Did Unconventional Interventions Unfreeze the Credit Market? Some International Evidence

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Abstract

When the credit market was frozen in spite of a low nominal interest rate during the 2008-2010 global financial crisis, many governments undertook a set of unconventional measures, such as debt guarantee, bank recapitalization, and purchase of bank toxic assets. Did these unconventional interventions achieve their intended policy objective of unfreezing the credit market? This paper pursues a systematic investigation of this question. We first construct a novel and comprehensive dataset of 231 interventions for 15 countries from August 2008 to July 2010 and identify a subset of those most likely containing elements of a surprise based on the media coverage during that period. We then use stock price data on 6344 listed non-financial firms in those countries and explore heterogeneous responses to the interventions across firms in different sectors. We find that the stock prices of firms increased when the interventions were implemented, particularly for firms with large intrinsic liquidity needs for working capital. This positive and differential effect was more pronounced if the banking sector experienced a higher abnormal return around an intervention date. Moreover, the results become even stronger for the subset of intervention announcements that are more likely to contain surprise components. These findings suggest that unconventional interventions have alleviated the liquidity constraint faced by non-financial firms. However, relative to the severity of the financial crisis, the quantitative effect of any given interventions was limited.

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1. **Introduction**

When the credit market in most countries was frozen during the height of the 2008-2009 global financial crisis, even after the nominal interest rate was forced low by central banks' quantitative easing approach, many governments (through their central banks or financial ministries) undertook an additional set of "unconventional measures" to repair the banks' balance sheet and to induce them to be more willing to lend. These measures include injecting capital directly into the banks, allowing banks to use central banks' discount window with non-governmental securities as collaterals, buying toxic assets from the banks, guaranteeing bank debt, announcing more generous deposit insurance, etc. Desperate by a fear of a return to the Great Depression, and inspired by the examples set by the US Federal Reserve and the Treasury, a long list of countries tried at least some of the unconventional measures, and many tried multiple measures over a period of time. Did these unconventional interventions achieve their intended policy objective of unfreezing the credit market? To prepare for intelligent policy responses in a future crisis, it would be useful to know the answer.

The goal of this paper is to examine this question using international firm-level data. To see the relative contribution of the paper, we first review the existing literature. There are newly developed theories studying the potential effects of unconventional interventions (see Bebchuk and Goldstein (2009), Philippon and Schnabl (2009), Gertler and Kiyotaki (2010), Cúrdia and Woodford (2010), and Del Negro et al (2010)). These models show that unconventional monetary interventions could have large effects when short-term nominal interest rates are constrained by the zero lower bound, although the impacts may differ across intervention types.[2] There is a growing but still relative dearth of rigorous empirical evidence on the effect of unconventional interventions implemented. Most of these evidence focus on interventions in the U.S. (see Taylor and Williams (2009), Christensen, Lopez and Rudebusch (2009) and Wu (2009) on Term Auction

[2] For example, Gertler and Kiyotaki (2010) study unconventional monetary policies in a DSGE model that allows for financial intermediaries facing endogenous balance sheet constraints, and show that both discount window lending and equity injections work in a similar fashion to mitigate a crisis. Bebchuk and Goldstein (2009) study how strategic complementarities among bank investments affect government intervention, while Philippon and Schnabl (2009) analyze interventions in a model where credit freezes due to a debt overhang problem.

Facilities; and Veronesi and Zingales (2009), Gagnon et al (2010) and Neely (2010) on large scale asset purchases.)[3] In cross-country settings, Aït-Sahalia et al (2009) examine the effects of the interventions on LIBOR-OIS spreads and report a weak positive effect. These empirical studies so far have not distinguished the effect on the credit supply and other continuing shocks from demand and other factors that could affect the customers of the banking sector.

In this paper, we pursue a systematic investigation of this question, using stock price data on 6344 listed non-financial firms in 15 developed and emerging countries. We will explore heterogeneous responses to the interventions by firms in different sector, a methodology that allows us to better isolate the effect on credit supply from the interventions.

We first construct a comprehensive dataset on unconventional government interventions in 15 countries, combining searches of an electronic news database (Factiva) that covers all major financial newspapers and wire reports, and an internal IMF document that summarizes national policy responses to financial crisis. Our sample period is from September 2008 to July 2010, covering three periods: the spillover of the global financial crisis after the Lehman Bankruptcy (from Sept 2008 to March 2009), the alleviation of the crisis from April 2009 to December 2009, and the 2010 European Sovereign Debt Crisis.

We propose a simple framework that explores heterogeneity across non-financial firms based on their differential *ex ante* vulnerability to financial shocks. If there is a positive supply-of-finance shock due to government intervention, the effect is likely to be larger on those firms that are relatively more financially constrained to start with. To determine cross-firm vulnerability to a supply-of-finance shock, we construct a sector-level intrinsic dependence on external finance for working capital. As shown in Tong and Wei (2010), these sectors suffered a disproportionate amount of decline in stock values right after the Lehman Bankruptcy due to the freeze of credit market.

[3] For example, Veronesi and Zingales (2009) focus on Paulson Plan in 2008, perform an event study by examining stock returns and credit default swaps, and show that this plan adds $132 billion to the banking sector at a taxpayers cost of between $15 and $47bn.

We find that, on average, the stock prices of non-financial firms rise when governmental interventions are implemented. Moreover, intervention has a greater impact on firms that are intrinsically more dependent on external finance for working capital. Hence, government interventions on the financial market have alleviated the liquidity constraint faced by non -financial firms. These results are robust to various specifications, such as controlling for firm size, beta factor, and the aggregate demand channel of government intervention. The results are also robust to the two-way clustering of standard errors at the sector level as well as the intervention-day level.

Stock returns in the banking sector tend to rise around an intervention day. In addition, when banks experience a higher abnormal return, non-financial firms with a greater intrinsic demand for external finance also exhibit a higher stock return. A likely interpretation is that the effect of interventions on non-financial firms is at least partially channeled through the banking sector.

