Industry sigma is the average standard deviation of EBIT of each industry, which is classified by 2-digit SIC codes.

Table 6: Predicted cash ratios and their deviations from actual cash ratios in the post-Asian financial crisis period

Year	Whole sample		Small firms		Large firms		Non-dividend paying firms		Dividend paying firms	
	Predicted	Actual-Predicted	Predicted	Actual-Predicted	Predicted	Actual-Predicted	Predicted	Actual-Predicted	Predicted	Actual-Predicted
1999	0.099	0.009 (<0.01)	0.101	0.014 (<0.01)	0.098	0.009 (0.01)	0.082	-0.005 (0.30)	0.112	0.019 (<0.01)
2000	0.102	0.006 (0.10)	0.099	0.010 (0.03)	0.104	0.004 (0.33)	0.086	-0.005 (0.33)	0.112	0.012 (0.01)
2001	0.098	0.013 (<0.01)	0.096	0.018 (<0.01)	0.099	0.007 (0.04)	0.082	0.003 (0.63)	0.106	0.017 (<0.01)
2002	0.102	0.014 (<0.01)	0.097	0.023 (<0.01)	0.104	0.008 (0.03)	0.083	0.008 (0.20)	0.111	0.017 (<0.01)
2003	0.104	0.020 (<0.01)	0.096	0.028 (<0.01)	0.108	0.015 (<0.01)	0.081	0.013 (0.05)	0.112	0.022 (<0.01)
2004	0.106	0.019 (<0.01)	0.099	0.025 (<0.01)	0.109	0.016 (<0.01)	0.085	0.003 (0.61)	0.113	0.024 (<0.01)
2005	0.103	0.021 (<0.01)	0.098	0.027 (<0.01)	0.105	0.019 (<0.01)	0.080	0.011 (0.16)	0.109	0.024 (<0.01)
2006	0.104	0.024 (<0.01)	0.099	0.028 (<0.01)	0.106	0.022 (<0.01)	0.087	0.017 (0.03)	0.109	0.025 (<0.01)

The Table summarizes the predicted cash ratios of sample firms from 1999 to 2006, and deviations of the actual cash ratios from those predicted by Fama-MacBeth's (1973) regression of the modified Opler et al.'s model (1999). The coefficients of Fama-MacBeth's regression are the average coefficients from annual cross-sectional regressions estimated over the period of 1991-1996. The cash ratio is measured as the ratio of cash and short-term investments to the book value of total assets. Estimates from the regression are as follows: Cash ratio = 0.140- 0.172 Industry Sigma - 0.001 Market-to-book ratio - 0.0004 Firm size + 0.342 EBIT/asset - 0.205 NWC/assets - 0.327 Capex/assets - 0.166 Leverage + 0.184 Dividend/assets + 0.237 Equity issuance/assets + 0.129 Increase in total debt/assets. The table reports the mean predicted cash ratios and difference between actual cash ratios and predicted cash ratios by year for the whole sample, small and large firms, and non-dividend and dividend paying firms. The numbers in parentheses are p-values from t-tests to test whether the actual minus predicted cash ratios are different from zero.

Table 7: Estimation of regressions on cash ratios

	Model 1 OLS	Model 2 OLS	Model 3 Changes	Model 4 F-M	Model 5 Fixed Effect	Model 6 OLS	
Dependent variable:	Cash ratio	Log(Cash/ net assets)	Cash ratio	Cash ratio	Cash ratio	Cash ratio Interaction	
						Estimates	Post-crisis dummy
Intercept	0.128 (<0.01)	-3.754 (<0.01)	0.013 (<0.01)	0.154 (<0.01)	0.156 (<0.01)	0.103 (<0.01)	0.055 (<0.01)
Lag dcash			-0.054 (<0.01)				
Lag cash			-0.093 (<0.01)				
NWC/assets	-0.118 (<0.01)	-0.835 (<0.01)	-0.118 (<0.01)	-0.147 (<0.01)	-0.122 (<0.01)	-0.141 (<0.01)	0.037 (<0.01)
Investments/assets	-0.182 (<0.01)	-1.561 (<0.01)	-0.111 (<0.01)	-0.210 (<0.01)	-0.155 (<0.01)	-0.185 (<0.01)	-0.026 (0.33)
EBIT/assets	0.176 (<0.01)	2.405 (<0.01)	0.196 (<0.01)	0.198 (<0.01)	0.120 (<0.01)	0.198 (<0.01)	-0.040 (0.27)
Market-to-book ratio	0.012 (<0.01)	0.075 (<0.01)	0.009 (<0.01)	0.014 (<0.01)	0.010 (<0.01)	0.010 (<0.01)	0.010 (<0.01)
Firm size	0.0001 (0.82)	0.108 (<0.01)	0.080 (<0.01)	-0.001 (0.36)	0.0004 (0.73)	0.003 (<0.01)	-0.006 (<0.01)
Leverage	-0.183 (<0.01)	-2.029 (<0.01)	-0.009 (0.10)	-0.188 (<0.01)	-0.162 (<0.01)	-0.169 (<0.01)	-0.033 (<0.01)
Dividend dummy	0.011 (<0.01)	0.115 (<0.01)	0.005 (<0.01)	0.002 (0.78)	0.010 (<0.01)	0.004 (0.19)	0.011 (<0.01)
Industry sigma	0.390 (<0.01)	3.805 (<0.01)	0.041 (0.69)	0.432 (0.11)	0.296 (<0.01)	0.062 (<0.01)	0.709 (<0.01)
Post-crisis dummy	0.006 (<0.01)	0.144 (<0.01)	0.003 (0.03)				

