Money, Markets, and Jobs:
Essays on Financial Stability

by

Eric Tong

Submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Economics, the University of Auckland, 2016.

Abstract

This thesis examines three aspects of the global financial crisis: the pre-crisis buildup of bank fragility and the role played by US monetary policy; the market mayhem triggered by asset managers in the wake of US monetary policy normalisation following the crisis; and the labour market consequences of a withdrawal of bank credit following re-evaluation of financial collateral by investors.

Using theoretical and empirical methods I show that, while each of these episodes appear as outcomes of an interchange of optimism and panic, they can be interpreted as rational responses by market participants to deep frictions within the economy. Specifically, I find that (i) there is evidence of a global financial cycle in which loose US monetary policy heightens the default risk of banks in other countries; (ii) market panics and the equilibrium allocation of arbitrage capital hinge on the stance of monetary policy. Since arbitrage profits depend on expectations of future crises, which are contingent on the actions of central banks, asset managers keen to keep up with their peers may race to sell assets at the same time; (iii) worsening collateral quality does not always trigger screening by banks but, when it does, employers are deprived of funds to hire, triggering job losses.

The analysis contributes to the wider debate on the use of monetary and macroprudential policy to foster financial stability.

To Grandma, who would have been proud.

Acknowledgements

My biggest debt of gratitude is to Professor Prasanna Gai, without whose motivation and steadfast guidance this thesis would not have been possible.

I would also like to thank the researchers at the Reserve Bank of New Zealand – Punnoose Jacob, Benjamin Wong, Miles Parker, and Leo Krippner – whose comments have shaped the ideas of this thesis. I am grateful to Lorenzo Ductor, Ryan Greenaway-McGrevy, and Erwann Sbai, for their contributions to the design of the empirical experiments; Professor Ippei Fujiwara and Harold Cuffe, for their suggestions at the Australian National University PhD Conference and the Macroeconomic Dynamics Workshop hosted by Victoria University of Wellington; and Addison Pan, for her generous sharing of data access, without which the empirical analysis would have been hindered. In addition, I have benefited greatly from the many conversations I have had with teachers at the University of Auckland, among them, Basil Sharp, Arthur Grimes, Robert Scollay, Martin Berka and Matthew Ryan (now AUT).

This thesis is dedicated to my family and close friends – Ringo, Carol and Claris. Carol has served as my severest critic over time, and Claris has been a tireless supporter throughout. I am very much indebted to them.

Contents

Chapter 1

Introduction

A central issue for policymakers has been whether to lean against a credit cycle boom, or clean up after the bust[1]. The expansion phase of a credit cycle involves surges in asset prices and leverage, which, when reversed, can lead to grave outcomes. Households' wealth falls with asset prices, and deleveraging restricts credit supply and consumption for a prolonged period of time. Banks fail during the process; workers become unemployed. Examining the evolution of real per capita GDP of around 100 systemic banking crises, Reinhart and Rogoff (2014) find that, on average, it takes eight years for a country to return to its pre-crisis level of income. The global financial crisis of 2007 serves as a vivid reminder of the severity of a credit crunch.

Despite such large stakes, there is little consensus concerning the management of financial cycles. The US Federal Reserve, in whose currency more than 40% of global

[1]The Federal Reserve has repeatedly eased monetary policy after a crash: in 1987 (the stock market crash), in 1990-91 (the property crash, and the Savings and Loans crisis), in 1998 (LTCM), and most recently in 2007. Episodes also exist where the FOMC eased monetary policy *prior* to a crash to "insure" against a potential, albeit unlikely, downside risk of financial instability and deflation. For example, in 2003, despite several indicators pointing towards a robust recovery, the FOMC lowered interest rates due to concern for "the probability, though minor, of an unwelcome substantial fall in inflation." (See Greenspan (2003); White (2009); and Bernanke, Reinhart, and Sack (2004)). Recently, debates have also arisen within the ECB on whether preemptive actions should be used to counter rising global risks (Speciale, 2016).

financial assets are denominated[2], adheres to a conventional strategy that focuses exclusively on prices stability and full employment (Kohn, 2006)[3]. In contrast, the European Central Bank advocates a system of two "pillars", the second of which points to "a somewhat tighter policy stance in the face of an inflating asset market than they [central banks] would otherwise pursue if they had been confronted with a similar macroeconomic outlook under more normal asset market conditions." (Stark, 2009)[4]. Similarly, the Bank of Japan incorporates factors such as asset prices and credit volume into its two "perspectives" of economic assessment (BoJ, 2011). In accordance with the Financial Services Act 2012, the Bank of England consults the Financial Policy Committee on the complementarity of monetary policy and financial stability considerations[5]. In short, major central banks diverge in their stance towards credit imbalances, with the ECB, the Bank of Japan, and the Bank of England expressing their willingness to lean against a credit boom with monetary policies, should a need arise.

This thesis attempts to clarify our understanding of the drivers and consequences of financial instability against this backdrop. Using theoretical and empirical analyses, it explores several aspects of the financial cycle. These include: the global influence of US monetary policy on risk-taking attitudes of banks; asset fire-sales and their consequences; and real consequences for the labour market of collateral crises. While these episodes appear as an interchange of optimism and panic, they can be interpreted as rational

[2] Global financial assets as of 2014 worth US$28 trillion, of which $12 trillion is denominated in US dollars (BIS Locational banking statistics Table 5a).

[3] Kohn (2006) believes that only a substantial contraction in monetary policy can dampen speculation, but that such magnitude would simultaneously trigger recessions, leaving the net payoff unknown. Yellen (2009) also notes that countries that did not ease monetary policy between 2002 and 2004 also experienced house price bubble. As such, both members of the Federal Reserve Board cast doubt on the causal relationship between monetary policy (especially that in US) and financial instability.

[4] Also, Axel Weber, then president of the Deutsche Bundesbank, remarked in a speech in 2008 that ECB "realises implicit risks in times when money and credit growth is dynamic, asset prices go up and risk perceptions decline, possibly creating the need to act despite sufficiently low current inflation rates".

[5] See Remit and Recommendations for the Financial Policy Committee (2013) section C(ii), http://www.bankofengland.co.uk/financialstability/Documents/fpc/letters/chancellorletter130410.pdf.

response of agents towards deep frictions within the economy, thus bringing new insights to the financial instability hypothesis of Minsky (1989).

The contemporary debate of "cleaning" versus "leaning" against a credit boom can be placed in the broader history of economic thought. Then, as now, economists noticed the exuberance of credit preceding speculation and recession. The great recessions beginning in 1825, 1873, and 1929 all shared these characteristics (Schumpeter, 1934), as did the more recent Nordic, Japanese, and South East Asia crises (Kindleberger and Aliber, 2005). In contrast to the classical dichotomy (Patinkin, 1956), both Keynes and Hayek believed that monetary injections affected real variables. However, they departed on the consequences of such injections. Hayek believed that monetary expansion suppressed the money rate below the natural rate, promoting malinvestment and instability (Hayek, 1967, p.54)[6]. In contrast, Keynes reflected that the interest rate "is not self adjusting at a level best suited to the social advantage but constantly tends to raise too high" (Keynes 1936, 351). It was underinvestment, not malinvestment, that amplified disturbances in the economy. He believed that "it was the task of monetary policy to prevent or offset this dire sequence of events by pumping money into the economy" (Skidelsky, 2006). In this respect, by depicting monetary policy as both cause and remedy of financial instability, the thesis offers a partial synthesis of these two schools of thought.

Inspired by Rey's (2013) analysis of a global financial cycle, Chapter 2 estimates the relationship between US monetary policy and default risks of banks around the world. Using a panel set of 257 banks over 26 countries, and controlling for macroeconomic conditions, risk appetite, and bank-specific heterogeneity, the Chapter finds that an

[6]As such, Hayek proposed "in ordinary times a more or less automatic system of regulating the quantity of money" (Hayek, 1979), which is somewhat similar to the stance of Friedman. When asked: "... would it be preferable to abolish the Fed entirely and just have government stick to a monetary growth rule?" Friedman replied: "Yes, it's preferable, and there's no chance at all of it happening." See *Reason* magazine "Can we Bank on the Federal Reserve" November 2006, http://www.reason.com/news/sjpw/38384.html.

easing of US monetary policy by one standard deviation, increases banks' risks by 4 – 9%. Employing panel vector autoregression (PVAR) techniques, the Chapter also finds that the impact of US monetary policy is channelled through capital inflows, which the federal funds rate strongly influences. In the face of US monetary policy, national monetary policies are ineffective in determining the risks of banks, while capital controls may stamp out capital inflows caused by heightened risk appetite. The latter result echoes the recent endorsement by the IMF of capital controls as a valid tool of domestic macroeconomic management (Ostry, 2012; Ostry, Ghosh, Chamon, and Qureshi, 2012), and speaks to rising concerns that the US Federal Reserve, having its own mandate to fulfil, may not always place international financial stability as its utmost priority.

Whereas Chapter 2 studies the implications of loose US monetary policy, Chapter 3 discusses the risks of its reversal. The setting is the "taper tantrum" in the summer of 2013, where a carefully-worded statement by Ben Bernanke – then Chairman of the Federal Reserve Board – warning of the potential slowdown in quantitative easing programs, sparked a sell-off in the bond markets; credit risk premium rose by 50% during the tapering talk. Morris and Shin (2014) attribute the sell-off to the competitions among fund managers to outperform their peers. In Chapter 3, I extend the authors' analytical framework, and argue that central banks' communication may affect the ex ante likelihood of fire-sales, and hence, agents' storage of capital to profit from them. As capital may otherwise be deployed into production, its storage is wasteful. To mitigate the inefficiency – which would inevitably arise as monetary policy "normalises" – the Chapter considers a shock-exit strategy, akin to the sudden abandonment of a currency peg. The strategy involves retracting a prior commitment to loose monetary policy. If believed, the commitment will discourage the storage of capital ex ante; absent arbitrage capital on the sidelines, asset managers prefer holding onto risky assets, even if risk-free rate rises. Contingent on its usage, therefore, central banks may either cause or curb fire-sales through forward guidance.

Chapter 4 shifts the focus away from financial market turbulence to the real consequences of financial crises. The focus is the labour market. In terms of jobs lost, and the duration to regain employment, the global financial crisis has dealt the largest adverse impact on the US labour market since WWII[7]. Inspired by the sudden devaluation of "safe" assets at the dawn of crisis (Caballero, 2010), I build a model that features collateralisation in the financial sector à la Gorton and Ordoñez (2014) and labour markets imbued with search frictions between employers and workers (Diamond, 1982; Mortensen, 1982; and Pissarides, 1985). The model identifies a collateral quality threshold, below which banks switch from unmonitored to monitored lending. The switch accounts for a sudden loss of employers qualified for bank loans, and, hence, a sharp fall in job vacancies. In addition, by depicting unemployment as a result of employers' inability to secure funding (for hiring) with depreciated assets, the model softens the traditional boundary between "cyclical" and "structural" unemployment. Unemployment is cyclical as it is driven from the demand side of the labour market. But it is also structural, as a mismatch arises – not between employers and workers as conventionally conjured – but entrepreneurs and financiers in their intermediation of credit.

A final chapter concludes by highlighting and summarising some policy implications that stem from the analysis.

[7]Before the Great Recession, the longest period of US unemployment for an average job seeker was 20.5 weeks. In the Great Recession, the same average unemployed worker could search for more than 40 weeks without getting a job.

Chapter 2

The Global Financial Cycle

2.1 Introduction

The "*trilemma*" is a keystone of modern international finance[1][2]. It is impossible to have, at the same time, fixed exchange rates, independent monetary policy, and perfect capital mobility. In a recent contribution, Rey (2013) asks if the secular trend towards global financial integration and the increasing influence of the financial sector in the international financial system has repudiated the trilemma. She argues that financing conditions in the main centres of global finance set the tone for the rest of the world, regardless of the exchange rate regime. More specifically, through its effects on global investors' risk appetite, changes in US monetary policy trigger surges in capital inflows to peripheral countries, inducing local banks to take on extra risk. In short, there is a

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[1] This chapter is based on material presented in the 5th NZ Macroeconomic Dynamics workshop in honour of Professor Stephen J. Turnovsky, Victoria University of Wellington, 17 April 2015; the 56th Annual Conference of the New Zealand Association of Economists, Wellington, 29 June - 1 July 2015; the 20th Asia Pacific Decision Sciences Institute (APDSI) Conference, Hong Kong, 19-24 July 2015; and the University of Auckland PhD Conference, 1 September 2015. It has also been accepted for the XXIV International Conference on Money, Banking and Finance, to be held in Rome (3rd-4th December 2015), for a PhD Student Session.

[2] This chapter was awarded the Best Paper prize in the APDSI Conference and the University of Auckland PhD Conference.

global financial cycle underpinned by the federal funds rate.

Rey's perspective is shared by Bruno and Shin (2014). They find that regional banks in the periphery play a key role in the transmission of US monetary stance. Regional banks intermediate US dollars from wholesale banks in US and Europe to local borrowers. When US interest rate declines, local currency appreciates, giving the impression that local borrowers have become safer (as their assets are denominated in local currency). Banks lend more as a result. The initial impetus is reinforced by a mechanism in which extra lending dampens volatility, eliciting further lending and risk-taking, and thereby completing the circle.

In this chapter, I complement the work of Rey (2013) and Bruno and Shin (2014) by documenting a negative correlation between the stance of US monetary policy and the default risk of non-US banks. Existing analyses have focused on identifying the credit cycle and its channels, but the implications for default risk have yet to be taken into account. Controlling for macroeconomic conditions, risk appetite, and bank-specific heterogeneity, I estimate that an easing of US monetary policy by one standard deviation increases default risks by 4-9%. The estimation is based on a panel set of 257 banks across 26 countries, over the period 2001 – 2013. A novel aspect of my analysis is the use of the probability of default metric developed by the National University of Singapore Credit Research Initiative; the metric is shown to outperform credit ratings of other agencies, such as Moody's and Standard & Poor's (Duan and Van Laere, 2012)[3]. As a robustness check, I extend the original regressions to about 349 banks both within and beyond US, and find that the core results remain unchanged.

In the panel regression, I control for endogeneity among explanatory variables with

[3]For example, in a sample that includes 4059 firms and 124 default events, the 1-year accuracy ratio of the S&P corporate rating is 77%, while that of the NUS's probability of default is 89% .

the Arellano-Bover/Blundell-Bond dynamic panel estimators[4]. The negative relationship between US monetary policy tightness and default risks emerges as statistically significant across different set-ups, including alternative measures of banks' risk and monetary policy stance, different time-frames, and different subgroups as classified by the degree of capital controls, as well as the exchange rate regime in which the sampling bank resides. Since macroeconomic conditions and risk appetite – the two key factors that affect the measurement of default risks – are controlled for in the study, the negative correlation supports the notion that loose US monetary policy induces banks to *take* risks.

As a further exercise, I exploit the panel nature of the dataset, and perform a panel vector autoregression (PVAR). The impulse response functions reveal that impacts of US monetary policy are channeled through capital flows, which are themselves driven by the federal funds rate. A decrease in federal funds rate raises global risk appetite, increases capital inflows, and, ultimately, raises banks' default risk. In addition, I split banks by the degree of capital controls enforced in their countries, re-estimate the PVAR on both subgroups, and compare their impulse response functions. Capital controls appear effective in containing inflows, thus helping countries to preserve monetary independence. As such, these results corroborate the key insight of Rey (2013) on the changing nature of the trilemma.

The approach adopted in this chapter closely follows that of Altunbas, Gambacorta, and Marques-Ibanez (2014). These authors study how European banks' risk-taking is affected by changes in the monetary stance of the European Central Bank. While I use a similar estimation technique and independent variables, my dataset is different, as is my measure of banks' risk. Critically, I focus on the effects of US monetary policy, rather than those of regional monetary policies, as the authors have done. Indeed, in my

[4] Known also as system GMM.

analysis, local monetary policy loses statistical significance once US monetary policy is taken into account[5].

The Chapter proceeds as follows. In Section 2, I document some stylised facts about the relationships among US interest rates, global risk appetite, capital flows, and banking crises. Section 3 describes the dataset and the econometrics methodology. Section 4 discusses the results. Section 5 describes points of contact with the literature, and a final section concludes.

2.2 Stylised Facts

This section outlines a plausible causal relationship between the US policy interest rate, the risk appetite of global investors, capital inflows, and banking crises. Figure 2-1 plots the Volatility Index (VIX) compiled by the Chicago Board Options Exchange, and the 1-year lagged federal funds rate. VIX measures the implied volatility of the S&P 500 Index options. According to Bekaert, Hoerova, and Lo Duca (2013), VIX reflects both the stock market uncertainty perceived by investors, as well as their aversion to it. Figure 2-1 shows that the two series are positively correlated (correlation = 0.48). The correlation suggests that US monetary policy may have an influence over the risk appetite of investors.

In turn, risk appetite of investors may determine capital flows towards periphery countries. To capture the latter, I make use of a "capital inflows bonanzas" series compiled by Reinhart and Reinhart (2008). In their work, a capital inflow bonanza is defined as an episode in which a country receives larger than normal net inflows[6]. Figure 2-2

[5] Our analysis is also related to the "hot money" flows hypothesis (McKinnon, 2014; Korinek, 2011). The hot money hypothesis states that when other countries' interest rates are higher than that of the US, capital would flow from US towards these countries. As US dollar is the most popular currency and its circulation so wide, these US capital flows would lead to asset price appreciation in real estate and equities around the world.

[6] Operationally, a country is considered having a bonanza in a year if it receives inflows larger than the 80th percentile of the entire sample in the Reinhart and Reinhart (2008) database that year.