As we use the stock market response as a way to judge the impact of government intervention, it is important that the intervention announcement is not fully expected by the market. In general, it is not clear-cut whether certain intervention announcements are expected or not. Moreover, sometime a government may endogenously announce the bailout of a bank precisely at the same time when the bank makes an announcement of a substantial loss. All these would create a downward bias in estimating the true effect of the interventions on credit market conditions. To deal with this, we look through newspaper coverage of the intervention announcements one by one, and identify sentences in an announcement that suggest that the announcement is at least partly unanticipated. When we focus on these announcements (around 14% of the total announcements), we find a much stronger result of government intervention in alleviating financial constraints for non-financial sectors. We further separate "positive" and "negative" surprises, where positive (negative) shocks refer to the cases when the intervention is stronger (weaker) than the market's expectation. Negative shocks are found to reduce stock prices in sectors with large liquidity needs for working capital.

To gauge the economic impact of intervention, we compare the change of financial constraint around intervention with that around the Lehman-Bankruptcy period from Sept 12 to Oct 3, 2008. Relative to the severity of the financial crisis after the Lehman Bankruptcy, the quantitative effect of any given interventions was limited.

Moreover, the interventions have not alleviated the decline of aggregate demand. We compare interventions through bank balance sheets (including debt guarantees, recapitalization and asset purchase) and central bank liquidity support, and find the first type to be more effective in relaxing financial constraints faced by non-financial sectors. This is interesting given the hostile public reactions to many government interventions through bank balance sheets.

The paper proceeds as follows. Section 2 discusses patterns of un-conventional interventions across countries. Section 3 presents our key specification, construction of key variables, and sources of data. Section 4 discusses the main empirical results and a slew of robustness checks and extensions. Section 5 offers concluding remarks.

2. Taking Stock of Unconventional Interventions

In normal times, the set of conventional monetary policy tools in the sleeves of a central bank aiming at providing more liquidity into an economy consists of a reduction in the interest rate, an open market operation that buys government bills and bonds from commercial banks (and therefore puts more money into the hands of commercial banks), and a reduction in the required reserve ratio at which commercial banks are mandated to hold cash as a share of deposits. The global financial crisis during 2008-2009 was anything but normal. Commercial banks were hit by massive mortgage defaults either directly (from not being able to collect principals and interest payments of the mortgages on their books) or indirectly (through loss in value of mortgage asset backed securities, dissipation of the value of CDSs that they bought from nearly defunct insurance companies, etc), and therefore were looking for every and each way to conserve capital. Exacerbated by a fear for counter-party risk, they were reluctant to make new loans to firms and households, and were reluctant to make loans to each other. Liquidity constraint faced by non-financial firms increased substantially (on top of whatever other difficulties experienced by these firms) in spite of the central banks' effort to make the interest rate and the official discount rate low (Tong and Wei, 2008, and 2010). That is, the conventional policy tools didn't seem to work.

It is against this unusual background that the central banks around the world, and often other parts of the governments, started to experiment with non-conventional policy tools. Precisely because they are unconventional, these measures are not part of the

standard data bases. The first task for our project is to collect systematic information on the non-conventional interventions.

2.1. Constructing a data base

Our data set draws from a combination of IMF's internal database that underlines "Global policy responses to financial crisis range of interventions" (Chapter IV of Global Financial Stability Report October 2009) and our own electronic news search (through Factiva). We exclude from our sample those announcements on implementation guidelines following previously announced interventions (while they are counted as separate interventions in the IMF database).

The data cover three categories: Deposit insurance/Debt guarantees, Recapitalization/ Asset purchase, Central Bank liquidity support:

Deposit insurance	Enhancement of deposit protection in commercial banks
Debt guarantees	Government guarantee of bank debt (all or new liabilities)
Recapitalization	Capital injection into banks (in exchange for either preferred equity or subordinated debt)
Asset purchase	Purchase of toxic assets or purchase of assets from toxic banks
Central bank liquidity support	Longer funding terms, more auctions and/or higher credit lines; Domestic system lender of last resort: wider collateral rule; Other liquidity support (e.g., support of money market funds); Foreign exchange lender of last resort: forex swap lines.

As our methodology in identifying the effect of the interventions on liquidity constraint calls for firm-level data in multiple sectors, we focus our sample on 14 developed and emerging economies, each of which has 100 or more non-financial firms in Worldscope, and have undertaken at least two non-conventional interventions. They are Canada, France, Germany, Greece, India, Indonesia, Italy, Japan, Korea, Singapore, Sweden, Switzerland, Turkey, and the United Kingdom, respectively. We intentionally exclude the United States because one of our key regressors (a firm's intrinsic dependence on external finance for working capital) is constructed from the accounting data for US firms, and we wish to ensure the exogeneity of the regressor in our exercise.

Moreover, the United States had many interventions that were close in proximity in dates, making it more difficult to cleanly identify an event window.

For each intervention, we have data on the announcement date and the type of intervention. Sometimes we have information on the monetary value of the interventions but we don't have information on the monetary value of the need for interventions.

Figure 1 plots the number of interventions from September 2008 to January 2010, while Figure 2 plots the distribution of different types of interventions.[4] Across all 15 countries in the sample, there are 231 intervention days in total, including 20 enactment or enhancement of deposit insurance, 56 government guarantees of debt by financial institutions, 74 direct re-capitalizations of financial institutions, 37 asset purchases, and 51 central bank liquidity supports. As a government may undertake more than one intervention per day, the total number of inventions is greater than the total number of intervention days.

When non-conventional interventions started in the third quarter of2008, they took the form of liquidity support. The incidence of intervention skyrocketed in the fourth quarter of 2008 after the Lehman's bankruptcy. In that quarter, there were 86 interventions, encompassing all types. In the first quarter of 2009, the number of interventions shrank by half to 47, when the dominant types were direct recapitalizations and asset purchases. In the second quarter of 2009, the incidence declined further to 27. However, the pace of interventions picked up again in the second quarter of 2010, with the unfolding of the European Sovereign Debt Crisis. Note however that it is natural for certain types of intervention to decrease over time. For example, there is a natural limit on the number of deposit insurance that government can implement after the first enactment.

2.2 Identifying announcements with a surprise

Some of the interventions were subject to extensive debates. By the time they were announced, there was very little surprise in the announcement. In this case, our

[4] We exclude the U.S. interventions from the sample because there were too frequent interventions and they tended to bunch together. Since the interventions for a typical non-US country are relatively sparse, our quasi-event approach can identify the effect more accurately.

event study methodology would not identify any effect of the interventions even if they are truly effective. For this reason, we make an attempt to identify a set of intervention announcements that are most likely to contain some elements of a surprise.