Year dummies					Yes	
Adj. R ²	0.174	0.140	0.190	0.187	0.499	0.184
N	14335	14327	12364	14335	14335	14335

Table 7 exhibits the results of regressions on cash ratio. Cash ratio is used as the dependent variable in model 1, 4, 5, and 6, natural logarithm of cash/net assets in Model 2, and changes in cash ratio in Model 3. Net assets are measured as the book value of total assets minus cash. Lag dcash is measured as the difference between the preceding two cash ratios. In Model 6, we estimate a model that allows for changes in both the intercept and slope coefficients. Lag cash is the prior year's cash ratio. *NWC/assets* is the ratio of net working capital minus cash and short-term investments to the book value of total assets. *Investment/assets* is calculated as the sum of capital expenditures and acquisitions, divided by the book value of total assets. *EBIT/assets* is the ratio of earnings before interests and taxes (EBIT) to the book value of total assets. Market-to-book ratio is calculated as the sum of total debt and the market value of equity, divided by the book value of total assets. Firm size is a natural log of the book value of total assets (\$ in thousands), which is translated to U.S. dollars using year-ending currency rates. Leverage is the ratio of total debt to the book value of total assets. Dividend dummy takes a value of 1 if a firm distributes cash dividend in a given year, and otherwise 0. Industry sigma is the average standard deviation of EBIT of each industry, which is classified by 2-digit SIC codes.

Table 8: Median cash ratios and investments ratios conditional on financial constraints for pre-existing firms

Panel A. Annual median cash ratios and investments ratios conditional on firm size, dividend payment, and leverage

Year	Small firms			Large firms			Non-dividend-paying firms			Dividend-paying firms			High leverage firms			Low leverage firms		
	N	Cash	Investments.	N	Cash	Investments.	N	Cash	Investments.	N	Cash	Investments.	N	Cash	Investments.	N	Cash	Investments.
1990	18	0.093	0.085	230	0.071	0.076	33	0.062	0.050	237	0.077	0.071	82	0.063	0.080	166	0.085	0.071
1991	105	0.075	0.086	331	0.073	0.062	54	0.065	0.048	419	0.073	0.075	132	0.069	0.069	304	0.079	0.068
1992	169	0.054	0.080	381	0.076	0.066	73	0.074	0.055	519	0.070	0.070	164	0.067	0.073	386	0.080	0.068
1993	193	0.055	0.072	453	0.069	0.056	83	0.058	0.041	606	0.064	0.062	205	0.051	0.062	441	0.080	0.058
1994	226	0.060	0.065	597	0.073	0.059	131	0.060	0.040	734	0.070	0.067	260	0.059	0.059	563	0.082	0.061
1995	349	0.052	0.068	818	0.072	0.064	211	0.054	0.042	997	0.070	0.070	350	0.054	0.072	817	0.075	0.063
1996	355	0.058	0.061	830	0.068	0.064	188	0.053	0.038	997	0.066	0.067	355	0.049	0.070	830	0.076	0.060
1997	338	0.058	0.053	791	0.068	0.056	255	0.050	0.037	898	0.070	0.060	328	0.045	0.053	801	0.080	0.056
1998	310	0.061	0.039	746	0.066	0.040	455	0.055	0.028	628	0.075	0.046	296	0.047	0.028	760	0.079	0.043
1999	304	0.068	0.028	690	0.074	0.028	456	0.055	0.019	577	0.098	0.034	277	0.052	0.018	717	0.084	0.032
2000	284	0.063	0.032	631	0.079	0.030	361	0.055	0.023	607	0.087	0.037	245	0.057	0.023	670	0.084	0.035
2001	259	0.074	0.033	593	0.082	0.029	300	0.058	0.021	604	0.093	0.036	222	0.069	0.025	630	0.086	0.032
2002	244	0.080	0.033	570	0.087	0.029	283	0.057	0.020	586	0.096	0.034	210	0.062	0.026	604	0.093	0.030
2003	237	0.085	0.033	549	0.092	0.031	221	0.063	0.021	620	0.101	0.034	206	0.068	0.031	580	0.099	0.032
2004	237	0.088	0.037	553	0.098	0.039	226	0.057	0.026	621	0.114	0.042	216	0.077	0.038	574	0.107	0.038
2005	229	0.094	0.036	554	0.099	0.041	197	0.062	0.029	644	0.111	0.044	213	0.070	0.039	570	0.109	0.040
2006	226	0.097	0.038	564	0.103	0.039	195	0.064	0.026	652	0.111	0.042	219	0.069	0.040	571	0.112	0.038