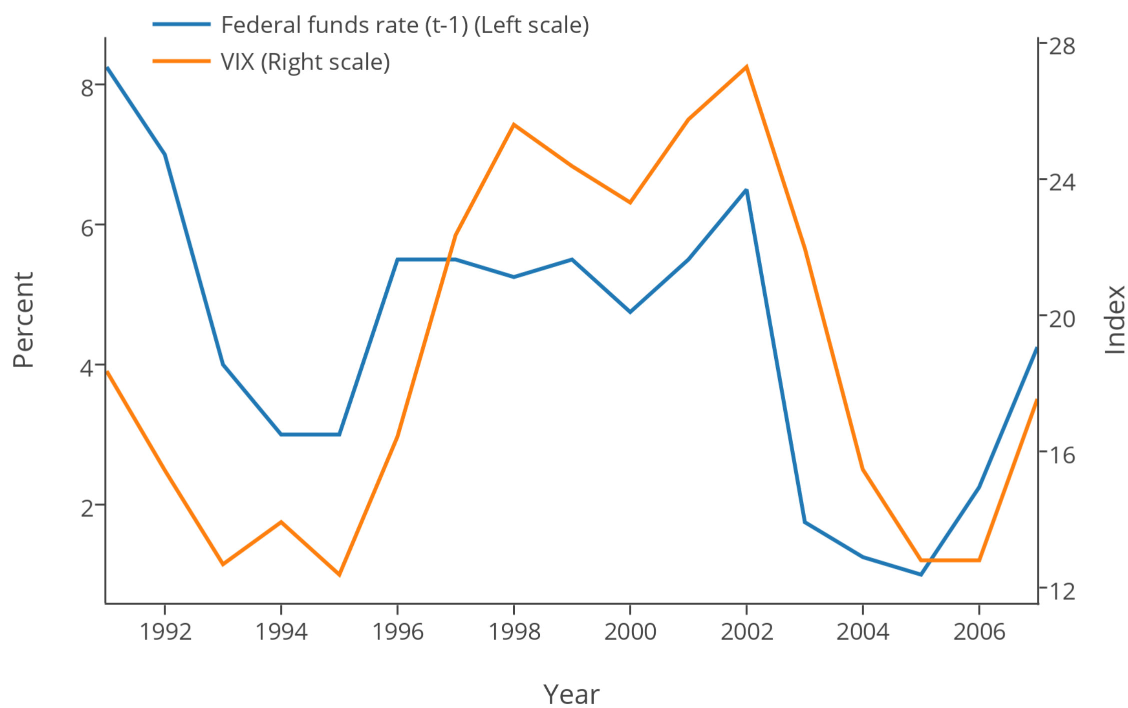


Figure 2-1: Federal funds rate and VIX.

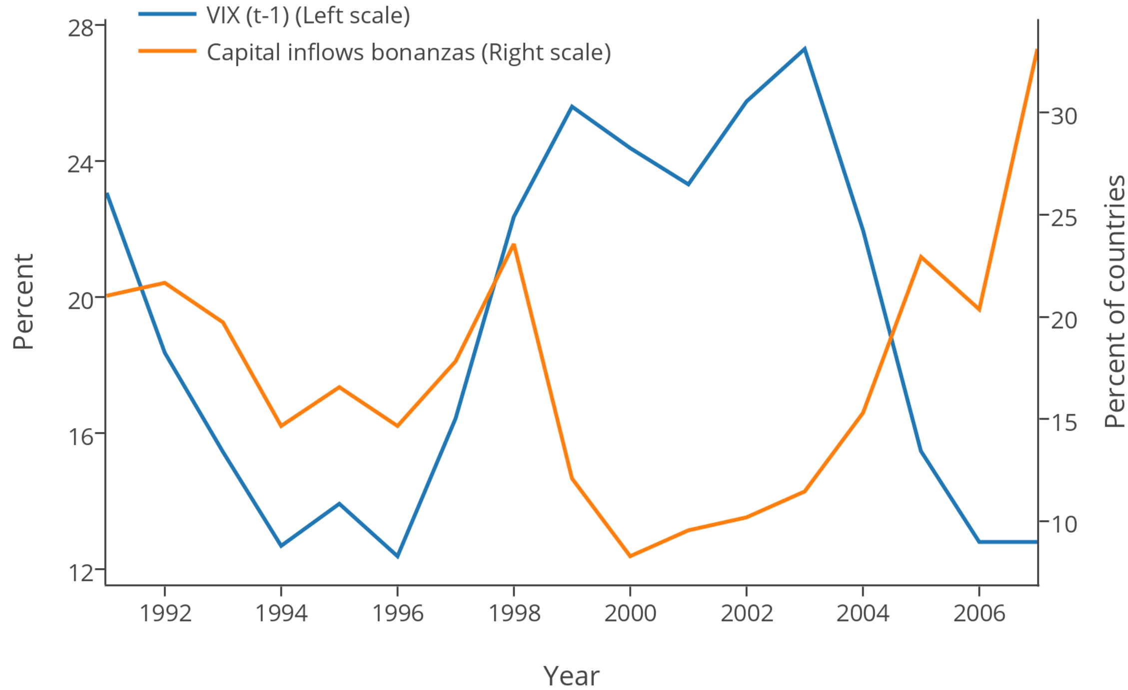


Figure 2-2: VIX and capital inflows. The bonanzas series represents the fraction of countries in the world that experienced "large" capital inflows, as identified by Reinhart and Reinhart (2008).

plots the 1-year lagged VIX and this bonanza series, where the right scale of the figure captures the fraction of countries experiencing bonanzas in a particular year. The figure shows that while the two series moved in tandem prior 2000, they have diverged since. In particular, the surge in capital inflows since 2002 has been accompanied by a gradual decline in VIX, with a negative correlation of -0.54 between the two series[7]. One interpretation of it is that increased risk appetite of investors has contributed to the international flows of funds.

Figures 2-1 and 2-2 have shown the correlations between US monetary policy and

[7] The fraction of countries not having capital inflows bonanzas is $100 -$ the fraction of countries with bonanzas. Therefore, the correlation between VIX and coutries *not* having bonanzas is the opposite of -0.54, that is, 0.54.

risk appetite, and risk appetite and capital inflows respectively. In the next two figures, the relationship between capital inflows and banking crises is further explored. Figure 2-3 graphs the lagged capital flows bonanzas, with a series that captures the fraction of countries having a banking crisis around the world. It is labelled as "Banking crises" in Figure 2-3, which is also compiled with the Reinhart and Reinhart (2008) database. As the figure shows, the two series are positively correlated until 2001 (correlation coefficient = 0.73). After 2001, a "super bonanza" appeared to have taken hold, with the lag between a bonanza and a crisis apparently lengthened. In turn, the longer lag was followed by the outbreak of the global financial crisis. To substantiate the potential link between capital inflows and banks' risks, Figure 2-4 plots the unconditional probability of a banking crisis, and the probability of it conditional on the country's experiencing of a capital inflows bonanza t years ago. The latter is markedly higher than the former, suggesting that capital inflows may make banks riskier.

2.3 Data and Methodology

The panel consists of 257 banks from 26 countries and covers the period from 2001Q1 to 2013Q4. Banks are drawn from Bloomberg, and are identified based on the Global Industry Classification Standard (GICS). I select companies that are designated as "banks" by the GICS code (code 4010), and that have a valid measurement of default risks, to be discussed below. A complete list of the banks, their total assets and number of employees, is provided in the Appendix.

2.3.1 Dependent Variables

The primary measure of banks' default risk is the forward, 1-year default probability of banks ($PD_{i,k,t}$), compiled by the Credit Research Initiative (CRI) of the National

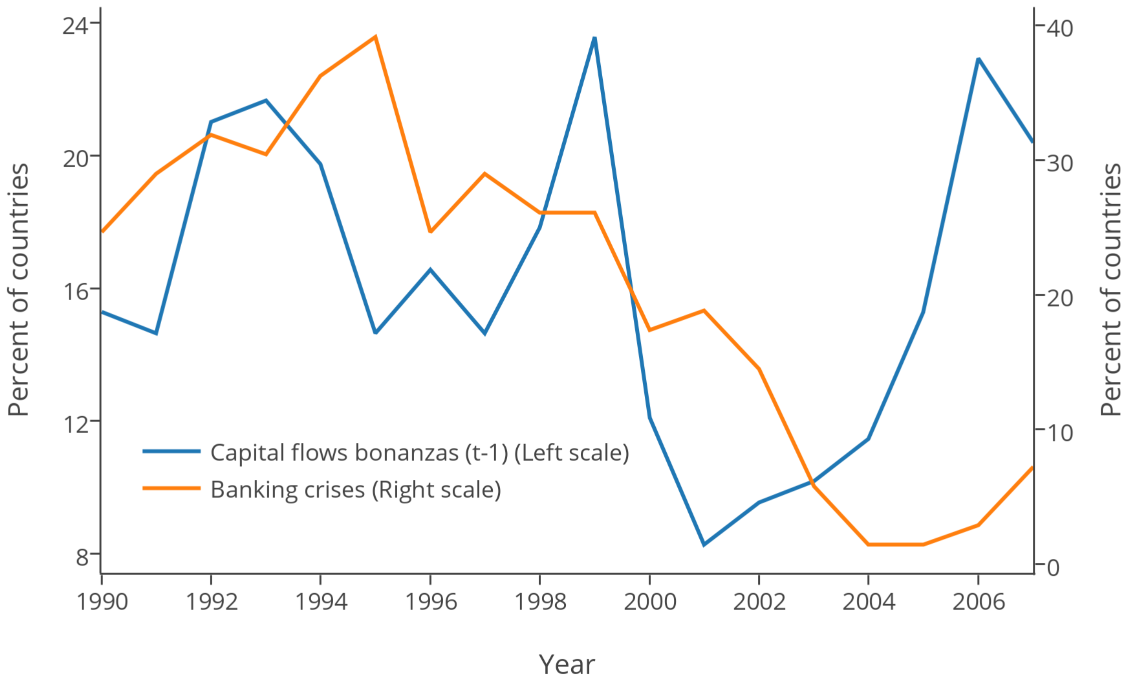


Figure 2-3: Capital inflows and banking crises. The banking crises series captures the percent of countries around the world that experienced banking crisis in a particular year, identified by Reinhart and Reinhart (2008).

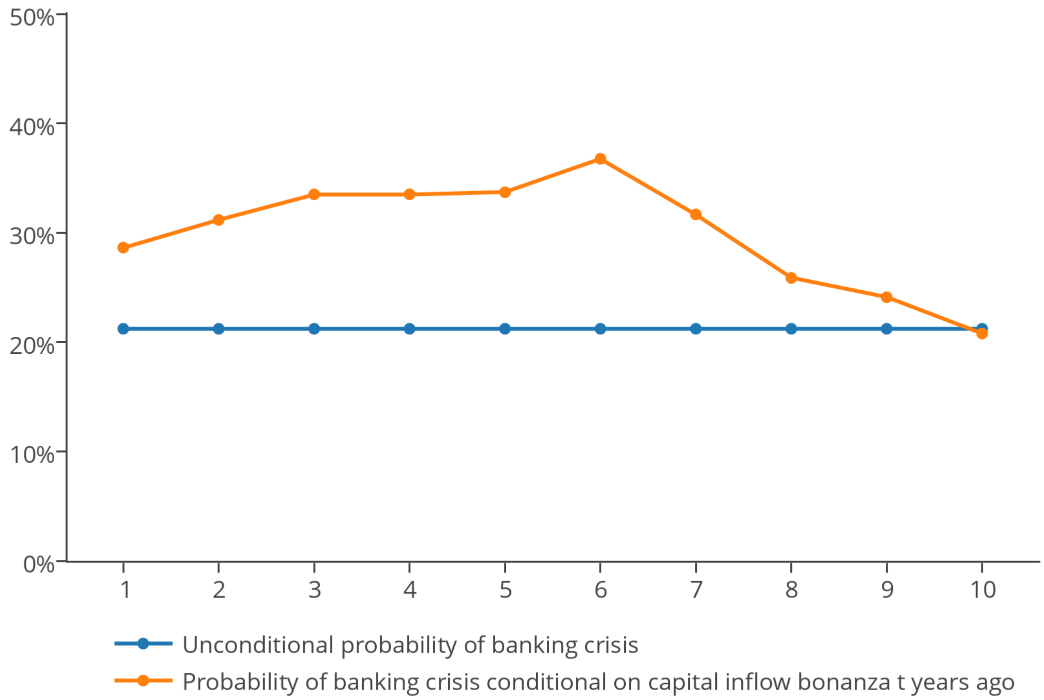


Figure 2-4: Conditional probability of banking crisis after capital flow bonanza. This figure depicts the probability of a crisis in a country that has experienced a capital inflow bonanza t years ago. For comparison, the straight horizontal line indicates the unconditional probability of a crisis.

University of Singapore. The subscripts i, k, t denote bank's identity, country, and time period respectively. The variable $PD_{i,k,t}$ is estimated from twelve variables: two risk factors common to a particular economy, namely, the stock market return and the short-term interest rate; six firm attributes in level – leverage, liquidity, profitability, relative size, market misvaluation (market-to-book ratio), and idiosyncratic volatility; and four firm attributes in trend. Parameters of the input variables are calibrated by maximising a likelihood function, with the calibration based on around 50,000 firms drawn from 30 economies. Details of the construction of $PD_{i,k,t}$ are documented in Duan and Van Laere (2012) and the technical report of CRI[8].

In addition to $PD_{i,k,t}$, I compute an alternate measure of bank risk. Specifically, I deduce the idiosyncratic risk components of banks from the Capital Asset Pricing Model (CAPM). As is well known, the equation of CAPM is

$$R_{i,k,t} = \beta_{i,t} * R_{m,k,t} + \varepsilon_{i,k,t},$$

where $R_{i,k,t}$ is the daily stock market excess return of banks (in logarithm)[9], $R_{m,k,t}$ is the excess return of the broad stock market index m of country k, and $\varepsilon_{i,k,t}$ is the residual return of bank i that is unaccounted for by the market return. Idiosyncratic risk is the volatility of this residual return.

2.3.2 Independent Variables

The key independent variable is the US natural interest rate gap, $USGAP_t$. The natural rate gap is the difference between a country's real, 3 month money market interest rate,

[8] http://d.rmicri.org/static/pdf/2014update1.pdf
[9] Excess return refers to stock return less risk free return.

and the Hodrick-Prescott filter of that series[10]. Widely applied in macroeconomics, the HP filter is used to identify the long-term trend of a series from its short-term fluctuations. In tracing the trend, a multiplier called λ is specified; the higher the λ is, the more penalty is applied to the cyclical component in favour of the trend component. Following the suggestion of Hodrick and Prescott, a λ of 1600 is chosen for our quarterly data[11]. A positive gap reflects that monetary policy is tight when compared to historic average (vice versa for a negative gap). Critically, the variable is a global variable – banks around the world face the same cost of wholesale funds, based on the stance of US monetary policy, at any given point in time. As a robustness check, I use the effective federal funds rate (FFR_t) as an alternate measure of US monetary policy stance. And I measure the local monetary policy stance by compiling the natural rate gap ($NRGAP_{k,t}$) and overnight interest rate ($ONR_{k,t}$) for each country.

I follow standard practice and measure investor risk appetite with the Volatility Index (VIX_t); according to Bekaert, Hoerova, and Lo Duca (2013), VIX reflects actual stock market uncertainty perceived by investors, as well as their aversion to it. To control for macroeconomic conditions, I include the probability of default of non-financial firms (also compiled by the NUS) ($PDF_{k,t}$) and the $GDP_{k,t}$ of each country. I also control for capital inflows with the gross external deposits of banks ($EXDEP_{k,t}$) drawn from the locational database of the Bank for International Settlement (BIS).

Finally, in line with Altunbas et al. (2014), I include stock market indices of countries ($SM_{k,t}$) as proxy for collateral value. I also include the nominal exchange rate for each country (domestic currency/US$), denoted as $ER_{k,t}$.

[10] The Hodrick and Prescott (1997) filter breaks down a time series y_t into a smooth path g_t and remaining deviations (residuals or shocks) ε_t.

[11] Taylor rule residuals are not used here because Taylor rule requires the specification of the relative weights applied by central banks to the goals of price versus output stability. While this information is readily available for US, it may not be easily obtained for other countries; applying a uniform weight across all central banks (e.g. 0.5 to inflation and 0.5 to output stability) may also appear arbitrary.

Variable	Units	Descriptions
PD	Percent	Probability of default of banks. Compiled by National University of Singapore, it is considered a more transparent and accurate measure of credit risks than comparable measures from other credit rating agencies.
PDF	Percent	Probability of default of non-financial firms. Also drawn from the National University of Singapore.
USGAP	Percentage point	Natural rate gap of US. A negative read implies relatively loose US monetary policy, and a positive read implies the opposite.
FFR	Percent	Federal Funds rate
VIX	Percent	Volatility Index compiled by the Chicago Board of Exchange.
NRGAP	Percentage point	Countries' natural rate gaps.
ONR	Percent	Countries' overnight interest rate, as a measure of the countries' monetary policy stances.
EXDEP	USD billions	Gross external deposits of the banking system of a country. Difference of EXDEP between two periods represents capital inflow into a country.
ER	Denominated in one US dollar	Exchange rate
SM	US dollar	Standardised stock market indices in USD compiled by Datastream, Reuters.
BEL	Quarters	Number of consequtive quarters US monetary policy has remained loose (USGAP<0).
Dummy_Float		Countries identified by IMF Exchange Rate Classification as "free floating" as of 2007.
Dummy_Open		Countries with relatively loose control over capital account during the sample period, as identified by the Chinn-Ito Index.

Table 2-5: Variable definitions.

Tables 2-5 and 2-6 describe and summarise the key variables used in the chapter.

I perform two experiments. First, I estimate a panel regression of bank risk on US monetary policy stance. The objective is to test whether banks are induced by loose US monetary policy to take risk. Second, I estimate a panel vector autoregression (PVAR). A vector autoregression allows for endogenous responses among explanatory variables; the panel nature of the dataset permits the control of unobserved heterogeneity across banks. The impulse response functions reveal how the endogenous variables interact and

	Probability of Default (%)	Natural Rate Gap (p.p.)	Capital Inflow (USD millions)	GDP growth (Quarter, %)	Depreciation against USD (Quarter, %)	Stock Market Return (Quarter , %)	Number of Banks	Weight Inside Sample (%)
Argentina	0.65	1.76	-288.1	1.44	3.45	-0.08	2	0.8
Australia	0.31	-0.11	3278.3	1.28	-1.03	1.98	4	1.6
Brazil	0.91	0.07	755.3	1.39	0.25	2.44	5	1.9
Canada	0.63	-0.14	3191.7	1	-0.73	1.56	9	3.5
Switzerland	0.18	-0.21	1249.2	1.75	-1.14	1.27	11	4.3
Chile	0.31	-0.01	259.8	1.84	-0.26	2.42	5	1.9
China	0.32	0.18	4726.6	4.66	-0.59	3.54	2	0.8
Colombia	0.46	0	193.3	2.72	-0.35	5.38	2	0.8
Czech. Rep.	0.19	-0.04	237.8	1.12	-1.34	1.78	1	0.4
Denmark	0.54	-0.1	2043.7	0.87	-0.72	2.02	13	5.1
Euro Area	0.65	-0.21	60320.9	1.34	-0.72	0.39	50	19.5
UK	0.55	-0.06	39041.2	1.16	-0.16	0.43	5	1.9
Hong Kong	0.17	0.09	1792.9	1.2	-0.01	1.17	5	1.9
Indonesia	2.62	-0.04	251.5	1.77	0.34	3.64	4	1.6
India	1.89	0.04	404.9	2.24	0.57	3.01	17	6.6
Japan	0.32	-0.01	2606.9	0.17	-0.3	0.19	66	25.7
Korea	1.38	-0.1	799.9	1.27	-0.32	3	2	0.8
Mexico	0.2	0.04	1007.1	1.18	0.58	3.15	2	0.8
Malaysia	0.41	0.06	251.8	2.66	-0.32	2.25	10	3.9
Norway	0.82	-0.14	1814.3	1.29	-0.76	2.06	9	3.5
Philippine	0.6	0.16	133.7	2.76	-0.28	2.93	6	2.3
Poland	0.4	0.06	126.2	1.57	-0.55	1.51	6	2.3
Sweden	0.56	0.04	4238	1.83	-0.94	1.44	4	1.6
Thailand	0.39	-0.25	395.9	2.36	-0.65	3.8	5	1.9
Taiwan	0.3	-0.1	1006.2	1.07	-0.22	0.74	9	3.5
South Africa	0.81	-0.2	646.6	1.35	0.56	2.56	3	1.2

Table 2-6: Summary statistics.

respond to exogenous shocks to $USGAP_t$, thereby offering a lens on *how* US monetary policy affects domestic financial sectors.