For each intervention, we read media coverage, typically by the leading English-language newspapers or newswires, retrieved from www.factiva.com, with an eye for comments that suggest whether the intervention or at least its scale was beyond the original market expectations. For example, on October 13, 2008, France implemented a debt guarantee and a re-capitalization. The International Herald Tribune on the following day declared that "The scale of the government moves took some by surprise… 'The capital-raising is of a much larger scale than anticipated,' said Simon Willis, an analyst at NCB Stockbrokers in London." As another example, on May 7, 2009, the Bank of England's Monetary Policy Committee voted to continue with its program of asset purchases financed by the issuance of central bank reserves and to increase its size by £50 billion to a total of £125 billion. The Times reported this intervention announcement with the title of "Surprise as Bank of England pours extra £50bn into bond-buying to boost economy".

By this methodology, we identify 31 announcements (out of a total of 231 intervention announcements), or 14% of the total, as containing an element of a surprise. It is important to note that some of the remaining 86% of the interventions could still contain an unanticipated component but our methodology cannot pick it up. As a case in point, a subset of announcements that we do not classify as "surprises" are related to the European Union's authorization of individual member countries' bailout plans. Our reasoning is that the market may already have been aware of the member countries' initial submission of the bailout plans to the European Commission and did not believe that the EU would reject the submissions. In reality, of course, the EU's authorization could have removed some uncertainty and therefore contain some elements of surprise. However, to be on the conservative side, as long as no major media outlets treated them as a surprise in the news reports, we wouldn't either.

As an extension, we further separate "positive" and "negative" surprises, where positive shocks refer to the cases when the announced intervention is stronger than market's expectation, and negative shocks refers to the cases when the intervention is weaker than the market's expectation. For example, on Nov 20, 2008, France announced

a 20 billion Euro fund to invest in viable firms in need of cash, and shore up the balance sheets of companies deemed vulnerable in the face of falling stock prices. But this program appears to be below the market expectation according to Agence France Presse: "The amount announced was far below the 100 billion euros (125 billion dollars) initially floated as the planned startup capital last month when Sarkozy announced his French version of a sovereign wealth fund." As another example, on May 13, 2009, the German government announced a plan to help banks rid themselves of distressed assets by shifting them to "bad banks". The Wall Street Journal in its news report (as opposed to the comment section) called the plan "wishy-washy," and stated that "analysts said the plan doesn't do enough to restore banks' capital or make lenders come clean on their losses." Our methodology has identified six cases with a negative surprise (outside the United States).

3. Methodology

Our methodology is a hybrid of an event study approach and a cross-country cross-sector analysis that explores interactions between cross sector differences in the intrinsic dependence on external finance for working capital and cross country differences in the timing of intervention announcements.

Our sample consists of changes in log stock prices at the firm level from date t-1 to date t+n in countries when there is an intervention announcement on date t. We look at the window (t-1, t) first (and will look at windows with an elapse of more time since the intervention announcements – to be done).

3.1 Basic specification

Our basic empirical strategy is to check whether, in a given country, an *ex ante* classification of firms by their characteristics in terms of degree of liquidity constraint helps to predict the *ex post* magnitude of their stock price changes around intervention announcements. To be precise, our specification is given by the following equation:

$$\text{StockReturn}_{i,k,j,t} = \beta_1 \text{FinancialDependence}_k + \beta_2 \text{Control}_{i,k,j,t} + \text{fixed effects} + \varepsilon_{i,k,j,t}$$

where *i* stands for company, k for sector, *j* for country and *t* for intervention day. To see how a government (non-conventional) intervention affects the extent of a liquidity crunch in a country, we focus on the coefficient on non-financial firms' dependence on external finance. The slope coefficient, β_1, then captures the degree to which the extent of a credit crunch depends on government intervention.

Asset pricing models provide guidance for control variables. We add the two factors from Fama and French (1992): firm size (log of assets), and stock market return multiplied with beta. The beta is for year 2007, measured by the correlation between weekly firm-level stock return and weekly market return for year 2007. We follow Whited and Wu (2006) and incorporate the two factors by entering the relevant firm characteristics directly in our regressions rather than entering them indirectly by going through a factor model first. For control variables, these two ways of incorporating the factors should be equivalent. Entry of firm characteristics directly in our regressions is easier to implement, though the interpretation of the coefficients on these factors is less straightforward.

Moreover, as stock price may change due to the impact of intervention on aggregated demand, we further control for sector-level intrinsic sensitivity to the demand shock as in Tong and Wei (2010).

Finally, due to the rapid unfolding of crisis and the quick implementation of interventions, we drop the intervention days when there is at least one intervention in the previous three days. Doing so helps us to reduce the compounding effects from earlier interventions.

3.2. Key Data

Percentage change in stock price

The daily stock price index is retrieved from Datastream, which adjusts for dividends and capital actions such as stock splits and reverse splits. To reduce the inference of illiquid stocks, we drop the cases when there is no single trade of the stock at the announcement day, the day before and the day after. We measure stock return as the log difference between stock price at the announcement day (t) and that at the previous trading day (t-1). In the robustness check, we will also look at the return between (t+1) and (t-1).

Financial dependence index

We develop a measure of intrinsic liquidity needs for working capital (DEF_WK): Working capital is required for a firm to operate and to satisfy both short-term debt payment and ongoing operational expenses. Firms may use lines of credit, term loans or commercial paper to cover their working capital needs. If a liquidity crunch makes it difficult for a firm to raise funds for working capital, we would like to capture that. If there is an unexpected liquidity crunch for working capital, those industries that depend intrinsically more on external finance for working capital should experience a larger decline of stock prices.