Panel B. Median changes in cash ratios and investment ratios and difference-in-difference tests

	Small firms (1)	Large firms (2)	(1)-(2) (p value)	Nondividend -paying firms (3)	Dividend- paying firms (4)	(3)-(4) (p value)	High- leveraged firms (5)	Low- leveraged firms (6)	(5)-(6) (p value)
Cash ratios	0.021	0.013	(0.25)	0.002	0.021	(0.05)	0.005	0.019	(0.09)
Investment ratios	-0.025	-0.020	(0.82)	-0.007	-0.025	(0.01)	-0.030	-0.019	(0.15)

Panel A of Table 8 shows the median cash ratios and investments ratios (investments/assets) for the financially constrained and unconstrained firms. The sample firms are classified into financially constrained and unconstrained firms using firm size, dividend payment, and leverage. A sample firm-year is classified as a small firm if its total assets belong to the bottom 30% of total assets of the sample firms as of the end of 1996. A sample firm-year is also classified as a highly-leveraged firm if its leverage ratio belongs to the top 30% of the leverage ratios of the sample firms. Small firms, non-dividend-paying firms, and highly-leveraged firms are considered financially constrained firms. Panel B of Table 5 reports the median changes in cash ratios and investments ratios, and the results for the difference-in-difference tests. Changes in cash ratios and investments ratios are measured as the differences in cash ratios and investments ratios between 2006 and 1996 for each firm. The t-test is used in the mean difference test. The p-values are based on the Satterthwaite approximation of standard errors. The Wilcoxon test is used in the median difference test.

Table 9: Estimation of cash ratios for financially constrained vs. unconstrained firms

Variable	Financially constrained firms		Unconstrained firms	
	Estimates	Interaction Post-crisis dummy	Estimates	Interaction Post-crisis dummy
Intercept	0.093 (<0.01)	-0.011 (0.75)	0.118 (<0.01)	0.095 (<0.01)
NWC/assets	-0.078 (<0.01)	0.045 (<0.01)	-0.168 (<0.01)	-0.0003 (0.98)
Investments/assets	-0.143 (<0.01)	0.065 (0.19)	-0.201 (<0.01)	-0.060 (0.07)
EBIT/assets	0.228 (<0.01)	-0.101 (0.10)	0.196 (<0.01)	-0.034 (0.43)
Market-to-book ratio	0.024 (<0.01)	-0.001 (0.88)	0.007 (<0.01)	0.012 (<0.01)
Firm size	0.002 (0.38)	-0.001 (0.65)	0.003 (<0.01)	-0.008 (<0.01)
Leverage	-0.122 (<0.01)	0.005 (0.79)	-0.177 (<0.01)	-0.086 (<0.01)
Industry sigma	-0.276 (0.25)	0.823 (0.01)	0.188 (0.21)	0.672 (<0.01)
Adj. R ²		0.131		0.197
N		3,631		10,704

Table 9 exhibits the results of OLS regressions with clustered errors on cash ratio for the subsamples of financially constrained firms and unconstrained firms. Financially constrained firms are non-dividend-paying firms while unconstrained firms are dividend-paying firms. We estimate a model that allows for changes in both the intercept and slope coefficients. NWC/assets is the ratio of net working capital minus cash and short-term investments to the book value of total assets. Investment/assets is calculated as the sum of capital expenditures and acquisitions, divided by the book value of total assets. EBIT/assets is the ratio of earnings before interests and taxes (EBIT) to the book value of total assets. Market-to-book ratio is calculated as the sum of total debt and the market value of equity, divided by the book value of total assets. Firm size is a natural log of the book value of total assets (\$ in thousands), which is translated to U.S. dollars using year-ending currency rates. Leverage is the ratio of total debt to the book value of total assets. Dividend dummy takes a value of 1 if a firm distributes cash dividend in a given year, and otherwise 0. Industry sigma is the average standard deviation of EBIT of each industry, which is classified by 2-digit SIC codes.

Figure 1. Mean cash ratios (%) for East Asian firms vs. U.S. firms