As a further exercise, I re-run the PVAR on two subgroups of banks as classified by the degree of capital controls enforced by their countries. The exercise ascertains whether capital controls mitigate the effect of US monetary policy.

2.3.3 Experiment 1 (Panel Regression)

The baseline regression is of the form:

$$
\begin{aligned}
PD_{i,k,t} = {} & \beta_1 PD_{i,k,t-1} + \beta_2 USGAP_{t-1} + \beta_3 NRGAP_{k,t-1} + \beta_4 Log\left(GDP\right)_{k,t-1} \\
& + \beta_5 PDF_{k,t-1} + \beta_6 Log\left(SM\right)_{k,t-1} + \beta_7 Log\left(ER\right)_{k,t-1} \\
& + \beta_8 Log\left(VIX\right)_{t-1} + \beta_9 Log\left(EXDEP\right)_{k,t-1} + \alpha_i + \varepsilon_{i,t},
\end{aligned} \quad (2.1)
$$

where α_i is the unobserved time-invariant individual effect, and $\varepsilon_{i,t}$ the error term.

The lag of $PD_{i,k,t}$ is included to reflect the persistence of default risk over time. The key coefficient of interest is β_2. If $\beta_2 < 0$, the relationship between US monetary policy and bank default risk is negative. β_3 captures the relationship between local monetary policy and default risk. Also relevant is β_8, which captures the sensitivity of bank risk to changes in investor risk appetite.

I explore eight versions of this regression, to be labelled as models (1) to (8). Model (1) is the baseline regression, where $PD_{i,k,t}$ is regressed on $USGAP_{t-1}$ and the control variables in equation (2.1). Model (2) replaces $PD_{i,k,t}$ with the idiosyncratic banks' risks derived from CAPM ($RISK_{i,k,t}$), while model (3) replaces $USGAP_{t-1}$ by the federal funds rate as an alternative measure of monetary policies. The sample of models (1) –

(3) span from the first quarter of 2001 to the last quarter of 2008. In model (4), the coverage extends to the last quarter of 2013, as a response to some authors' beliefs that a structural break emerges following the outbreak of the global financial crisis (Didier et al., 2012; Thao and Daly, 2012).

Models (5) and (6) insert three interaction terms to the baseline model. They are, namely, (a) the square of US monetary policy stance ($USGAP^2$ in model (5), and FFR^2 in model (6)); (b) US monetary stance times the gross external deposits, $EXDEP$; and (c) US monetary stance times the number of quarters US monetary policy has been expansionary, BEL[12].

Models (7) and (8) add two dummies onto the baseline model. The first dummy separates banks by the exchange rate regime (fixed and float) in which they reside. The separation is based on the de facto Classification of Exchange Rate Arrangements of the IMF. The second dummy separates banks by the degree of capital account openness enforced by their countries, as measured by the Chinn-Ito index (Chinn and Ito, 2006). Model (7) uses $USGAP_{t-1}$ as the monetary stance measure, and model (8) uses FFR_{t-1}.

As a robustness check, I redo the eight regressions with the addition of US banks. This has increased the number of banks from 257 to 349. Results of these regressions, labelled as models (9) – (16), are presented in table A-2 of Section A.1.3 in the Appendix.

To simplify the presentation, I will suppress the subscripts of the acronyms in the following.

2.3.4 Endogeneity

To guard against endogeneity problems, all variables are lagged one quarter. But the unbiasedness of the estimation could still be compromised, if PD and independent vari-

[12] BEL stands for below. Specifically, BEL is the number of consequtive quarters $USGAP$ has remained negative.

ables influence each other at delays of two quarters or more. Arguably, prior to the global financial crisis, default risk did not have a material impact on monetary policy. As Stark (2011) notes, prior to the crisis, central bankers largely disregarded credit indicators[13]. Even after the crisis, many countries have enacted procedures – such as the creation of macro-prudential policy committees – to separate financial stability issues from monetary policy considerations (see, for example, Kohn, 2013)[14].

To further, and more formally, control for endogeneity, I use the Arellano-Bover/Blundell-Bond dynamic panel estimators. This method is known as system Generalised Method of Moments (GMM), which instruments variables with lags of the variables' own first differences. GMM is efficient and consistent, provided that (i) the model is not subject to serial correlation; and (ii) the instruments used are valid.

To ensure the first criterion is met, I report the Arellano-Bond test for autocorrelation in the differences in residuals. First order serial correlation is expected because of the shared component between two differences in residuals. If second order autocorrelation is detected, then only instruments from the third lag onwards are used.

To ensure that the second criterion is also met, I employ the Hansen test of instrument exogeneity. As a large set of instruments will overfit endogenous variables and weaken the power of the Hansen test (Sargan, 1958)[15], I follow Roodman (2009), and limit the set by "collapsing" the columns of its instrument matrix. The instruments are then

[13] Jürgen Stark was a member of the Executive Board of the ECB. The remark was made at the 2011 Annual Emerging Markets Conference.

[14] Donald Kohn is now a member of the Financial Policy Committee of the Bank of England. He noted in a speech:

"An important benefit from macroprudential policy will be to limit the constraint that financial risks may place on monetary policy. Increasing capital and liquidity buffers – especially in good times – will mean the *MPC need not be as concerned about the effects of its policies – both tightening and easing – on financial stability.*"

[15] There exists little guidance from the literature on how many instruments is "too many" (Ruud 2000, 515), in part because the bias is present to some extent even when instruments are few. A minimally arbitrary rule of thumb is that instruments should not outnumber individual units in the panel.

further reduced to their principal components[16]. These measures limit the number of instruments to be smaller than cross-section units (banks) – a rule of thumb recommended by Roodman in regard to the optimal number of instruments.

2.3.5 Experiment 2 (Panel VAR)

To identify the transmissions of shocks, I adopt the technique of panel vector autoregressions (PVAR) deployed by Love and Zicchino (2006). This technique combines the traditional VAR approach, which treats all variables in the system as endogenous, with the panel data approach, which allows for unobserved individual heterogeneity. Our PVAR model can be specified as:

$$y_{it} = \mu_i + y_{it-1} + \varepsilon_{it}, \tag{2.2}$$

where y_{it} is a vector of bank-level variables. To avoid obtaining biased coefficients that result from correlation between the fixed effects and the regressors, the Helmert procedure is used to remove the forward mean, i.e. the mean of all the future observations available for each country-year. This procedure preserves the orthogonality between the transformed variables and the lagged regressors, thus enabling the use of lagged regressors as instruments of y_{it-1} (Arellano and Bover, 1995).

The PVAR model is of first order. Results do not change when more lags are included. The choice of one lag is supported by both the Akaike Information Criteria and Bayesian Information Criteria (see Section A.1.1 in Appendix). I include four endogenous variables in the PVAR. They are the probability of defaults of banks (PD), the logged gross

[16] The principal component method has been shown to reduce instrument count in a minimally arbitrary way (Kapetanios and Marcellino 2010; Bai and Ng 2010; Mehrhoff 2009).

external deposit of banks ($EXDEP$), the federal funds rate (FFR), and the log of VIX (VIX). Therefore, y_{it} can be expanded to:

$$y_{it} = \begin{bmatrix} PD_{it} \\ Log\left(EXDEP\right)_{it} \\ FFR_t \\ Log\left(VIX\right)_t \end{bmatrix}.$$

In a VAR, variables that are ordered first are more exogenous, and affect subsequent variables both contemporaneously and with a lag; variables ordered later are less exogenous, and only affect previous variables with a lag. Slow moving variables should therefore be placed before responsive ones. By this rule, I rank the variables in the order presented above. Banks' default risks reflect both changing economic conditions and the actions taken by bank managers over time, which are considered to be relatively slow-moving. I place $EXDEP$ in the second position, to reflect the responsiveness of banks and firms alike to market news regarding capital allocation decisions, and the speed of executions that can be carried out through electronic systems.

In contrast, although the federal funds rate is not considered fast-moving – the Federal Open Market Committee meets at intervals of five to eight weeks to decide on the fed fund target rate – I place it at a later position to suppress its explanatory power, which, given the hypothesis, seems a prudent course to take[17]. Similar to Rey (2013), I position VIX last, to reflect the spontaneity of equity markets.

[17] One downside of this ordering, however, is that it implies idiosyncractic shocks to a single bank can affect the federal funds rate decision, which seems implausible in most states of the world (unless the bank in concern is systematically important). To address this issue, I've re-run the PVAR in the order of $FFR_t, \log\left(VIX_t\right), PD_{it}, \log\left(EXDEP_{it}\right)$. The results of the impulse response functions are documented in Figures A-3 – A-6 in Appendix A.1.4. They are largely similar to Figures 2-10 – 2-13 presented in Section 2.4.2 below.

Cholesky decomposition is used to identify orthogonal shocks in the variables of interest, and examine their effect on other variables in the system. To analyze the response of one variable to a shock in another variable, I compute the impulse-response functions (IRFs). Confidence intervals for the IRFs are generated with 1000 Monte Carlo simulations[18].

The sample size of this exercise covers the 259 non-US banks over the period 2001Q1 – 2013Q4.

2.3.6 Different Capital Control Regimes

As a supplement to the PVAR exercise, I also split countries into two groups based on their degree of capital controls. The split is carried out by reference to the Chinn-Ito index. A reading of "1" signifies complete openness, while "0" implies complete closure. I refer to the two subgroups as open and closed economies respectively. The distinction is relative, and is based on the average Chinn-Ito value of countries during the span of sample. Table 2-7 lists member countries of the subgroups.

After splitting the samples, PVAR is performed on each subgroup. To compare the impulse responses of the two subgroups, I take the difference in their IRFs. Because the two samples are independent, the impulse response of the differences is equal to the difference in impulse responses.

Table 2-8 presents the summary statistics by the capital mobility subgroups. At first sight, banks in countries with capital control, on average, have higher default risk. This result is not surprising, since countries with capital controls are typically developing countries that have riskier business environments. Note also that capital controls mea-

[18]In practice, the regression code randomly generates a draw of coefficients β of the baseline model using the estimated coefficients and their variance–covariance matrix and re-calculate the impulse-responses.The programme repeats this procedure 1000 times. It then generates 5th and 95th percentiles of this distribution which we use as a confidence interval for the impulse-responses.

Countries by Capital Openness

Panel A: Open economies	Average Chinn-Ito Index	Panel B: Closed economies	Average Chinn-Ito Index
Euro Area	1	Greece	0.9
Switzerland	1	Czech Republic	0.9
Denmark	1	Chile	0.8
United Kingdom	1	Australia	0.7
Hong Kong	1	Mexico	0.7
Norway	1	Indonisia	0.7
Sweden	1	Korea	0.5
Japan	1	Brazil	0.4
Canada	1	Philippines	0.4
		Poland	0.4
		Malaysia	0.4
		Colombia	0.4
		Argentina	0.3
		Thailand	0.3
		China	0.2
		India	0.2
		South Africa	0.2

The Chinn-Ito index measures a country's degree of capital account openness. "1" indicates complete openness, while "0" complete controlled capital account. The score shown here is the annual average between years 1999 and 2012. Countries with less than perfect capital mobility are categorised as controlled capital regime. The division is arbitrary and relative.

Table 2-7: Countries by relative capital account openness.

	Countries with capital control	Countries without capital control
Probability of Default (%)	0.86	0.48
Natural Rate Gap (p.p.)	0.02	-0.05
Capital Inflow (USD millions)	661.7	20317.4
GDP growth (Quarter, %)	1.98	0.87
Depreciation against USD (Quarter, %)	-0.01	-0.55
Stock Market Return (Quarter , %)	2.5	0.69
Number of Banks	85	172

Table 2-8: Summary statistics by capital mobility regimes

sures appear effective – the difference in average quarterly capital inflows between the two subgroups is large. Countries with capital controls also exhibit higher GDP growth and stock market returns, which are typical of developing countries.

2.4 Results and Discussion

2.4.1 Panel Regression

Table 2-9 presents the results of the panel regression. There are four key points to note. Firstly, banks' default risks are persistent. A one percentage point increase in default risks is followed by 0.5 to 0.6 percentage point increase in default risks in the subsequent quarter. Secondly, except for models (5) and (8), US monetary policy is shown to be significantly and negatively related to banks' default risks. Because the general economic conditions are controlled for (by GDP and PDF), the negative coefficient

VARIABLES	(1) Baseline Model	(2) Alternative Risk Measure (CAPM Risk)
PD	0.65***	
	(0.09)	
USGAP	-0.02***	-0.13***
	(0.01)	(0.03)
NRGAP	0.004	-0.008
	(0.003)	(0.007)
Log(GDP)	-0.29*	-0.652
	(0.18)	(0.461)
PDF	0.396*	0.802**
	(0.213)	(0.395)
Log(SM)	0.19**	0.805***
	(0.08)	(0.214)
Log(ER)	-0.01	-0.173
	(0.15)	(0.254)
Log(VIX)	0.05	0.038
	(0.11)	(0.115)
Log(EXDEP)	0.19	0.292
	(0.196)	(0.493)
CAPM Risk		0.781***
		(0.263)
Observations	7,967	7,967
Number of Banks	257	257
Sample Period	2001 Q1 - 2008 Q4	2001 Q1 - 2008 Q4
Number of Instruments	35	32
Test for AR(1) Pr > z =	0.091	0.002
Test for AR(2) Pr > z =	0.350	0.758
Hansen Test Pr > Chi2 =	0.946	0.644

Table 2-9: Panel regression results. Except model (2), the dependent variable of all models is banks' probability of default (PD). All explanatory variables are lagged one quarter. Standard errors (reported in parentheses) are clustered at the country level to control for the fact that, nancial conditions of banks within a country are correlated with one another. Seasonal dummies are included in all regressions. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

VARIABLES	(3) Alternative monetary policy stance (Federal Fund Rate)	(4) Full Sample
PD	0.651***	0.493***
	(0.054)	(0.071)
FFR	-0.029***	
	(0.009)	
ONR	0.008	
	(0.008)	
USGAP		-0.052**
		(0.02)
NRGAP		0.013
		(0.008)
Log(GDP)	-0.299**	-0.309
	(0.125)	(0.243)
PDF	0.462***	0.837***
	(0.152)	(0.229)
Log(SM)	0.288***	0.209
	(0.056)	(0.128)
Log(ER)	0.131	-0.116
	(0.293)	(0.228)
Log(VIX)	-0.044	-0.209**
	(0.085)	(0.099)
Log(EXDEP)	0.143	0.275
	(0.154)	(0.287)
Observations	7,967	13,107
Number of banks	257	257
Sample Period	2001 Q1 – 2008 Q4	2001 Q1 – 2013
Number of Instruments	29	49
Test for AR(1) Pr > z =	0.076	0.002
Test for AR(2) Pr > z =	0.126	0.451
Hansen Test Pr > Chi2 =	0.342	0.998

VARIABLES	(5) Interaction terms (with natural rate gap)	(6) Interaction Terms (with federal funds rate)
PD	0.512***	0.526***
	(0.06)	(0.05)
NRGAP	0.015*	
	(0.008)	
ONR		0.01
		(0.007)
Log(GDP)	-0.301	-0.247
	(0.210)	(0.314)
PDF	0.606***	0.706***
	(0.143)	(0.194)
Log(SM)	0.110	0.382***
	(0.147)	(0.124)
Log(ER)	-0.053	-0.059
	(0.168)	(0.198)
Log(VIX)	-0.159**	-0.176*
	(0.076)	(0.105)
Log(EXDEP)	0.299	0.091
	(0.263)	(0.295)
USGAP	-0.147	
	(0.141)	
$USGAP^2$	0.0103	
	(0.009)	
USGAP × Log(EXDEP)	0.005	
	(0.011)	
USGAP × BEL	0.019*	
	(0.01)	
FFR		0.239**
		(0.098)
FFR^2		-0.018**
		(0.009)
FFR × Log(EXDEP)		-0.013**
		(0.006)
FFR × BEL		-0.01**
		(0.005)
BEL	0	0.018
	(0.005)	(0.014)
Observations	13,107	13,107
Number of banks	257	257
Sample Period	2001 Q1 – 2013 Q4	2001 Q1 – 2013 Q4
Number of Instruments	59	49
Test for AR(1) Pr > z =	0.001	0.005
Test for AR(2) Pr > z =	0.375	0.388
Hansen Test Pr > Chi2 =	0.997	0.971

Variables	(7) Exchange rate and capital mobility regimes (Natural rate gap)	(8) Exchange rate and capital mobility regimes (Federal funds rate)
PD	0.5***	0.547***
	(0.055)	(0.061)
USGAP	-0.072**	
	(0.03)	
FFR = L,		-0.01
		(0.028)
NRGAP	0.01	
	(0.008)	
Log(GDP)	-0.171	-0.125
	(0.224)	(0.196)
PDF	0.747***	0.599***
	(0.198)	(0.158)
Log(SM)	0.157	0.28*
	(0.117)	(0.151)
Log(ER)	-0.025	0.294
	(0.166)	(0.191)
Log(VIX)	-0.164**	-0.118*
	(0.074)	(0.061)
Log(EXDEP)	0.254	0.135
	(0.238)	(0.244)
Dummy_float	-1.699	-3.591
	(3.098)	(3.729)
Dummy_float × USGAP	-0.127	
	(0.092)	
Dummy_open	-0.29	0.945
	(2.2)	(2.667)
Dummy_open × USGAP	0.181*	
	(0.105)	
ONR		0.009
		(0.007)
Dummy_float × FFR		0.062
		(0.047)
Dummy_open × FFR		-0.084*
		(0.047)
Observations	13,107	13,107
Number of banks	257	257
Sample Period	2001 Q1 – 2013 Q4	2001 Q1 – 2013 Q4
Number of Instruments	64	52
Test for AR(1) Pr > z =	0.002	0.002
Test for AR(2) Pr > z =	0.41	0.427
Hansen Test Pr > Chi2 =	1	0.986

should reflect more banks being induced by loose monetary policy into taking risks, than that risks have gone up because the economy performs poorly. Thirdly, monetary stances of local authorities, as measured by the natural rate gap ($NRGAP$) and overnight interest rate (ONR) , are shown to be statistically insignificant, suggesting that in a financially integrated world, local monetary policies are ineffectual in affecting banks' risk attitudes. Fourthly, from model (4) onward, VIX is negatively related to banks' default risks. The result is consistent with the risk-taking channel proposed by Rey (2013). Rey finds that an increase in VIX lowers capital inflows to periphery economies and banks' leverage. The results here clarify the inverse relations between VIX and banks' risks.