We construct a sector-level measure of intrinsic need for external finance for working capital by the concept of a "cash conversion cycle", which has also been adopted by Raddatz (2006) and Kroszner, Laeven, Klingebiel, (2007). The cycle measures the time elapsed from the moment a firm pays for its inputs to the moment it receives payment for the goods it sells. We assume that dependence on external finance for working capital is due to pure technological reasons, such as the length of time in the production process and the mode of operation. For firms in the United States during a non-crisis period, when the supply of finance is as abundant as in any country, the relative values of the cash conversion cycle across sectors reflect relative true needs for external finance for working capital. More specifically,[5]

$$\text{Cash conversion cycle} = 365 * \left(\frac{\text{inventories - account payables}}{\text{cost of goods sold}} + \frac{\text{account receivables}}{\text{total sales}} \right)$$

The sector-level proxy is constructed as follows: First, for each U.S. firm from 1990 to 2006, we calculate the cash conversion cycle based on annual data from Compustat USA Industrial Annual. Then we calculate the median within each U.S. SIC 3-digit sector, and apply it as the sector's intrinsic dependence on external finance for working capital. The index for the U.S. firms is then extrapolated to other countries. As in Raddatz (2006), we rely on U.S. firm data in that the supply of liquid funds is much

[5] Inventories, accounts receivable, and accounts payable are year-end numbers, while costs of goods and sales are aggregated over the year. Hence we follow the literature and multiply the ratio by 365, i.e., the number of days in a year.

more elastic in the US, and hence observed differences in relative working capital levels across industries are mainly demand driven. The median and mean values of this index are both 71 days, and the standard deviation is 41 days.

Tong and Wei (2010) document that sectors with large DEP_WK experienced a larger decline of stock prices during the 2007-2008 global liquidity crisis period, as well as around the Lehman's Bankruptcy.

Control Variables and Summary Statistics

In some subsequent analyses, we add other variables meant to control for risks, such as the factors from the Fama-French (1992) model, which are firm size (as measured by the log of book assets), and beta from the datasets of Worldscope and Datastream. In our model, we use the domestic beta. Griffin (2002) finds that domestic factor models explain much more time-series variation in returns and have lower pricing errors than the world factor model. Moreover, the addition of foreign factors to domestic models leads to less accurate in-sample and out-of-sample pricing. Hence, "practical applications of the three-factor model… are best performed on a country-specific basis".

Another regressor is an index of a firm's sensitivity to a contraction in consumer demand. Tong and Wei (2008) propose such an index at the sector level based on the stock price reactions of the firms in that sector to the September 11, 2001 terrorist attack. To construct the index, we first compute the change in log stock price for each US firm from September 10, 2001 to September 28, 2001. We then look at the mean of log stock price change for each three-digit SIC sector, and use it as the sector-level demand sensitivity. Excluding financial sector firms, we are left with 361 3-digit level sectors in total.

This index reflects the sensitivity of a firm's stock price to an unexpected shock in consumer demand, and it is not contaminated by a firm's sensitivity to liquidity shocks or other factors. We verify that there was a big downward shift in expected aggregated demand, as reflected by a downward adjustment in the consensus forecast of subsequent U.S. GDP growth in the aftermath of the shock at the same time, because the Federal Reserve took timely and decisive actions, it may be argued that the effect of the 9/11 shock on firms' financial constraints was small or at most short lived. In the 2001 episode, both the level of the real interest rate and the TED spread (risk premium), after

initial spikes, quickly returned to a level only moderately higher than the pre-9/11 level. This suggests that the market regarded the Federal Reserve's actions in the first few days following the terrorist attack as sufficient to restore the market's desired level of liquidity. We therefore conclude that the cumulative stock price change from September 10 to 28, 2001, is unlikely to also reflect firms' reactions to a deterioration of credit availability. (In contrast, the subprime crisis news is associated with a much greater increase in the TED spread.) Additional details can be found in Tong and Wei (2008).

Lastly, firms with a higher pre-crisis leverage ratio may have more difficulty in rolling over their debt during a crisis. In addition, a higher leverage ratio may by itself trigger a larger decline in stock price for a given demand shock. Hence we include the leverage ratio as a control variable. To reduce the impact of endogeneity, we use the leverage measured at the end of year 2007, which is predetermined to government interventions since Q3, 2008.

Table 2 summarizes the dependent and key explanatory variables. The stock return in the first row captures the log difference in stock prices for non-financial firms from the day before the intervention (t-1) to the intervention day (t). The sample mean of the change in log prices is 0.042%. A t-test suggests that the sample mean is postive and significantly different from zero with a p-value of 0.01. The 2nd row focuses on banks. There the mean stock return of banks around the intervention date is 0.34%. A t-test suggests that this mean is also significantly positive with a p-value smaller than 0.001. In the 3rd row, we report average daily change in log stock prices outside the intervention periods (from t-4 to t-3). By comparing Columns 1 and 3, we can see that stock prices tend to do better on intervention days than on non-intervention days.

4 Results

4.1 Baseline Results

We start with the basic specification in Equation 1 and report the results in Table 3. We find that government interventions on financial sectors have significantly positive impact on alleviating the liquidity constraints of non-financial firms. The results are presented in Table 3. In Column 1, we first include the financial dependence for working capital (DEP_WK). We find that stock return is significantly higher for sectors with large DEP_WK around the interventions. Note that, standard errors are clustered at the level of

3-digit sector (We get very similar results if we do two-way clustering by 3-digit sector and intervention day). In Column 2, we add firm leverage at the end of year 2007, and find the interventions to have a significantly positive impact on firms with a high leverage. Columns 1 and 2 both suggest the easing of liquidity constraint. In Column 3, we add demand sensitivity and firm size. We find that sectors with high demand sensitivity also experience significant gains. The results in Columns 1 and 2 are little affected. In Column 4, we further include beta in 2007 multiplied by market return around the interventions. This reduces the coefficients for DEP_WK, but DEP_WK is still significant. However, demand sensitivity becomes insignificant. In Column 5, we add intervention fixed effects (231 of them in total). This further reduces the coefficient of DEP_WK but still significant at the 10% level.