Results on the non-linear impacts of explanatory variables are ambiguous. When natural rate gap is used as the monetary stance measure (model (5)), one cannot detect the explanatory power of US monetary policies. But when the federal funds rate is used (model (6)), it is found that while US interest rate and banks' default risks share a positive correlation, the marginal impact of the former is diminishing, as captured by the negative coefficient of FFR^2. Also, banks in countries with larger capital inflows take more risks for a given easing of monetary policies (negative coefficient of $FFR \times LEXDEP$).

Models (7) and (8) gauge the impacts of different capital mobility and exchange rate regimes. The results are again inconclusive. When the natural rate gap is used (model (7)), it is found that the influence of US monetary policy is mitigated by capital mobility (as shown by the weakly significant 0.18 coefficient of $Dummy\_open \times USGAP$). When the federal funds rate is used (model (8)), however, a country that allows capital flows tends to see its banks taking up more risks for a given easing of US monetary policy, as represented by the coefficient of -0.08 in model (8).

As a robustness check, I redo the eight regressions with the addition of US banks to the data sample. The sample size has increased from 257 to 349 banks. I take away the local monetary stance variables ($NRGAP$ and ONR) because firstly, they are largely insignificant in the previous exercises, and secondly, from the perspective of US banks, *USGAP* equates to *NRGAP*, and including both would result in perfect multicollinearity. The results of these regressions (labelled as models (9)-(16)) are documented in table A-2 of the Appendix. They are largely consistent with the main results reported in this Section. For instance, default risks remain persistent, and in models (9), (11), (12), and (13), US monetary policy remains significantly and negatively related to banks' default risks. Some results are weaker, however. When CAPM risk (standard deviation of idiosyncratic stock's returns) is used as the risk measure, for example, US monetary policy is shown to be insignificant. The same result obtains when the federal funds rate is used in the interaction terms model (model (14)), and when regimes dummies are included (models (15) and (16)).

2.4.2 Panel Vector Autoregression

To further decompose and illustrate the risk-taking channel of monetary policy, I perform a first order panel vector autoregression (PVAR) with banks' probability of default (PD), logged external deposits of banks $(EXDEP)$, federal funds rate (FFR),and logged volatility index (VIX). The key findings are as follows:

i. An increase in FFR leads to a contemporaneous increase in VIX (lower right panel, Figure 2-12).

ii. An increase in VIX leads to a persistent fall in capital inflows over 20 quarters (upper right panel, Figure 2-13).

iii. An increase in capital inflows leads to a persistent increase in banks' default risks (upper left panel, Figure 2-11). Reading (i) – (iii) together, an increase in FFR would lead to an increase in VIX, a decrease in capital inflows, and a decrease

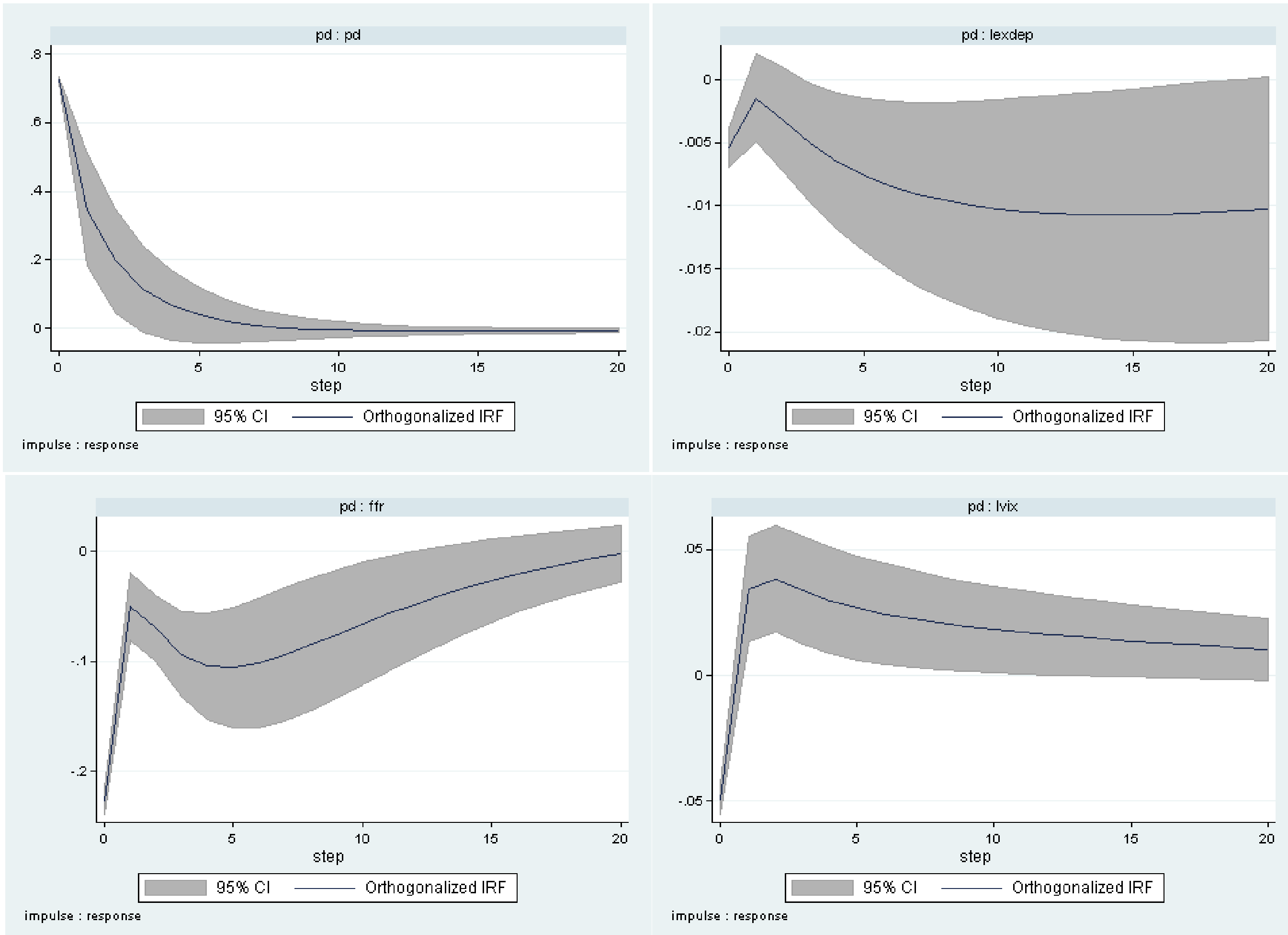


Figure 2-10: Response to increase in banks' default risks.

in banks' risks, thus matching with the prediction of the risk-taking channel of monetary policy.

iv. In return, an increase in banks' default risks lowers capital inflows, suppresses the federal funds rate, and raises the global risk aversion (Figure 2-10).

2.4.3 PVAR on Capital Control Subgroups

Figures 2-14 – 2-17 plot the difference in impulse responses between the open and closed economies. The difference is taken as the impulse responses of the open economies less

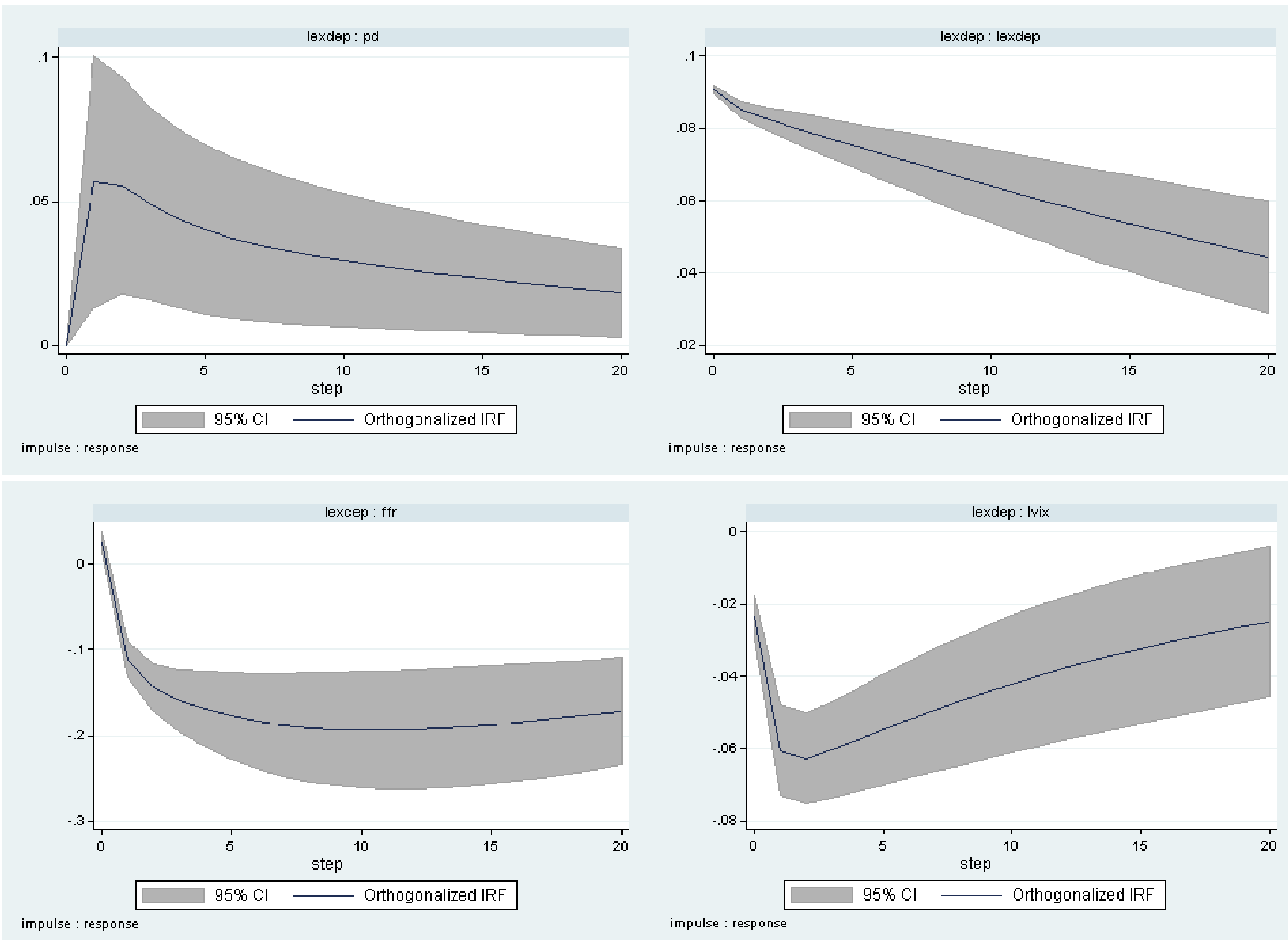


Figure 2-11: Response to increase in capital inflows.

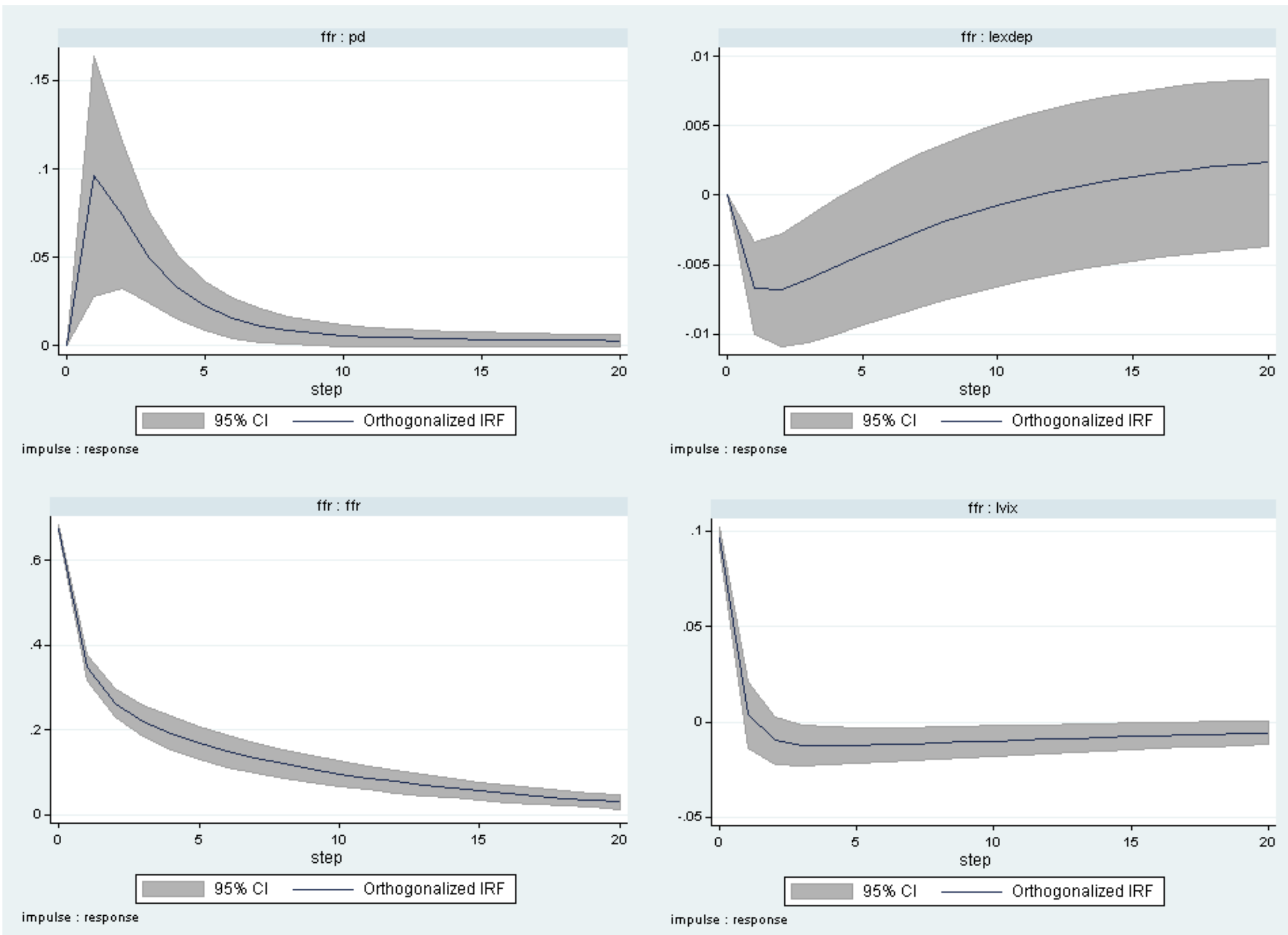


Figure 2-12: Response to increase in federal funds rate.

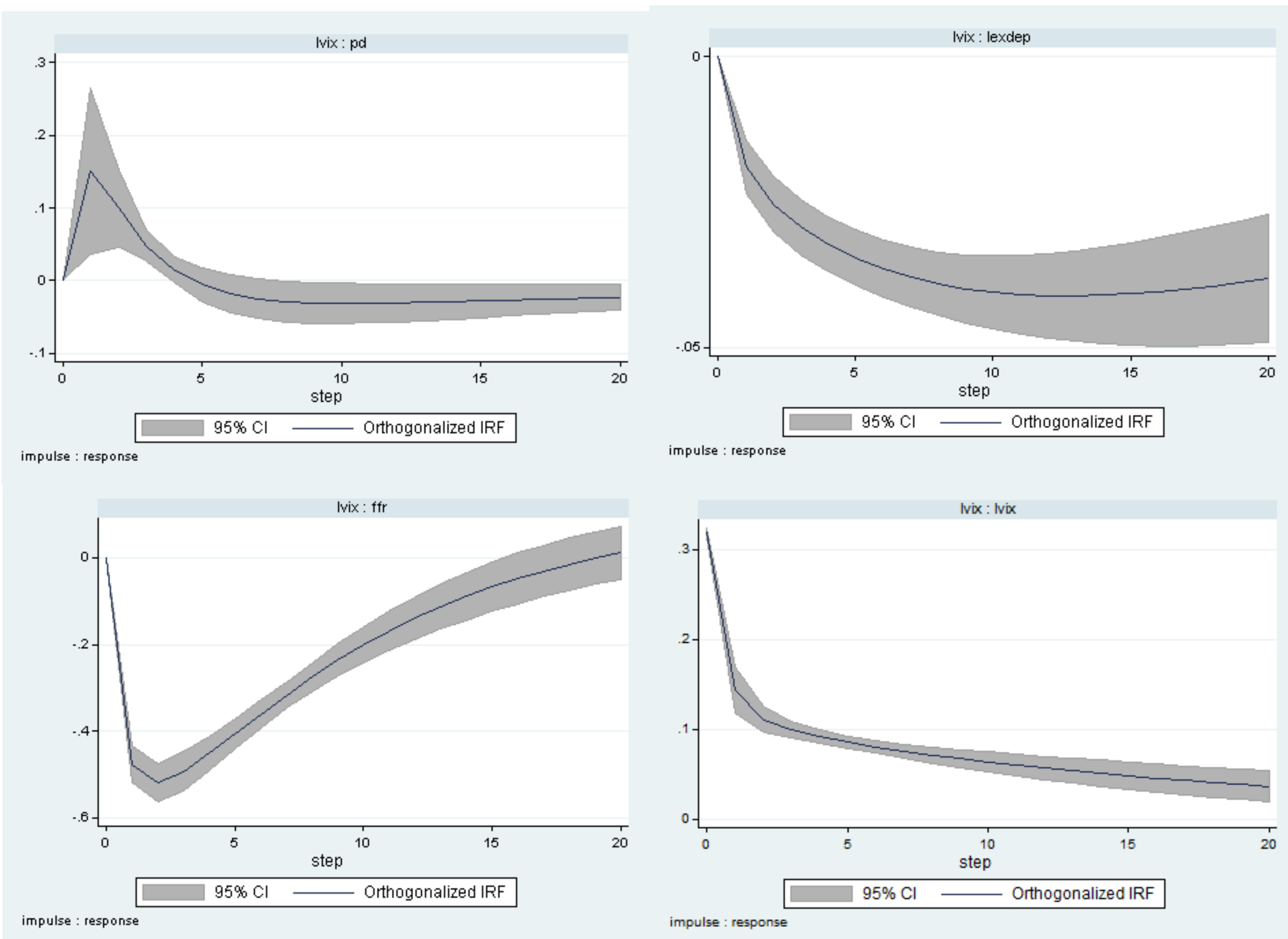


Figure 2-13: Response to increase in VIX.

those of the closed economies. Because the two subgroups are independent, the impulse response of the differences is equal to the difference in impulse responses[19].

As in the previous section, there are several responses that are of particular interest. First, in the lower right panel of Figure 2-16, it is found that when US interest rate rises, open economies sustain a higher level of increase in VIX than closed economies do. Second, the upper right panel of Figure 2-17 shows that, for a given increase in VIX, open economies experience more reduction in capital inflows than closed economies. This result points to the effectiveness of capital controls, and implies that closed economies are more capable in fending off capital inflows than open economies are.

Finally, the upper left panel of Figure 2-16 shows that for a given increase in US interest rate, default risks of banks in open economies fall more than the default risks of banks in closed economies. Because the results are symmetric, it implies that the rise in risks of banks in open economies, if US monetary policy eases, will also be larger.

2.5 Related Literature

This Chapter is closely related to the literature on the risk-taking channel of monetary policy (Borio and Zhu, 2012). It describes, in addition to the traditional channel (Sarno and Taylor, 2008) and balance-sheet channel (Bernanke and Gertler, 1995), how monetary policy transmits to the broader economy. While all three channels relate to the real economy, the risk-taking channel distinguishes itself by drawing an association between loose monetary policy and default risk of banks, thus depicting implications for the broader financial stability.

Two major channels of risk-taking are discerned. In the first, when central banks

[19] The difference of the confidence intervals is not presented here. Therefore, the differences revealed below may not be statistically significant, and are indicative only.

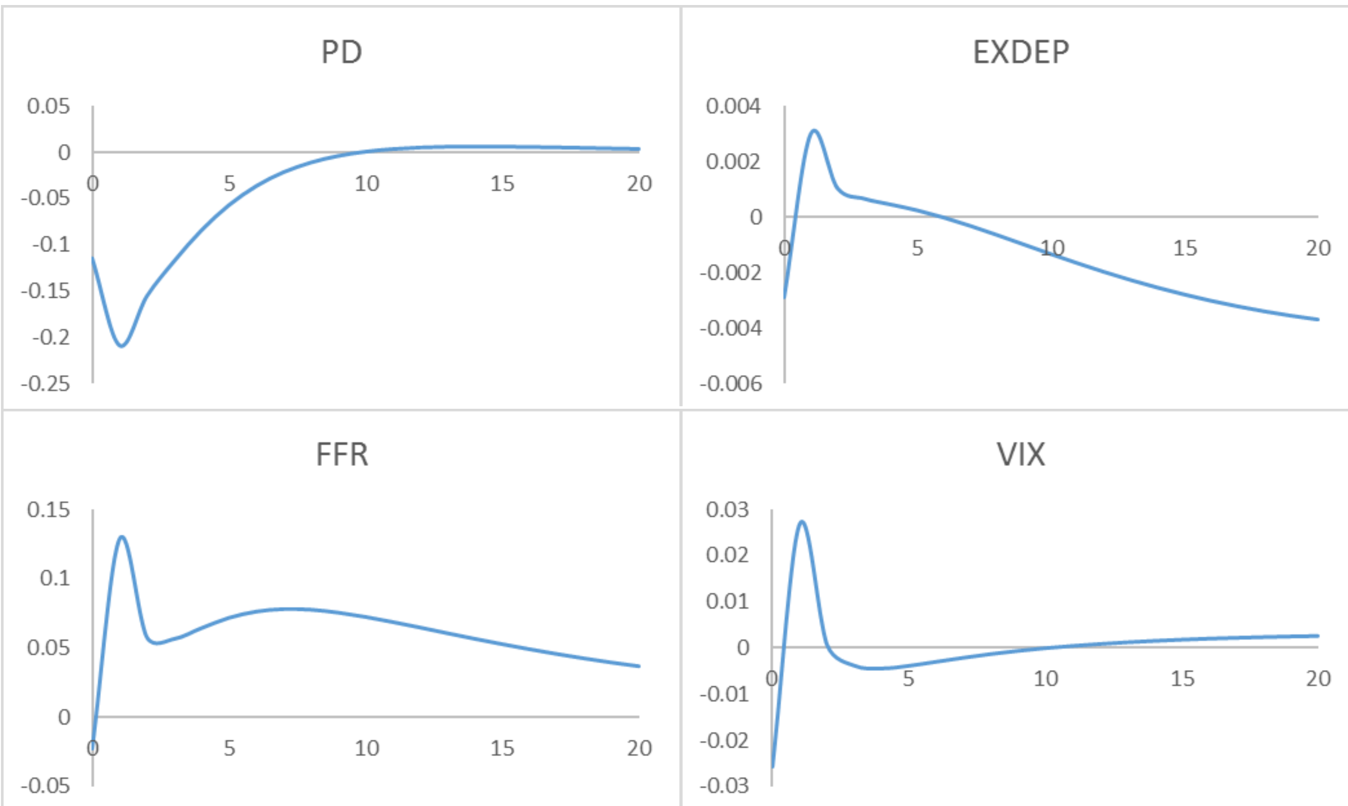


Figure 2-14: Difference in response to increase in *PD*
(Open –Controlled capital fl owsregimes).

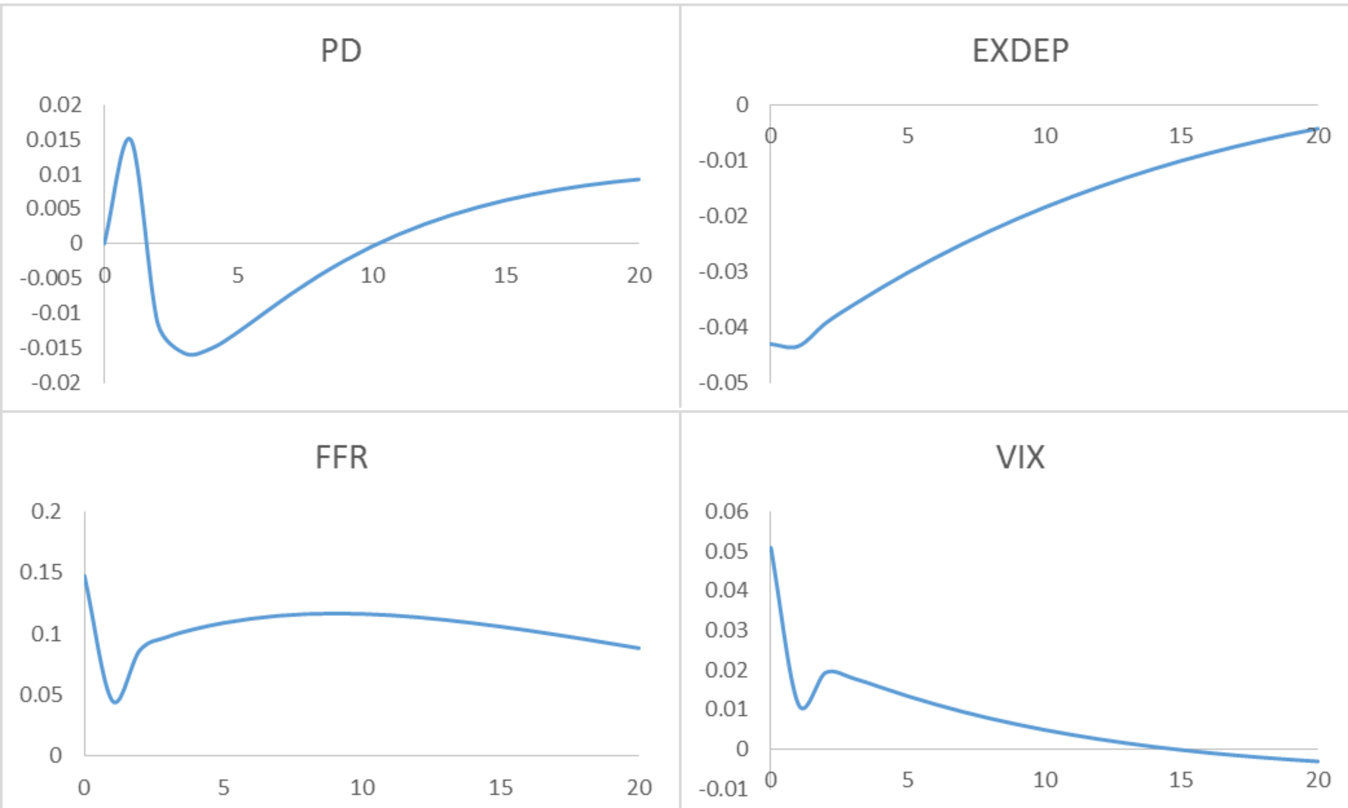


Figure 2-15: Difference in response to increase in *EXDEP*
(Open –Controlled capital flows regimes).

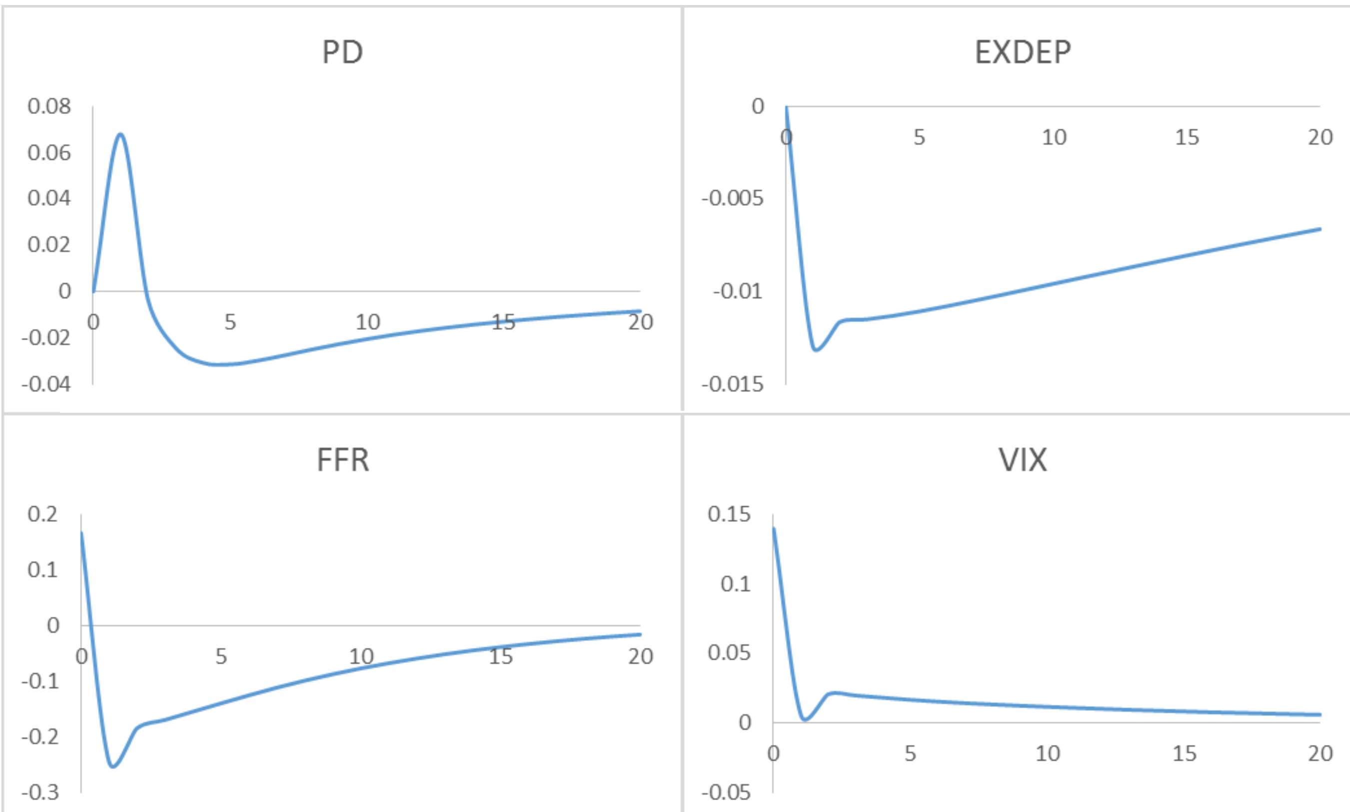


Figure 2-16: Difference in response to increase in *FFR*
(Open –Controlled capital fl ows regimes).

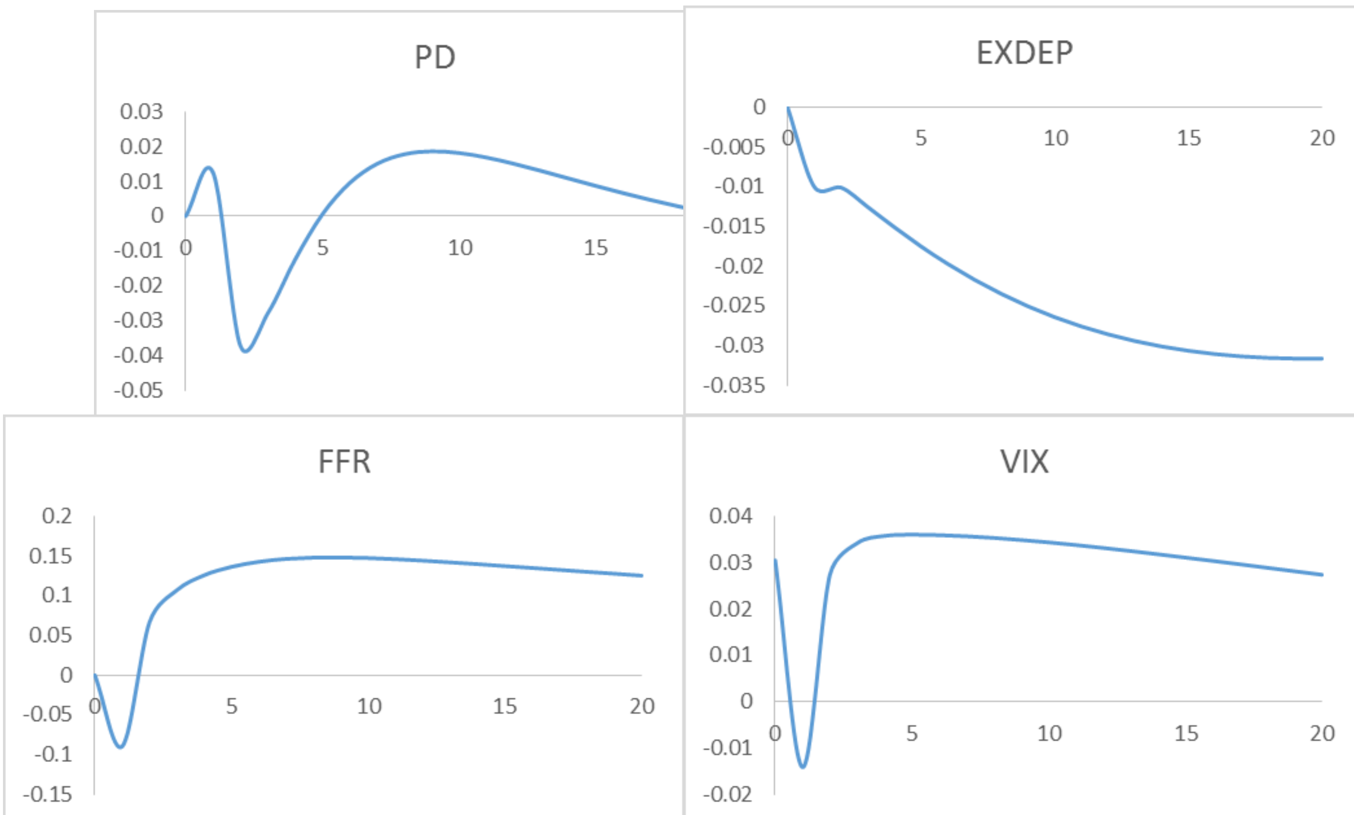


Figure 2-17: Difference in response to increase in VIX (Open –Controlled capital fl ows regimes).

lower real yield on safe assets, risk-neutral banks respond by adjusting their portfolios towards risky assets (De Nicolò et al., 2010). The adjustment continues until returns on both types of investments are re-equalized – the process of which increases risks of banks. In the second channel, low interest rates improve valuations and, at the same time, tames volatility (Adrian and Shin, 2010). The combination convinces banks to measure risk in a more benign way. Believing that their capacity to bear risk is bolstered, banks expand lending and load up leverage, only to be revealed later to the realisation that risks were but temporarily lowered; their overstretching causes their subsequent failure. If a contrast is to be made, the first channel alludes to banks actively taking risk, whereas in the second, bank managers, inadvertently or not, get misled into taking risk.

A related (but prominent) channel is the "search for yield" argument proposed by Rajan (2005). Rajan alludes to the commitment of financial institutions to reaching a certain return on assets entrusted by clients. When safe yields are low, managers of these institutions are forced to invest in riskier assets. Compared to the two channels above, this channel relates more to the fund management industry, their operations and risk-implications are addressed in Chapter 3[20].