In the last column, we also consider the abnormal return at the firm level:

$$\text{AbnormalReturn}_{i,k,j,t} = \text{StockReturn}_{i,k,j,t} - \alpha_{i,2006} - \beta_{i,2006} * \text{LocalMarketReturn}_{i,k,j,t}$$

Both $\alpha_{i,2006}$ and $\beta_{i,2006}$ are estimated based on a market model regression, i.e., the regression of weekly stock return onto weekly local market return for the year 2006. We use 2006 data, as it is not contaminated by the 2007-2010 crisis itself. This approach helps to control for missing variables that affect the stock market. But if the market model is not well-specified (such as a low explanatory power), then using abnormal return may introduce noise into the dependent variable and bias up the standard errors of explanatory variable. In any case, we include it as an additional column in Table…

To gauge the economic significance of the intervention, we examine the effect of the Lehman Brothers collapse on the liquidity constraint using the exact same methodology. That is, we examine the stock return from Sept 12, 2008 (last Friday before Lehman Bankruptcy) to Oct 3, 2008 (last Friday before a joint effort by central banks to save the economy).[6] Of course, if the Lehman collapse induced a tightening of liquidity

[6] On October 8, 2008, Central banks in USA (Fed), England, China, Canada, Sweden, Switzerland and the European Central Bank cut rates in a coordinated effort to aid world economy.

constraint, we would expect the coefficient on the measure of dependence on external finance to be negative. The results, presented in Table 4, are consistent with this. If we just include DEP_WK and leverage, the coefficient on DEP_WK is -0.028 and statistically significant. In other words, stock prices fell more for firms that are more dependent on external finance. This is our evidence that liquidity constraint tightened after the Lehman collapse (Tong and Wei (2010) find a similar result for a two-day window around the Lehman collapse for selected 24 emerging economies). In the last column when we add more firm controls, we find that the coefficient of DEP_WK (-0.025) to be an order of magnitude larger than the corresponding coefficient for the intervention sample (last column of Table 3). To summarize, while the nonconventional interventions helped to unfreeze the credit market in a statistically significant way, the effect of an average intervention is economically small. Therefore, it takes an accumulation of many such interventions for the effect to be large enough to reverse the credit tightening induced by the financial crisis.

One may be concerned that the results are compounded with the signal effect of intervention. For example, intervention may signal a weak underlying fundamental and hence reduce stock price. In other words, an insignificant effect of intervention may either suggest that intervention has no real impact (due to say poor design), or that the positive real impact and the negative signal impact cancel each other. We argue that interventions would signal worse state of credit constraint only when intervening authorities both have superior information than the market and wait until the date of the intervention to reveal the information. A normal political logic would suggest that politicians would first disclose the information to justify a need for action and then go on to try to organize a policy action. Moreover, our narrative approach (of reading media reports about each intervention) would have discovered whether there is new information about the state of credit constraint contained in the intervention announcement.

4.2 Intervention announcements with a surprise

As stated earlier, intervention announcements with little surprises are not expected to have as strong an effect as those with a surprise. In Table 5, we include an interaction term between a dummy denoting an intervention with a surprise and DEP_WK, in addition to leverage, and demand sensitivity. The specifications in Table 5

are similar to Table 3. Throughout the specifications, we find that Surprise*DEP_WK is significantly positive. In the last column, we include intervention fixed effects, now the coefficient on Surprise*DEP_WK is smaller but still significant at the 5% level.

In Table 6, we look at the subsample of days with surprising interventions. This reduces our sample to around 16% of that in Table 5. Across all the specifications, DEP_WK is significant at the 1% level, even in the last column when intervention fixed effects are included. Moreover, the magnitude of the coefficient for DEP_WEK in the last column of Table 5 is 0.0051, five times of that in the last column of Table 3 (0.0011). Hence, surprising interventions indeed have a larger impact than other interventions.

However, while the coefficient on DEP_WK is statistically significant, its absolute magnitude is again much smaller than the corresponding coefficient in the Lehmann event in Table 4 (only about one fifth of that in Table 4). This hence suggests that each intervention alone is not enough to offset the liquidity crunch after the Lehman bankruptcy, but cumulative impacts of a series of interventions could still be significant. Also, the demand sensitivity is not significant either in the last column of Table 6, with a coefficient of 0.069, much smaller than that for Lehman event (-1.09). This further suggests that the interventions have done little in improving aggregate demand.

4.3 Broad-based interventions

Some interventions focus narrowly on individual banks, but others are much more broad-based, covering the entire banking system. Approximately 73% of the interventions in the sample can be said to be broad based. In Table 7, we add an interaction term between a dummy for broad-based interventions and DEP_WK. The interaction term is significant in all specifications except Column 5, where we include intervention fixed effects. In the last column, we focus only on the subsample of broad-based interventions. In this case, DEP_WK is significantly different from zero at the 5%.

4.4 The impact of banking sector return

Our underlying hypothesis so far is that intervention announcements potentially improve the stability and balance sheet of the banking system and hence allow banks to provide liquidity. If this hypothesis holds, then when bank systems experience a higher

abnormal return around the intervention announcements, sectors with higher DEP_WK are more likely to experience higher abnormal return as well. To test this, we take the following steps: first, we run a CAPM model of the bank-sector stock return onto the market return for each year separately from 2006 to 2010, and construct abnormal returns for the banks. Second, we interact the abnormal bank return with DEP_WK and use it as an explanatory variable for the stock return of non-financial firms.

One needs to be careful about the interpretation of the coefficient on the interaction term. If interventions alleviate liquidity constraint faced by non-financial firms by first making the banks healthier and more willing to lend, one should expect to see that the firms would especially well when banks are also doing better. In this sense, a positive and significant coefficient on the interaction term is consistent with this interpretation. But we are not able to prove that the chain of causality has to go from government interventions to better bank health to less liquidity constraints by non-financial firms. If non-financial firms do better, for whatever reason, banks benefit indirectly since non-financial firms are the ultimate source of bank profits.

In any case, the regression results are presented in Table 8. In Column 1, we include the abnormal return of bank sector itself and find that it has a significant and positive impact. [Note that we have already included Beta factor, hence abnormal bank sector also increase the abnormal return of non-financial sector.] In Column 2, we include the interaction term between bank sector abnormal returns and DEP_WK. We find that the interaction term does have a positive coefficient which is significant at the 1% level. In Column 3, while we include the intervention date fixed effects, the coefficient on the interaction term is still positive and significant. In Column 4, we construct a dummy of high abnormal bank return, which equals one when the abnormal bank return for that day is one standard deviation (of abnormal bank returns) above zero. The interaction term of this dummy and DEP_WK is also significantly different from zero.

4.5 Different types of interventions

As another extension, we decompose all non-conventional interventions into two types: central bank liquidity support and balance sheet approach (including deposit insurance, debt guarantees, recapitalization, and asset purchase), and check if one type is

more effective than the other.[7] The empirical evidence is still limited on the relative effectiveness of different intervention types. Aït-Sahalia et al (2009) compare market recapitalization and liquidity support, and find that recap has more impact than central bank liquidity support in reducing the LIBOR_OIS spread.