Empirically, several studies have been conducted to establish the link between monetary policy and banks' risk-taking. Jiménez et al. (2014) uses micro data of the Spanish Credit Register over the period 1984–2006 to investigate whether the stance of monetary policy has an impact on the level of risk of individual bank loans. They find that,

[20] A fourth channel relates to the "Greenspan put", which discusses how central banks affect risk taking through the expectation of a strong policy response to negative shocks. If agents expect the central bank to cut rates aggressively when a shock threatens the stability of the system, they will tend to assume greater risk. Proponents of this mechanism have largely focused on the reaction function of the central bank rather than the level of the policy rate. Indeed, it is the implicit promise of lower rates, rather than low rates themselves, that cause this collective moral hazard. Actually, contrary to what is typically argued, it is high interest rates that would leave greater room for monetary stimulus, hence encouraging risk-taking. An easy stance reduces the collective moral hazard problem by shrinking the room for further monetary expansion.

although in the short term, low interest rate reduces risk by strengthening the capacity of existing borrowers, in the medium term, banks soften lending standard and grant more risky loans, hence raising the overall risk profile. In another study, Ioannidou et al. (2015) investigate the impact of changes in interest rates on loan pricing, using Bolivian data over the period 1999–2003. They find that, when interest rates are low, banks both increase the number of new risky loans, and reduce the rates charged on risky borrowers.

Finally, as discussed at the outset, Altunbas et al. (2014) take a more international perspective, and analyse the link between monetary policy and bank expected default frequencies (EDFs) using data for 600 European and US listed banks over the period 1999–2008. Despite the similar methods used in the authors' work and in this Chapter, my work uses a different measurement of default risk, centres on a different dataset, and, critically, focuses on the impact of US monetary policy *conditional on regional monetary policies.* Consistent with Rey (2013) and Bruno and Shin (2014), my results suggest that US monetary policy is a global driver of banks' risk-taking.

2.6 Conclusion

I document a negative correlation between US monetary policy and default risk of banks globally. My findings are consistent with the recent ideas of Rey (2013) and Bruno and Shin (2014), who advance the notion of a global financial cycle.

From a practical perspective, small, open economies cannot expect the US Federal Reserve to internalise the spillover of its monetary policy: the Federal Reserve has a domestic mandate to fulfil, and, to the extent that US's and the world's economic conditions differ, US monetary policy may conflict with global financial stability. In such times, the analysis of this Chapter would suggest that small, open economies may impose capital controls to withstand the influence of US monetary policy. Whether such measures should be adopted requires further analysis on the optimal level of risk, and on the efficiency of alternative policies in achieving it. But the adoption of such policy is now in line with the recent endorsement by the IMF on the admissibility of capital controls as a tool of macroeconomic management (Ostry, 2012; Ostry, Ghosh, Chamon, and Qureshi, 2012).

Chapter 3

The "Taper Tantrum" of 2013: An Analytical Perspective

3.1 Introduction

In the summer of 2013, Federal Reserve Chairman Ben Bernanke indicated that the Fed would start slowing – tapering – the pace of bond purchases later in the year, conditional on continuing economic recovery. He said:

"If the incoming data are broadly consistent with this forecast, the Committee currently anticipates that it would be appropriate to moderate the monthly pace of purchases later this year. And if the subsequent data remain broadly aligned with our current expectations for the economy, we would continue to reduce the pace of purchases in measured steps through the first half of next year, ending purchases around midyear." – Press conference, 19 June[1].

Despite the carefully chosen wording, Bernanke's comments sparked a sell-off in the

[1] He also noted earlier on 22 May: "If we see continued improvement and we have confidence that that is going to be sustained, then in the next few meetings, we could take a step down in our pace of purchases." – Testimony to Congress.

bond markets. Within a period of six months, fixed income mutual funds in US experienced redemptions of up to 7% of their net asset values (Figure 3-1)[2]. Exchange-traded funds (ETFs) underwent similar developments, witnessing a withdrawal of $2.1 billion in the two weeks following the talk (Figure 3-2). Fund outflows prompted assets sale, and, as mutual funds and ETFs were big players in the financial market, commanding roughly 40% of global financial assets (McKinsey 2013), risk premia shot up[3][4]. The term premium increased by around 30 basis points between the first and second tapering talk (from 2% to 2.3%, Figure 3-3)[5]. The credit risk premium, defined as the yield spread between the Bloomberg High Yield Bond Index and the 10-year Treasury bond, rose by 130 basis points (from 2.8% to 4.1%) [6]. Outflows from the emerging market also widened

[2]The calculation is based on a subset of open-ended mutual funds collected from the ICI database. The subset includes funds invested in investment grade bonds, treasuries, mortgage-backed securities, and international bonds. Their total net asset values (NAVs) as of 18 June amounted to US$1890 million. Outflows between 19 June and 30 June were US$132 million. 132/1890 roughly equates 7%.

[3]As of 2013, industry estimates of assets under management (AUM) were between $76 to $87 trillion globally, which is equivalent to around one year's global GDP, or around three quarters of the assets of the global banking industry (IMF, 2015; The CityUK, 2013; OFR, 2014). Some 41% of these assets are intermediated by open-end mutual funds, and around 4% by ETFs (Pensions and Investments and Towers Watson, 2014). The European Fund and Asset Management Association estimates that mutual funds that focus on bonds manage around US$7.2 trillion in assets. Deutsche Bank estimates assets under management (AUM) by fixed income ETFs amount to $0.4 trillion. For reference, the annual bond issuance in 2013 was $3.2 trillion (Economist, 2014).

[4]The asset management industry has grown rapidly. In the United States, AUM have risen almost fivefold relative to GDP since 1946, from around 50% of GDP to around 240% of GDP. The patterns are similar across most OECD countries. There has been especially strong growth in funds active in specialist, often illiquid, markets – for example, since 2008, high yield bond funds and emerging market funds have grown at an annual rate of around 40% per year, outpacing growth in the global mutual fund industry by a factor of four. Flows into US mutual loan funds have spiked to $63 billion in 2013, having averaged $15 billion in the preceding three years. Passively managed funds such as Exchange Traded Funds (ETFs) have also grown in importance. They have risen from $2 trillion in 2003 to almost $8 trillion by 2012, a rise in global market share from 5% to 13%. The industry is also concentrated. The top 10 asset managers account for just less than 30% of the sector, the top 10 banks a little more than 20%. Their balance sheets are also similarly-sized. In aggregate, the top ten banks and asset managers total $20 trillion and $25 trillion in assets respectively. The world's largest asset manager (Blackrock) is around a third larger than the biggest bank (ICBC). But, on the other side, nine of the top 10 banks are larger than their asset management equivalents. See appendix for top 10 banks (by assets) and asset managers (by assets under management) as of 2012.

[5]Measured as the difference between 10-year and 3-month treasury rates.

[6]Effective duration of the Bloomberg High Yield Index is 7 years.

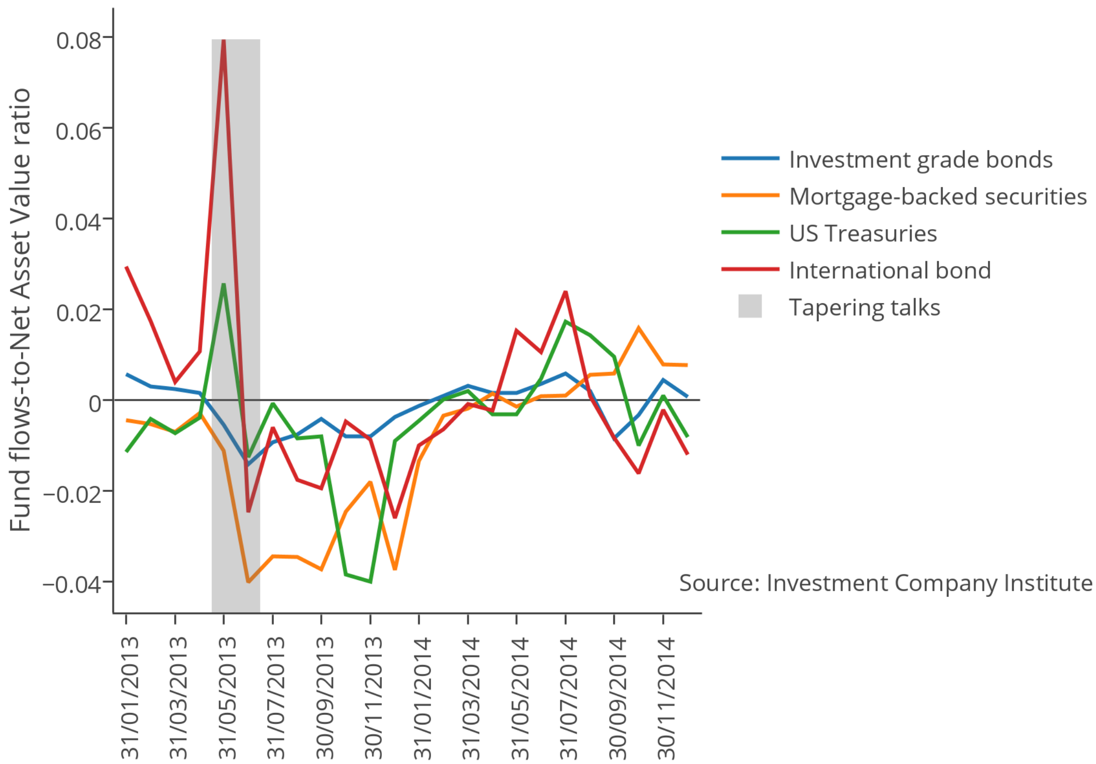


Figure 3-1: Fund flows-to-Net Asset Values ratio, selected categories of US mutual funds.

the sector's bond spreads by around 40 basis points[7]. The market reaction to Chairman Bernanke's speeches has come to be known as the "taper tantrum".

In this episode, as in any crisis in which fire-sales are involved, limited capital was available on the sidelines to cushion the plunge in prices[8]. Could agents not have foreseen the crisis and spared capital in advance? If they could, how might agents choose between profitable investments today, and the prospect of arbitrage tomorrow (that may, in fact, never arise ex post)? Is the storage of arbitrage capital socially optimal? And, if not, might central banks play a role in its allocation? This chapter considers these questions in a theoretical setting that is simple and transparent enough to clarify the underlying

[7]See Sahay, Arvanitis, Faruqee, N'Diaye, and Mancini-Griffoli (2014).
[8]See appendix for fixed income ETFs that experienced inflows during the taper tantrum.

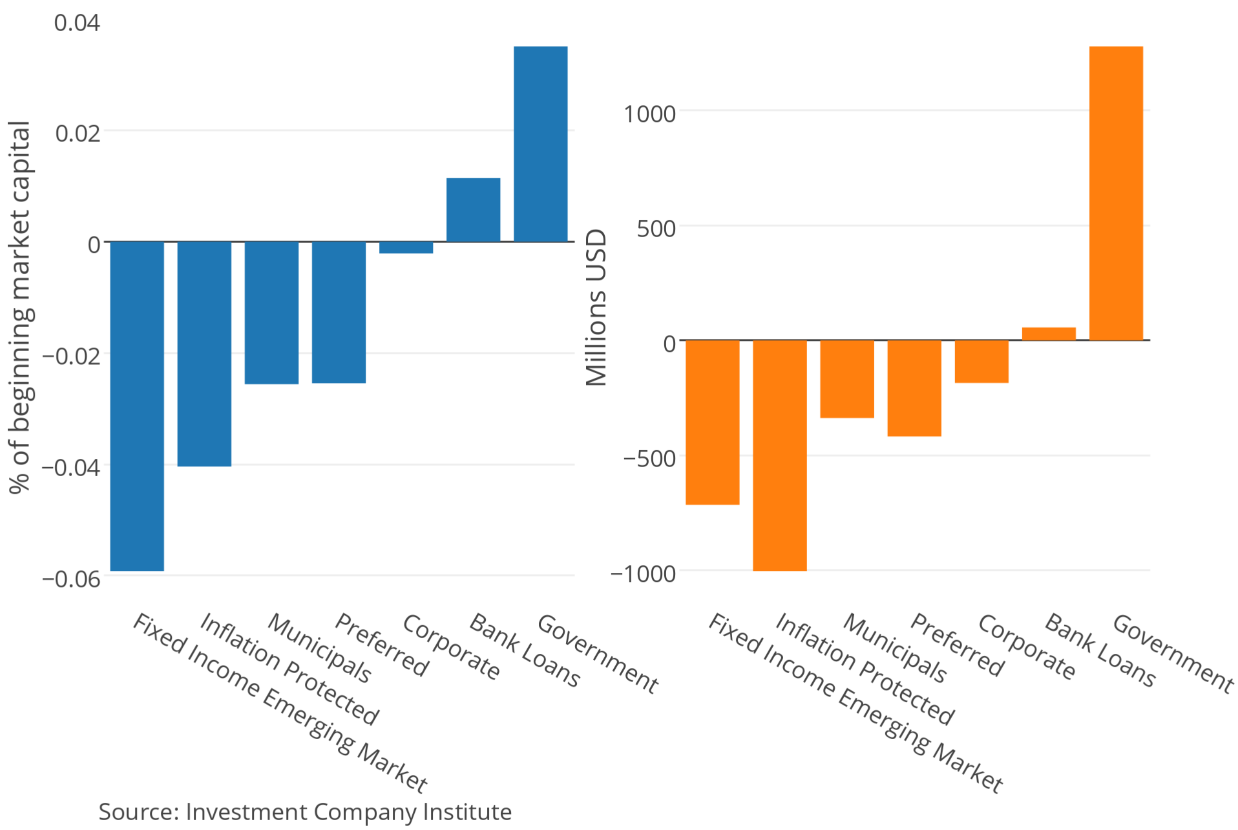
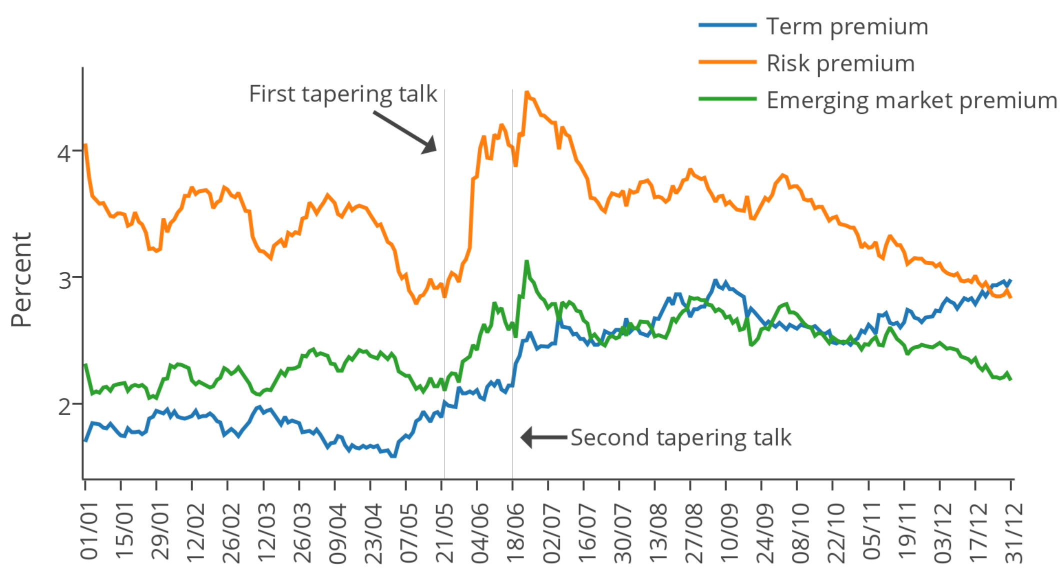


Figure 3-2: Fund flows of fixed income ETFs between 19 June and 30 June, 2013.



Term premium: 10Y Treasury bond - 3M Treasury bill

Risk premium: Bloomberg high yield bond index - 10Y Treasury bond

Emerging market premium: Bloomberg emerging market bond index - 10Y Treasury bond

Source: Bloomberg

Figure 3-3: Yield spread during 2013.

economic mechanisms at work.

In what follows, I build upon Morris and Shin (2014). Like them, I motivate *"relative underperformance aversion"* on the part of fund managers to explain their tendency to sell assets simultaneously – triggering a run on assets akin to a bank run. The aversion implies that fund investors rank asset managers according to their short term performance, and punish underperformers by withdrawing funds from them. To avoid lagging behind, asset managers may race to sell, even when holding onto assets is the socially optimal course to take. Relative ranking aversion is also highlighted by Rajan (2005), and has been used as a basis to describe a variety of trading dynamics scenarios that have systemic implications (herding: Vayanos, 2004; Feroli et al., 2014; excessive risk taking: Chevalier and Ellison, 1997; Basak et al., 2008; contagion: Calvo and Mendoza, 2000; Broner et al., 2006).

As in Morris and Shin (2014), I assume that communication between central banks and investors with respect to risk-free rate is imperfect. Due to relative performance aversion, actions of asset managers are strategic-complements – they either sell assets together if they believe other managers will sell, or hold together if they believe others will hold as well. If the communication were perfect, then the policy rate would become common knowledge among asset managers, and invite multiplicity of equilibria (Morris and Shin, 2003). Not only is such indeterminacy unsatisfactory, common knowledge seems unrealistic: the taper tantrum in June suggested that wide divergence existed among market participants as to the future of asset purchase programs (Stein, 2014a; Geanakoplos, 2009).

In my model, I resolve the indeterminacy of multiple equilibria by deploying global game methods. Agents receive noisy signals about the path of short-term interest rates, and so identify a unique threshold interest rate, above which a collective sale of assets – a fire-sale – sets off. Global games techniques were pioneered by Carlsson and van Damme

(1993), and have been widely applied in the study of financial crises (e.g. Morris and Shin, 1998; Abreu and Brunnermeier, 2003; Goldstein and Pauzner, 2005).

To the baseline setup, I introduce arbitrageurs à la Acharya, Shin, and Yorulmazer (2013). The merged model, thus, consists of three periods. In the initial period, each agent is endowed with a unit of capital, which he can use to invest in an asset – hence becoming an asset manager – or store up as arbitrage capital. The central bank conveys the monetary policy stance by announcing a plausible range of rates, one of which is selected in the interim period as the official risk-free rate. Although the actual occurrence of firesales remains unknown until the interim date, agents may gauge the likelihood of firesales by comparing the announced range to the threshold rate. On the initial date, agents derive the respective payoffs of being an asset manager and an arbitrageur, and allocate funds until both options offer the same rate of returns.

My results show that monetary stance of central banks affects the allocation of arbitrage capital in equilibrium. Arbitrageurs' profits depend on the expectation of future crises, the probability of which the central bank may influence. If it commits to loose monetary policy, the probability of firesales is removed, and no sensible agent spares capital in advance. On the other hand, if the guidance is open-ended, then firesales become conceivable, inducing some storage of arbitrage capital.

A corollary of my model suggests that, to avoid future tantrums such as that in 2013, the central bank may consider contracting monetary policy unexpectedly. A prior commitment to low interest rate serves to dissuade the storage of capital ex ante[9]. Absent valid buyers ex post, the best response of asset managers is to hold onto assets, regardless of the actual interest rate set. Thus, the central bank creates a *self-fulfilling* prospect of

[9]If the central bank has kept a good record in the past, then there is no reason why the financial markets would not take its words as given. According to the Survey of Primary Dealers conducted by the New York Federal Reserve, traders generally take Federal Reserve's announcements as they are.

having no firesales in equilibrium. Without encompassing the full benefits and costs of such strategy[10], the model merely states that it would not result in firesales, a disruption commonly thought would ensue under the circumstances. As an analogy, countries usually abandon currency pegs in an abrupt manner to conserve international reserves (Rebelo and Végh, 2008)[11]. Equivalently, a sudden increase in interest rate may avoid the unnecessary storage of arbitrage capital.

Consistent with Acharya et al. (2013), my results show that the storage of arbitrage capital is inefficient. In contrast to much of existing literature, however, the inefficiency is unrelated to the depth of firesales generated by arbitrageurs – in the model, losses to asset managers cumulate as gains to arbitrageurs, leaving net welfare unchanged. Instead, inefficiency comes from the bypassing of profitable investments, resulting in constrained production capacity in the future. The inefficiency persists even when arbitrageurs are as competent in managing assets as asset managers[12].

I derive comparative statics to study how two recent developments in the financial market may affect capital allocation. The first development is the soar in asset prices as attributable to the conduct of quantitative easing programs by central banks[13], and the second development is the increase in asset returns as economic conditions recover. In the model, these changes affect agents' payoffs both directly and indirectly. Directly, higher

[10] One obvious cost is the damage to central banks' credibility, which is thought to help anchor inflation expectations (Davis et al., 2014).

[11] The major reason for sudden withdrawal is to avoid a run on the affected currency that would drain reserves. See El-Erian (2015) for other measures adopted by central banks to mitigate disruptions after the peg abandonement, including (1) signal commitment to the peg until the last moment, (2) make the exit announcement after financial markets close on Friday, (3) communicate and re-communicate the reasoning (domestically and abroad) during the weekend, (4) coordinate with financial institutions and other central banks to put in place any necessary contingency measures.

[12] In our model, the ideal world is where arbitrage capital is zero and all resources are placed into investment, which would result in occasional severe fire sales, depending on how central bank conducts its monetary policy. Disconcerting though such events are, therefore, fire sales may not be harmful per se from a social welfare perspective.

[13] See Joyce et al. (2011, 2012); Krishnamurthy and Vissing-Jorgensen (2011).

asset prices adds to the acquisition cost of arbitrageurs, while higher asset returns raises arbitrageurs' payoffs in case of a fire-sale[14]. The indirect effects work via the likelihood of firesales, and are opposite to the direct effects. Higher asset prices entices asset managers to sell and increases the likelihood of firesales – to the benefits of arbitrageurs. On the other hand, higher asset returns persuades asset managers to hold onto assets, diminishing the expected payoffs of arbitrageurs. My model shows that, the relative dominance of direct to indirect effects depends on the initial stance of monetary policy. If it is loose, the indirect effect prevails.

I also consider the impact of imposing redemption fees on fund investors. The model reveals that such imposition reduces investors' sensitivity towards fund managers' performance, lowers the likelihood of firesales, and hence the storage of arbitrage capital. The result echoes the recent policy proposal of IMF (2015)[15]. From a broader perspective, my results are consistent with Feroli et al. (2014) and Stein (2014b), which suggest that there is no general separation principle between monetary and macroprudential policies.

The Chapter proceeds as follows. The next section outlines the model, where the equilibrium level of arbitrage capital is derived, and the welfare implications and comparative statics discussed. Section 3.3 relates the model to the wider literature. Section 3.4 concludes.

[14] As asset managers trade against arbitrageurs, their payoffs are opposite to each other.

[15] "Consideration should be given to the use of tools that adequately price-in the cost of liquidity, including minimum redemption fees, improvements in illiquid asset valuation, and mutual fund share pricing rules" (p.121, IMF (2015)). FSB (2013) also suggests that regulation and fund contracts should include tools, such as fees, gates, side-pockets, and suspension of redemptions, to manage large redemptions.

3.2 Model

The model consists of a unit mass of agents, a unit mass of households, and a central bank. Time is denominated in three periods: 0, 1, 2. Households are each endowed with one unit of wealth. At the beginning of date 0, each household entrusts its wealth to the management of one agent. An agent may use the wealth to buy one unit of asset, which yields a gross return of $R > 1$ units of goods on date 2. Agents who invest in assets are called asset managers.

An agent may alternatively store up the wealth on date 0. Storing wealth opens up an opportunity for the agent to purchase assets on date 1, should asset managers decide to sell. Agents who store wealth are called arbitrageurs. The asset price on date 1 is $\lambda < 1$. Its less than unity value represents a discount due to premature liquidation of the asset.

On date 0, the central bank sets out a range $[1, \widehat{r}]$ which the gross risk-free interest rate at date 1 may take. At the start of date 1, the central bank picks one rate out of the range, and announces it to the public. The announced rate, r, becomes the official risk-free rate agents can borrow from or lend to the central bank. Prior to the announcement, r is uniformly distributed between $[1, \widehat{r}]$. Throughout this model, r is assumed to be smaller than R. That is, the risk-free returns offered by the central bank is lower than that offered by financial assets[16].

Let $w \in [0, 1]$ be the fraction of agents who choose to become arbitrageurs on date 0, and $(1 - w)$ the corresponding fraction of asset managers. w can be interpreted as the allocation of capital for arbitrage activities. It is the key endogenous variable; its value

[16]This assumption may not sit well with the textbook mechanism of monetary policy. In principle, monetary policy works precisely by generating interest rates that exceed the return to capital, thereby shutting down valuable projects, and dampening a boom. But the assumption is consistent with the current world in which interest rate is kept at a very low level, due to a combination of both central banks' flooding of the market with liquidity, and the low growth prospect in the imminent future.

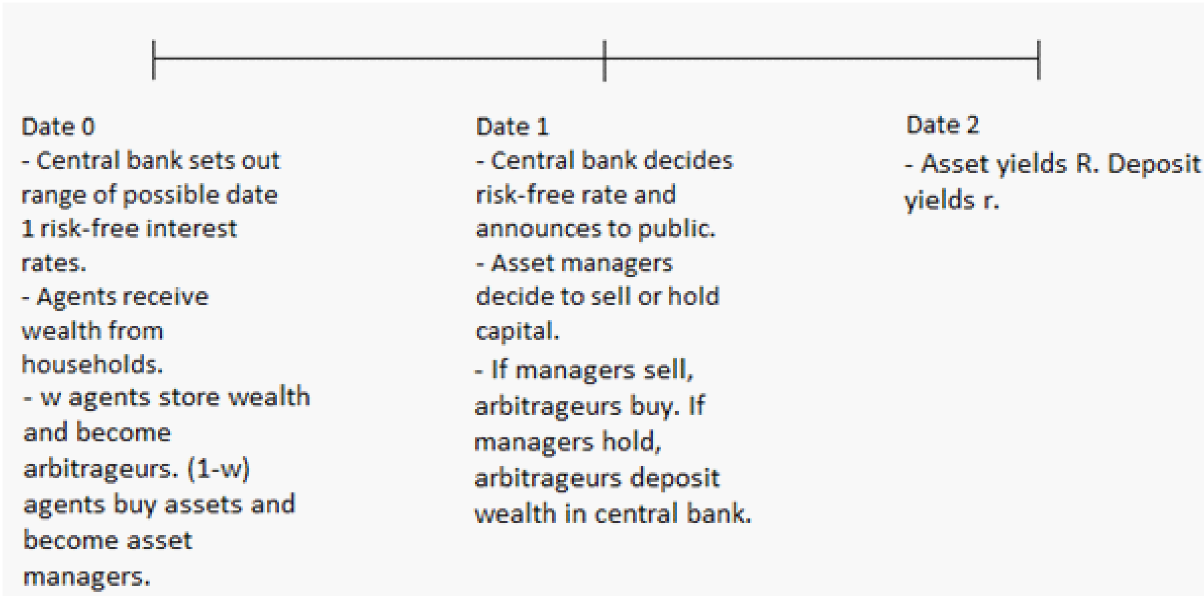


Figure 3-4: Timeline.

carries welfare implications. In what follows, I will describe the expected payoffs of an arbitrageur and an asset manager on date 0. I can then back out the equilibrium level of arbitrage capital, w^*, a point at which agents, having considered the respective payoffs, have no incentive to further switch capital allocation. Having derived w^*, I will discuss how arbitrage affects welfare, defined as the sum of expected payoffs of agents on date 0 . I finish with several comparative statics, including how monetary policy stance affects arbitrage capital allocation.

Figure 3-4 depicts the timeline.

3.2.1 Expected Payoffs of Arbitrageur

Let $x \in [0, 1]$ be the portion of asset managers who sell assets on date 1. As there are $(1 - w)$ managers, each holding one unit of assets, the total supply of assets at date 1 are $x(1 - w)$ units. Each arbitrageur may buy up to $[x(1 - w)]/w$ units of assets.

On date 1, the arbitrageur forms the following portfolio:

1. Deposit his stored wealth in the central bank.

2. Borrow from the central bank to buy all assets available to him.

This portfolio will yield a payoff of

$$r + \frac{x(1-w)}{w}(R - \lambda r) \tag{3.1}$$

on date 2. The first term represents the interest return on the deposits, and the second term is the net return from asset acquisition, where λr is the gross financing cost of each unit of assets. By assumption, R is larger than λr, implying that arbitrageurs are always willing to acquire all assets put on sale. And as they can borrow without limit from the central bank, arbitrageurs as a group can absorb any amount of assets put on sale.

3.2.2 Expected Payoffs of Asset Manager

An asset manager may choose to hold or sell his unit of assets on date 1. A manager who sells assets receives

$$\lambda r, \tag{3.2}$$

where λ is the revenue from sale, and λr the gross interest return from depositing this revenue in the central bank.

A manager who holds assets on the other hand receives

$$R(1 - \phi x) \tag{3.3}$$

units of goods on date 2, where x is the proportion of managers who choose to sell, and ϕ represents a modified version of the relative ranking aversion mentioned in Rajan

(2005). It is the punishment imposed by investors on fund managers who deviate from their peers' actions. Fund investors lack the expertise to evaluate asset managers, and gauge the latter's performance by comparing them to their peers' actions. If an asset manager holds onto assets amidst a tide of sales, he would be seen as countering the collective wisdom of his peers, prompting investors to withdraw funds. Although not modelled here, in reality, large-scale assets sale depresses assets prices, and hence the portfolio values of managers who hold onto assets. Evidence exists that fund outflows and inflows respond symmetrically to performance (Cashman et al., 2012).

Under this setup, there exists two equilibria, as depicted by Figure 3-5. If an asset manager expects all other managers to hold $(x = 0)$, then his payoff from holding is $R > \lambda r$. Thus, there is an equilibrium where all asset managers conform and hold onto assets. But if an asset manager expects all other managers to sell $(x = 1)$, then his payoff from holding assets is $R(1 - \phi)$, which is below λr for a sufficiently large ϕ. Thus, there is also an equilibrium where all asset managers sell.

Before the (collective) execution of sale, x is unknown, and asset managers need to work out an expectation of x to decide which action – $\{sell\}$,$\{hold\}$ – to take. Although the multiple equilibria has narrowed x down to two possibilities, it is insufficient for the managers to deduce the probability distribution of x. For one, the two equilibria need not happen with equal likelihood. If the relative gain of $\{hold\}$ over $\{sell\}$ at $x^* = 0$ is higher than the corresponding gain of $\{sell\}$ over $\{hold\}$ at $x^* = 1$, as Figure 3-6 depicts, then an asset manager may assign more weight to the belief that other managers will choose $\{hold\}$. He himself becomes likelier to choose $\{hold\}$. Other managers reason like him, leading to $\{hold\}$ being likelier to occur[17].

To select an equilibrium and work out a valid distribution of x, I draw on the literature

[17] That the equilibrium with higher relative payoffs is more frequently selected is supported by a series of experiments conducted by Van Huyck et al. (1990, 1991).

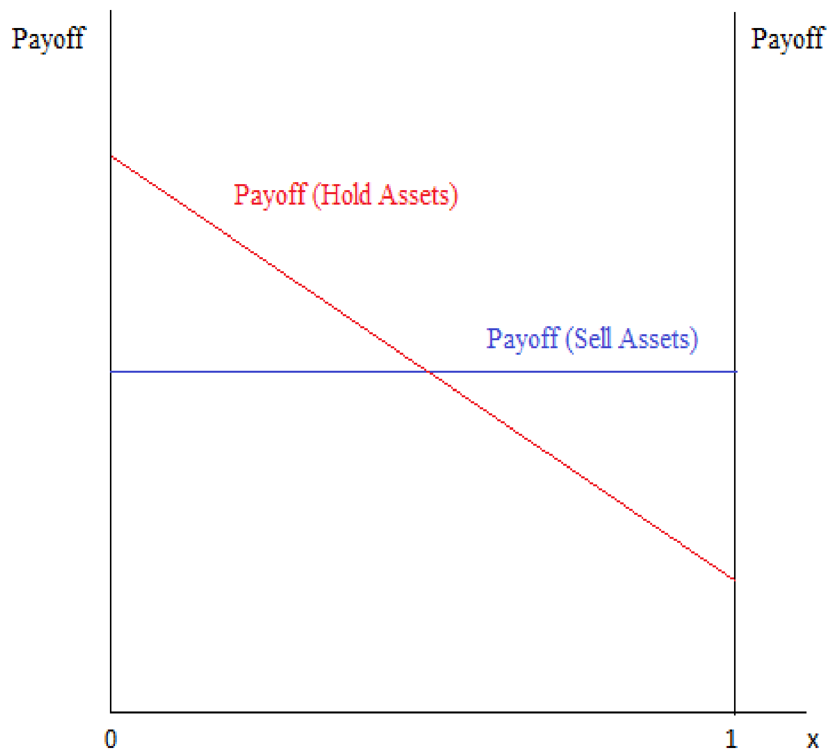


Figure 3-5: Payoffs in holding and in selling assets for asset managers.

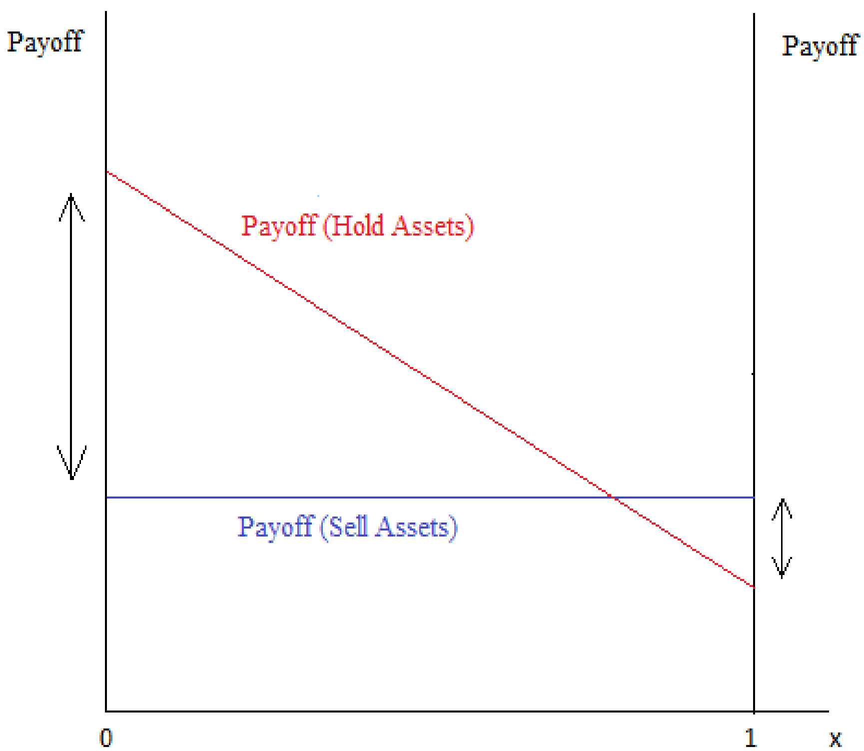


Figure 3-6: Higher relative payoff in collectively holding assets than in collectively selling assets.

on global games. As Morris and Shin (2003) show, the indeterminacy of many models can actually be attributed to two assumptions introduced to simplify the theory: (1) economic fundamentals are common knowledge, and (2) agents are certain about others' actions in equilibrium. Both assumptions are made for the sake of tractability, but they do more besides. They allow agents' actions and beliefs to be perfectly coordinated in a way that invites multiplicity of equilibria.

The global games technique adds noise to the game and removes the multiplicity. In the present application, it is assumed that managers cannot observe the actual interest rate chosen by the central bank, r. Instead, each manager i observes signal ρ_i of the true interest rate r given by

$$\rho_i = r + s_i, \tag{3.4}$$

where s_i is a uniformly distributed noise term, with realisation in $[-\varepsilon, \varepsilon]$ for small positive constant ε. The noise terms are independent across asset managers. They may capture both the opacity of central bankers' messages, and the diverse interpretation of them by market participants in real-life.

Morris and Shin (2003) show that, under this setup, it is optimal for asset managers to follow a switching strategy around a threshold signal ρ^*,where asset managers sell assets if they observe $\rho > \rho^*$, and hold assets if $\rho \leq \rho^*$. Moreover, when all managers adopt this strategy, they can infer that the density of x conditional on ρ^* is uniform over the unit interval $[0, 1]$. In other words, managers assign an equal likelihood to any realisation of the proportion of asset managers who choose to sell assets. This belief of uniform distribution of x is dubbed as Laplacian, after Laplace's (1824) suggestion that one should apply a uniform prior to unknown events from the "principle of insufficient reason". At $\rho = \rho^*$, asset managers are indifferent between holding and selling assets. In the following, I will derive the Laplacian belief in our context, followed by the derivation of the threshold interest rate (r^*) that underpins ρ^*. Morris and Shin show that the optimality of the switching strategy around ρ^* can also be found from iterated deletion of dominated strategies, and that no other strategy qualifies as an equilibrium.