We now examine the effectiveness of these two types in alleviating the financial constraint of non-finanical sectors. The resuts are in Table 9. In Column 1, we focus on the bank-balance-sheet-based approach and exclude the central bank liquidity support. There we find that DEP_WK has a positive coefficient, significant at the 5% level. In Column 2, the sample includes only central bank liquidity support. There DEP_WK has no significant impact, with a coefficient around one third of that in Column 1. Hence interventions focusing on bank balance sheet are more effective in alleviating the constraint on short-run corporate financing. In column 3, we pull the samples in column 1 and 2 together and add two interaction terms: CB liquidity support*DEP_WK, and Bank Balance Approach*DEP_WK. Again, we find that Bank Balance Approach*DEP_WK has a larger magnitude.

4.6 Other Robustness Checks and Extensions

We further look at the negative shocks (six in total as discussed earlier). For negative shocks, we see that DEP_WK has negative coefficients albeit insignificant (Table 10). This may be due to that some of the theoretically positive intervention effect is offset by the negative effects of compounding signals or events. For example, on 10/22/2008, the Reserve Bank of India injected $37 billion into the financial system to spur lending. But "Analysts said they were surprised the bank had not built on its recent aggressive easing of monetary policy with another rate cut" (Agence France-Presse). Also, on 5/13/2009, France provided €5 billion of capital to Natixis SA while Natixis made the same-day announcement of worse-than-expected losses.

So far, we look at stock return between t and t-1, where t is the intervention day. As a check, we look at the stock return between t+1 and t-1 and report the results in Table

[7] There have some theoretical debates on the effectiveness of different interventions in alleviating financial constraint, as different interventions address different components of bank sector's balance sheet and have different implications on the cost to the central bank and the government (see Bebchuk and Goldstein 2009 and Philippon and Schnabl (2009)).

11. Looking at the last column with country fixed effects, we find a larger effect for DEP_WK (0.0014) than that in Table 3 (0.0011). The larger effect of longer horizon suggests that the market may need time in digesting the contents of interventions.

5. Conclusions

The analyses provide evidence that government intervention during this crisis helped alleviating the liquidity constraints faced by non-financial firms. While the effect is statistically significant, the economic magnitude for an average intervention is modest when compared to the magnitude of the increase in liquidity constraint after the Lehman Brothers collapse.

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Table 1. Number of Interventions and Surprises

Country	# of interventions	# of positive surprises	# of negative shocks
Canada	10	3	0
France	16	3	1
Germany	41	3	1
Greece	15	2	0
India	2	0	1
Indonesia	3	2	0
Italy	20	2	0
Japan	11	2	0
Korea	15	2	0
Singapore	6	1	0
Spain	20	2	0
Sweden	27	1	0
Switzerland	6	1	0
Turkey	3	0	0
United Kingdom	36	7	2
Total	231	31	5

Source: Authors' compilations, with the second column based on IMF (2009) and the third column based authors reading of news coverage of the announcements.

Table 2. Summary Statistics

Variable	#of Obs	Median	Mean	St Dev	Min	Max
Stock return (%) between t-1 and t (non-financial firms)	85977	0.00	0.04	5.34	-17.6	18.1
Stock return (%) between t-1 and t (banks)	4493	0	0.35	4.91	-17.6	18.1
Stock return (%) between t-4 and t-3 (non-financial firms)	83522	0.00	-0.71	4.92	-17.3	14.3
Stock return (%) between t-4 and t-3 (banks)	4087	0	-0.63	4.12	-17.3	14.3
Leverage ratio	80517	0.15	0.18	0.17	0.00	0.98
Firm size	80517	12.1	12.16	2.05	4.48	19.5
Beta	79988	0.68	0.72	0.57	-0.94	2.30
Dependence on external finance for working capital	127	88.5	94.6	42.3	0.00	291.8
Demand sensitivity	149	1.51	1.59	1.21	-1.12	4.85

Source: Authors' calculations.

Table 3. Non-conventional Interventions and Liquidity Constraint

DEP_WK	0.0057**	0.0056**	0.0056***	0.0030**	0.0011*
	[0.0024]	[0.0023]	[0.0018]	[0.0012]	[0.00059]
Leverage		0.88**	0.43*	0.41**	0.22
		[0.40]	[0.25]	[0.18]	[0.13]
Demand sensitivity			0.24**	0.11	0.044
			[0.10]	[0.079]	[0.043]
Firm size			0.12***	0.048***	0.026***
			[0.014]	[0.0091]	[0.0095]
Beta*Market Return				0.59***	0.34***
				[0.027]	[0.029]
Constant	-0.4	-0.55*	-2.32***	-1.14***	
	[0.29]	[0.32]	[0.29]	[0.27]	
Intervention fixed effect	n	n	n	n	Y
Observations	76165	76165	75996	75520	75520
R-squared	0.002	0.003	0.007	0.194	0.267

Note: The dependent variable is the log difference between the stock price at the announcement day (t) and that at the previous trading day (t-1). DEF_WK denotes dependence on external financing for working capital. Standard errors, clustered at the 3-digit sector, are in brackets. ***, **, and * denote statistically significant at the 1%, 5%, and 10% levels, respectively.

Table 4. The Lehman Collapse and the Differential Stock Price Responses
--Change in log stock price from Sept 12, 2008 to Oct 3, 2008

DEP_WK	-0.028***	-0.028***	-0.025***
	[0.0074]	[0.0067]	[0.0056]
Leverage		-4.74***	-5.03***
		[1.15]	[1.23]
Demand sensitivity		-0.85***	-0.94***
		[0.28]	[0.29]
Firm size			0.14
			[0.20]
Beta*market return			0.31***
			[0.081]
Country fixed effects	y	y	y
Observations	5,132	5,123	5,094
R-squared	0.091	0.097	0.11

Note: The dependent variable is the change in log stock prices from Sept 12, 2008 to Oct 3, 2008. DEF_WK denotes dependence on external financing for working capital. Standard errors, clustered at 3-digit sector, are in brackets. ***, **, and * denote statistically significant at the 1%, 5%, and 10% levels, respectively.

Table 5. Pooling Surprising and Less Surprising Announcements

Surprise	-1.90***	-2.22***	-2.64***	-1.59***	
	[0.48]	[0.50]	[0.44]	[0.24]	
DEP_WK	0.0033*	0.0032**	0.0033***	0.0015	0.00035
	[0.0017]	[0.0016]	[0.0012]	[0.00095]	[0.00067]
Surprise*work	0.013***	0.013***	0.012***	0.0075***	0.0045**
	[0.0044]	[0.0043]	[0.0042]	[0.0024]	[0.0018]
Leverage		0.51*	0.1	0.30*	0.13
		[0.28]	[0.19]	[0.16]	[0.13]
Surprise*leverage		2.05***	1.80***	0.54	0.53
		[0.76]	[0.58]	[0.39]	[0.36]
Demand sensitivity			0.16**	0.088	0.035
			[0.080]	[0.071]	[0.045]
Surprise*Demand sensitivity			0.35***	0.10**	0.045
			[0.10]	[0.052]	[0.045]
Firm size			0.12***	0.048***	0.026***
			[0.014]	[0.0091]	[0.0095]
Beta*Market Return				0.59***	0.34***
				[0.028]	[0.029]
Intervention fixed effects	n	n	n	n	Y
Constant	-0.048	-0.14	-1.80***	-0.82***	
	[0.20]	[0.23]	[0.21]	[0.24]	
Observations	76165	76165	75996	75520	75520
R-squared	0.006	0.008	0.012	0.197	0.267

Table 6. Non-conventional Interventions and Liquidity Constraint-Shock Only					
DEP_WK	0.016***	0.016***	0.015***	0.0089***	0.0051***
	[0.0057]	[0.0055]	[0.0049]	[0.0028]	[0.0016]
Leverage		2.55***	1.50**	0.65	0.49
		[0.97]	[0.70]	[0.48]	[0.40]
Demand sensitivity			0.47***	0.17*	0.069
			[0.17]	[0.095]	[0.042]
Firm size			0.29***	0.12***	0.11**
			[0.060]	[0.038]	[0.051]
Beta*Market Return				0.59***	0.34***
				[0.029]	[0.042]
Intervention fixed effects	n	n	n	n	y
Constant	-1.95***	-2.36***	-6.35***	-3.25***	
	[0.66]	[0.70]	[0.59]	[0.40]	
Observations	12593	12593	12567	12465	12465
R-squared	0.013	0.018	0.035	0.213	0.272

Table 7. Broad-based versus Narrow Interventions

Systematic Intervention	0.25**	0.22**	0.14	-0.36***		
	[0.12]	[0.10]	[0.12]	[0.13]		
DEP_WK	0.0039*	0.0039*	0.0038**	0.0013	0.00058	0.0014**
	[0.0022]	[0.0021]	[0.0016]	[0.0010]	[0.00090]	[0.00060]
DEP_WK*Systematic Intervention	0.0027***	0.0026**	0.0026**	0.0023**	0.00074	
	[0.0010]	[0.0010]	[0.0011]	[0.0011]	[0.00074]	
Leverage		0.76**	0.31	0.14	-0.029	0.25
		[0.36]	[0.29]	[0.24]	[0.22]	[0.16]
Leverage*Systematic Intervention		0.16	0.15	0.37	0.34	
		[0.31]	[0.31]	[0.31]	[0.28]	
Demand sensitivity			0.2	0.068	0.062	0.033
			[0.12]	[0.070]	[0.055]	[0.040]
Demand sensitivity			0.06	0.063	-0.024	
*Systematic Intervention			[0.046]	[0.052]	[0.039]	
Firm size			0.12***	0.049***	0.026***	0.056***
			[0.014]	[0.0090]	[0.0095]	[0.011]
Beta*Market Return				0.59***	0.34***	0.34***
				[0.027]	[0.029]	[0.029]
Intervention fixed effects	n	n	n	n	y	y
Constant	-0.59**	-0.72**	-2.44***	-0.88***		
	[0.27]	[0.30]	[0.32]	[0.22]		
Observations	76165	76165	75996	75520	75520	54956
R-squared	0.004	0.004	0.009	0.194	0.267	0.304

Table 8. Is There a Banking Channel for Alleviation of Credit Crunch?

DEP_WK	0.0035**	0.0036***	0.0015**	0.0027*	0.00077
	[0.0014]	[0.0014]	[0.00061]	[0.0015]	[0.00073]
Bank Abnormal returns	5.42***	-1.28			
	[1.30]	[2.23]			
Bank Abnormal returns*DEP_WK		0.072***	0.040***		
		[0.017]	[0.014]		
Leverage	0.53***	0.53***	0.29**	0.51**	0.29**
	[0.20]	[0.20]	[0.15]	[0.20]	[0.15]
Demand sensitivity	0.13	0.13	0.053	0.13	0.052
	[0.087]	[0.085]	[0.046]	[0.085]	[0.046]
Firm size	0.047***	0.047***	0.022**	0.049***	0.022**
	[0.010]	[0.010]	[0.0095]	[0.010]	[0.0096]
Beta*Market Return	0.60***	0.60***	0.34***	0.59***	0.34***
	[0.031]	[0.031]	[0.031]	[0.030]	[0.031]
Dummy (high bank abnormal return)				-0.14	
				[0.14]	
Dummy (high bank abnormal return)				0.0035***	0.0029**
*DEP_WK				[0.0013]	[0.0014]
Constant	-1.23***	-1.23***		-1.21***	
	[0.32]	[0.31]		[0.31]	
Intervention date fixed effects	No	No	Yes	No	Yes
Observations	69,041	69,041	69,041	69,041	69,041
R-squared	0.197	0.197	0.27	0.196	0.27

Table 9. The Relative Effectiveness of Different Types of Interventions

	Bank Balance Sheet Approach Only	CB Liquidity Support Only	Combined Sample
DEP_WK	0.0015**	0.00053	0.00011
	[0.00060]	[0.00097]	[0.0022]
Bank Balance Sheet Approach*DEP_WK			0.0014
			[0.0021]
CB Liquidity Support*DEP_WK			0.000027
			[0.0014]
Leverage	0.13	0.39*	0.22
	[0.16]	[0.23]	[0.13]
Demand sensitivity	0.027	0.041	0.044
	[0.045]	[0.046]	[0.042]
Firm size	0.0087	0.061***	0.026***
	[0.014]	[0.016]	[0.0096]
Beta*Market return	0.32***	0.37***	0.34***
	[0.026]	[0.043]	[0.029]
Intervention day fixed effects	Y	Y	Y
Observations	49023	20293	75520
R-squared	0.152	0.411	0.267

Table 10. Interventions and Liquidity Constraint-Negative Shock Only				
DEP_WK	-0.0032	-0.0037	-0.0027	-0.0014
	[0.0033]	[0.0029]	[0.0029]	[0.0023]
Leverage		-0.12	0.19	0.86
		[0.53]	[0.50]	[0.54]
Demand sensitivity		0.061	0.1	0.13
		[0.12]	[0.099]	[0.11]
Firm size		-0.31***	-0.21***	-0.20***
		[0.046]	[0.045]	[0.048]
Beta*Market Return			0.38***	0.26***
			[0.045]	[0.055]
Intervention fixed effects	n	n	n	y
Constant	-0.95***	2.77***	2.11***	
	[0.36]	[0.57]	[0.54]	
Observations	2472	2468	2455	2455
R-squared	0.001	0.023	0.056	0.072

Table 11. Interventions and Liquidity Constraint (between t-1 and t+1)

DEP_WK	0.0071**	0.0070**	0.0070***	0.0053**	0.0014*
	[0.0031]	[0.0030]	[0.0026]	[0.0023]	[0.00081]
Leverage		1.06**	0.44	0.66**	0.071
		[0.45]	[0.28]	[0.27]	[0.15]
Demand sensitivity			0.31***	0.27**	0.088**
			[0.11]	[0.11]	[0.036]
Firm size			0.17***	0.090***	0.051***
			[0.019]	[0.020]	[0.016]
Beta*Market Return				0.69***	0.38***
				[0.021]	[0.023]
Constant	-0.54	-0.72*	-3.16***	-2.25***	
	[0.38]	[0.40]	[0.48]	[0.52]	
Intervention fixed effects	n	n	n	n	y
Observations	76165	76165	75996	75520	75520
R-squared	0.002	0.002	0.007	0.17	0.255

Fig 1. Number of Interventions and Surprising Interventions

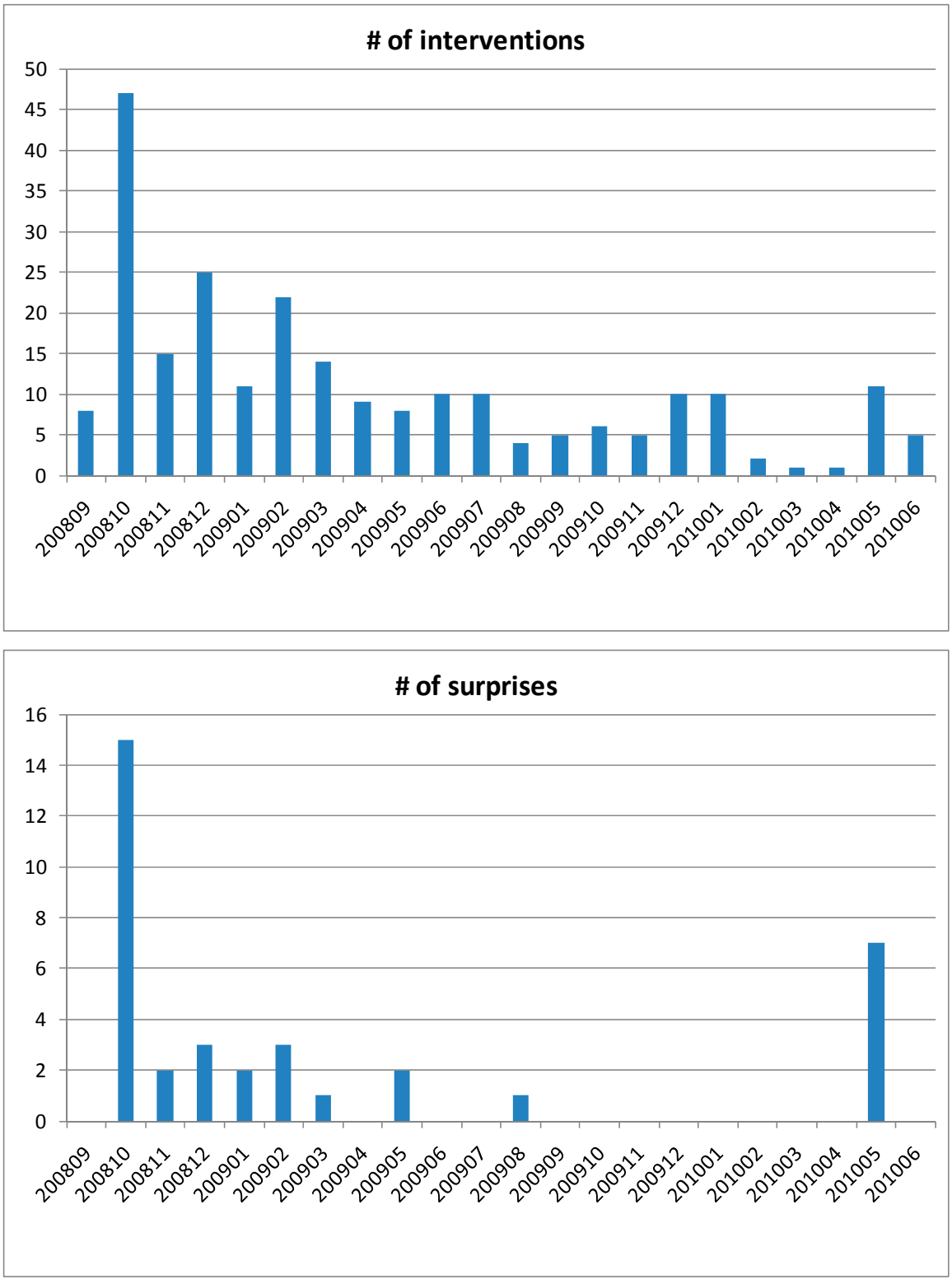

Figure 2. The Distribution of Intervention Types