3.2.3 Expectation of x

From equation (3.4), given the chosen official rate r, asset managers can deduce that possible signals received by other managers, ρ, are uniformly distributed between $[r-\varepsilon, r+\varepsilon]$. Moreover, from the switching strategy to which everyone follows:

$$\begin{cases} \text{Sell assets if} & \rho > \rho^* \\ \text{Hold assets if} & \rho \leq \rho^* \end{cases},$$

asset managers can further deduce that the portion of managers who sells is

$$\begin{aligned} x &= \Pr(\rho > \rho^*) \\ &= \Pr(r+\varepsilon > \rho^*) \\ &= \frac{1}{2\varepsilon}\int_{\rho^*}^{r+\varepsilon} d\rho_i, \text{ for } r-\varepsilon \leq \rho^* \leq r+\varepsilon. \\ &= \frac{r+\varepsilon-\rho^*}{2\varepsilon}. \end{aligned}$$

Now, let z be a constant that represents the portion of managers who choose to sell when r is at a specific level, r_0:

$$z = \frac{r_0+\varepsilon-\rho^*}{2\varepsilon}. \tag{3.5}$$

Then, to derive the Laplacian belief (x is uniformly distributed), it suffices to show that the probability of $x < z$ conditional on agent $i's$ observation of $\rho_i = \rho^*$, $\Pr(x < z|\rho_i = \rho^*)$, is linearly increasing in z. As x and z differ only in the interest rate, one can show that:

$$\begin{aligned} & \Pr\left(x < z \mid \rho_i = \rho^*\right) \\ = & \Pr\left(r < r_0 \mid \rho_i = \rho^*\right) \\ = & \frac{1}{2\varepsilon}\int_{\rho^*-\varepsilon}^{r_0} dr \\ = & \frac{r_0 - (\rho^* - \varepsilon)}{2\varepsilon}, \end{aligned}$$

where the second equality comes from the fact that, if an asset manager observes ρ^*, his best guess of r is ρ^*, and given the noise disturbance, his range estimation of r lies between $[\rho^* - \varepsilon, \rho^* + \varepsilon]$.

Substituting in equation (3.5), we can replace r_0 with $(\rho^* - \varepsilon + 2\varepsilon z)$. This gives us

$$\begin{aligned} & \Pr\left(r < r_0 \mid \rho_i\right) \\ = & \frac{(\rho^* - \varepsilon + 2\varepsilon z) - (\rho^* - \varepsilon)}{2\varepsilon} \\ = & z. \end{aligned}$$

As such, we have shown that

Lemma 1 *If asset managers follow a switching strategy around ρ^*, the density of x conditional on ρ^* is uniform over the interval* $[0, 1]$.

3.2.4 Threshold Interest Rate

As $\varepsilon \to 0$ – the actual interest rate becomes clear to every manager – signals (ρ) converge to the official rate (r). The switching strategy can be written as

$$\begin{cases} \text{Sell if} & r > r^* \\ \text{Hold if} & r \leq r^* \end{cases}.$$

With the lemma, we can pin down the equilibrium threshold interest rate (r^*), at which managers are indifferent between holding and selling. At $r = r^*$, the expected payoff of a manager who sells is

$$\int_0^1 \lambda r^* dx.$$

The expected payoff of a manager who holds when $r = r^*$ is:

$$\int_0^1 R(1 - \phi x)\, dx.$$

Equating the two expressions, one gets:

$$r^* = \frac{R}{\lambda}\left(1 - \frac{\phi}{2}\right).$$

The establishment of the switching strategy and the threshold interest rate means that, a concurrent sale of capital either occurs or does not occur. x is either 0 (when $r \leq r^*$) or 1 (when $r > r^*$). Defining the concurrent sale of assets as a fire-sale, I propose that

Proposition 2 *Firesales are less likely to occur if investors' aversion, ϕ, or the interim asset price, λ, is low.*

When ϕ decreases, investors exert less pressure on managers who hold assets. When λ decreases, returns from assets sale decrease accordingly. Both developments encourage assets holding and discourage assets sale, raising the threshold r^*, and making a fire-sale less likely to occur at any given interest rate. If r^* exceeds the upper bound of plausible interest rates, $\widehat{r}$, then a fire-sale will not occur.

3.2.5 Equilibrium Level of Arbitrage Capital (w^*)

When $r^* > \widehat{r}$, a fire-sale cannot conceivably occur, and $x = 0$. Conditional on this, the expected payoff of an asset manager is R, and the expected payoff of arbitrageurs is simply the interest returns from depositing the stored wealth, $E(r) = \frac{1}{2}\int_1^{\widehat{r}} dr = (1 + \widehat{r})/2$. As $R > E(r)$, the payoff of being an asset manager dominates that of an arbitrageur, and all agents opt for investing their wealth on date 0. $w^* = 0$.

On the other hand, when $r^* < \widehat{r}$, a fire-sale is conceivable on date 0. In this situation, the payoff of an arbitrageur is

$$\frac{1+\widehat{r}}{2} + \frac{1}{\widehat{r}}\left[\frac{1-w}{w}\int_{r^*}^{\widehat{r}} (R - \lambda r)\, dr\right], \tag{3.6}$$

where the first term is the interest returns from deposits, and the second term the payoff in case of a fire-sale. In a fire-sale, each arbitrageur will share among themselves $(1-w)/w$ units of assets, with each unit yielding a net return of $(R - \lambda r)$. The limits of the integral cover the values over which a fire-sale will occur.

The expected payoff of an asset manager is

$$\frac{1}{\widehat{r}}\left[\int_0^{r^*} R dr + \int_{r^*}^{\widehat{r}} \lambda r dr\right].$$

In the absence of firesales, each asset manager gains R. In a fire-sale, each manager receives λr.

Figure 3-7 plots the expected payoffs of asset managers and arbitrageurs against arbitrage capital allocation (w). The expected payoff of asset managers does not depend on w. On the other hand, the payoff of arbitrageurs is decreasing in w. When w is large, many arbitrageurs chase few assets, resulting in each arbitrageur acquiring only a small amount of assets in a fire-sale. The right hand side of w^* in figure 3-7 shows that, under this circumstance, arbitraging offers lower payoff than investing on date 0.

On the other hand, when $w \to 0$, $(1-w) \to 1$, a lot of assets were built on date 0, which can be acquired by the relatively few number of arbitrageurs in a fire-sale. At the limit, the ratio of assets to arbitrageurs approaches infinity. This boosts their payoff above that of asset managers. The left hand side of w^* in figure 3-7 illustrates this situation.

As figure 3-7 shows, only at w^* will the payoffs of arbitraging versus investing be equal. As w^* lies between 0 and 1, some resources will be allocated for arbitrage when a fire-sale becomes conceivable.

Our discussion can be summarised as following proposition:

Proposition 3 *When a fire-sale is inconceivable, all agents invest. When a fire-sale is conceivable, some resources will be allocated for arbitraging.*

A corollary of my model suggests that, to mitigate the tantrum in exiting the low

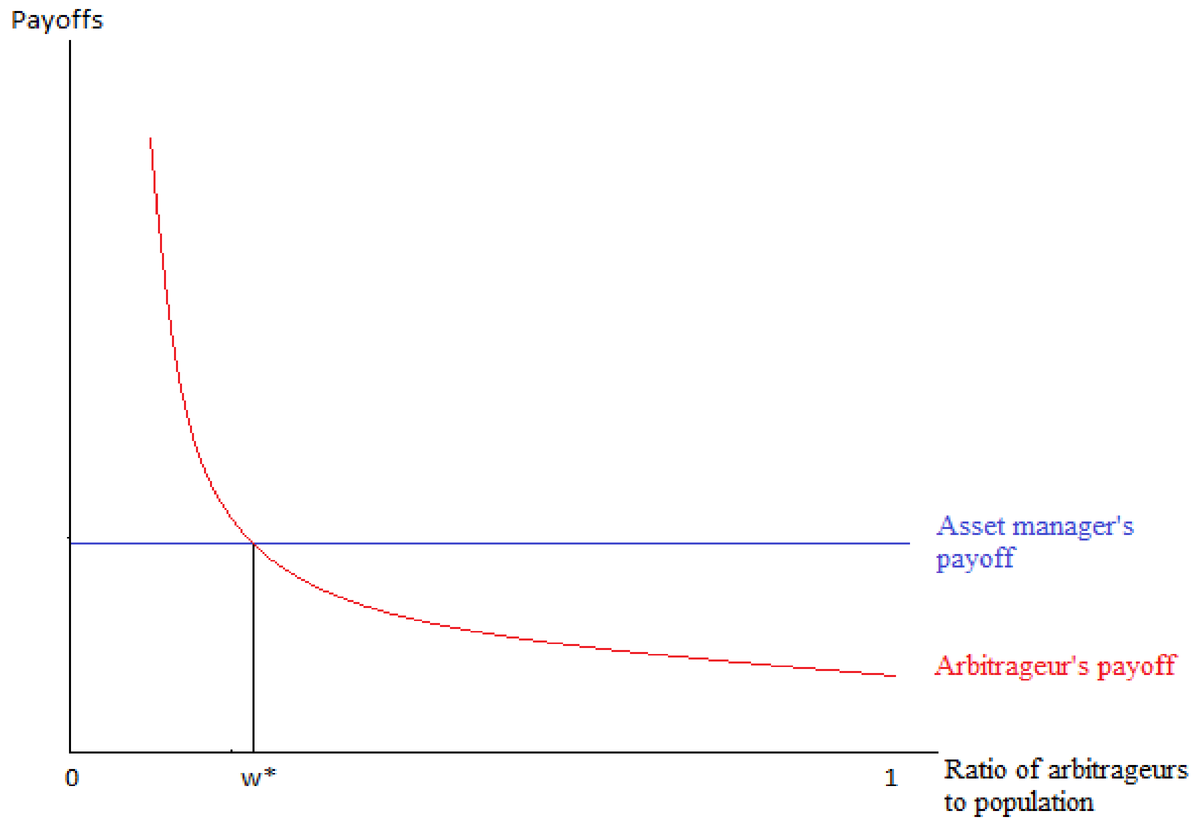


Figure 3-7: Expected payoffs of arbitrageurs and asset managers.

interest rate environment, the central bank may consider retracting its prior commitment towards loose monetary policy in an unanticipated manner. The commitment itself, if believed, would remove any prospect of firesales and arbitrage capital on the initial date ($x = 0$ and $w^* = 0$ in the model). Absent valid buyers on the interim date, the only equilibrium in which asset managers will settle is holding assets collectively – irrespective of the actual interest rate set. In other words, the prospect of no firesales, as promoted by the central bank, becomes *self-fulfilling*. Without encompassing a complete cost-benefit analysis on the practicality of such strategy, my model merely states that it would not result in a fire-sale, a disruption commonly thought would ensue under the circumstances. As a comparison, fixed exchange rate regimes usually abandon currency pegs in an abrupt manner in order to save international reserves. Evidence has shown that such strategy is the optimal course to take, should it be taken at all (Rebelo and Végh, 2008).

3.2.6 Welfare

I define welfare as the unweighted sum of agents' expected payoffs on date 0. When $w^* = 0$, all agents are asset managers. As each manager expects a payoff of R on date 2, total welfare ($W_{w^*=0}$) is simply R.

When $w^* > 0$, a run is plausible. Welfare ($W_{w^*>0}$) is

$$W_{w^*>0} = \Pr\left(No\ firesale\right) \cdot \left(Welfare|No\ firesale\right) + \Pr\left(firesale\right) \cdot \left(Welfare|firesale\right).$$

I show below that $W_{w^*>0} < W_{w^*=0}$.

In the absence of firesales, each arbitrageur will get $E\left(r|1 < r < r^*\right) = \left(1 + r^*\right)/2$.

Each asset manager will get R. So

$$(Welfare|No\ firesale) = w\frac{1+r^*}{2} + (1-w)\,R < R. \tag{3.7}$$

In a fire-sale, each arbitrageur will get

$$E\left(r|r^* < r < \widehat{r}\right) + \frac{1-w}{w}\left[R - \lambda E\left(r|r^* < r < \widehat{r}\right)\right].$$

And so all arbitrageurs combined will get

$$wE\left(r|r^* < r < \widehat{r}\right) + (1-w)\left[R - \lambda E\left(r|r^* < r < \widehat{r}\right)\right]. \tag{3.8}$$

Total payoffs received by asset managers in a fire-sale are

$$(1-w)\,\lambda E\left(r|r^* < r < \widehat{r}\right). \tag{3.9}$$

The sum of equations (3.8) and (3.9) gives

$$(Welfare|Firesale) = (1-w)\,R + w\frac{\widehat{r}+r^*}{2} < R. \tag{3.10}$$

Because $\Pr\left(No\ firesale\right)$ and $\Pr\left(Firesale\right)$ sums to one, by showing that both $(Welfare|No\ firesale)$ and $(Welfare|Firesale)$ are smaller than R, I have shown that

$W_{w^*>0} < W_{w^*=0}$.

Examining equations (3.7) and (3.10), one can see that the inferiority of $W_{w^*>0}$ lies not in the ability of arbitrageurs. They generate R from the assets just like the asset managers. The inferiority is also unrelated to the fire-sale discount – lower sale revenue to asset managers is offset by lower acquisition cost to arbitrageurs. Instead, it is the *storing* of arbitrage capital that diverts resources from building assets on date 0, hence restraining the productivity of the economy in future rounds. Even if a fire-sale breaks out, arbitrageurs are both willing to and capable of managing the assets; their availability however is constrained by the deficient investment on date 0. I summarise the discussion as:

Proposition 4 *The storage of arbitrage capital diverts resources from building assets. Even if arbitrageurs are capable of managing the assets, the lack of them due to insufficient investment constrains the economy's productivity. Deficient investment is the true cost of firesales.*

3.2.7 Comparative Statics

In the following, I consider the impacts of higher interim assets prices (λ), higher assets returns (R), and lower investors' aversion to anomaly (ϕ). These developments are likely to ensue as the economic conditions improve, and if redemption fees in the nature proposed by the Treasury and the IMF are introduced. Proofs are provided in the Appendix.

Higher Assets Prices (λ)

Higher assets prices affects arbitrageurs' payoff in two ways. On one hand, it raises the likelihood of firesales at any given interest rate (r^* decreases), and hence the ex ante prospect of arbitrageurs acquiring the assets. On the other hand, higher λ implies a higher acquisition cost. If monetary policy is loose ($\widehat{r}$ is low), it implies that the $r^*/\widehat{r}$ ratio is high, and that the original probability of firesales, $1 - r^*/\widehat{r}$, is low. Under these circumstances, the marginal drop in r^* will cause a relatively large increase in the first effect. In contrast, however, the second effect will be small – a low ex ante probability of firesales implies that any increase in λ will be muted in expectation. In sum, therefore, the first effect dominates, and arbitrageurs are better off.

For similar reasons, asset managers become worse off. Although a higher λ implies a prospect of selling assets at a higher price, it also lowers their chance of gaining the assets returns. If monetary policy is loose, the second effect will be relatively large, whereas the first effect, when framed in a low initial probability of run, will be relatively small. As such, the payoff of asset managers decreases.

Figure 3-8 illustrates the effect in equilibrium. More capital is allocated for arbitrage, leading to a lower welfare state.

Higher Assets Returns (R)

Higher assets returns lower arbitrageurs' payoff by reducing the chance of a fire-sale – the high returns keep asset managers from parting with assets at any given interest rate; the threshold interest rate, r^*, increases. On the other hand, higher assets returns increase the payoff of arbitrageurs in case of a fire-sale. Similar to the discussion above, if monetary policy is loose ($\widehat{r}$ is low), the first effect dominates, thus lowering the net payoff of arbitrageurs.

In contrast, asset managers benefit from both the less likely fire-sale and the higher assets returns. They also gain from the higher expected interest returns in case a fire-sale occurs (due to the higher r^*). Asset managers' payoff increases as a result.

Figure 3-9 illustrates the scenario. Arbitrage capital decreases in equilibrium.

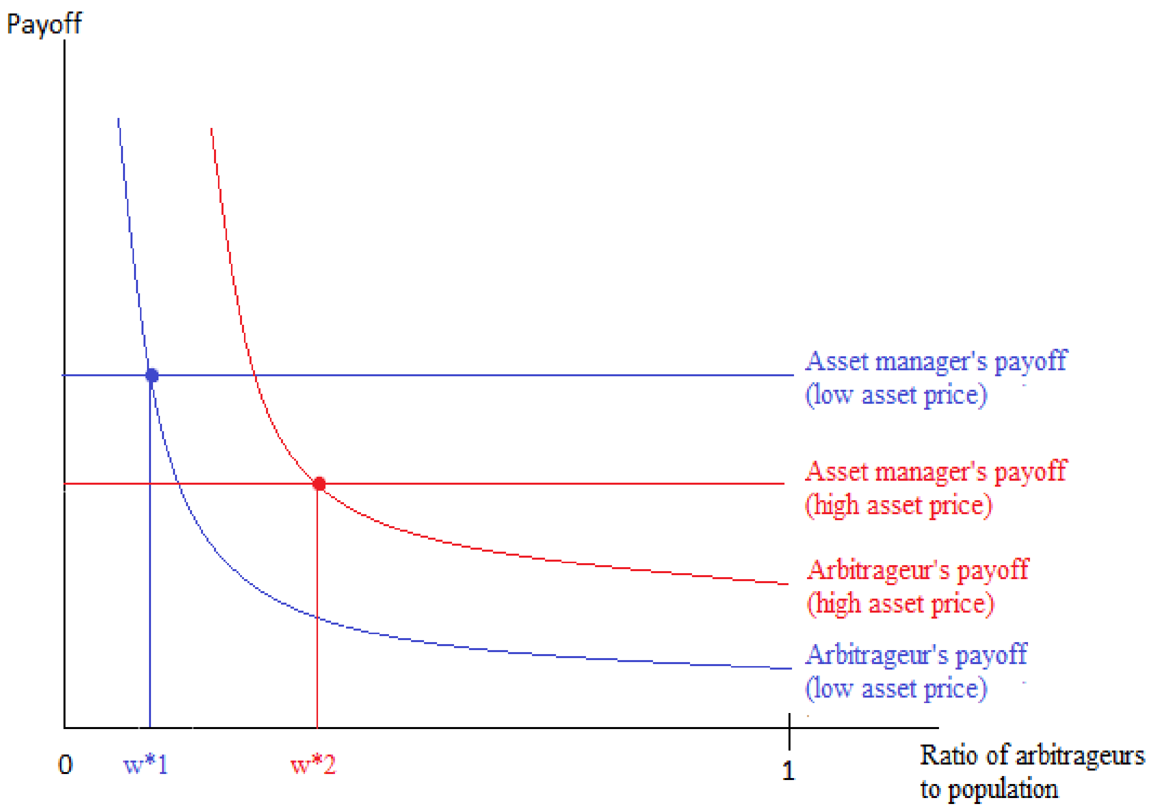


Figure 3-8: Effects of higher asset price (λ)

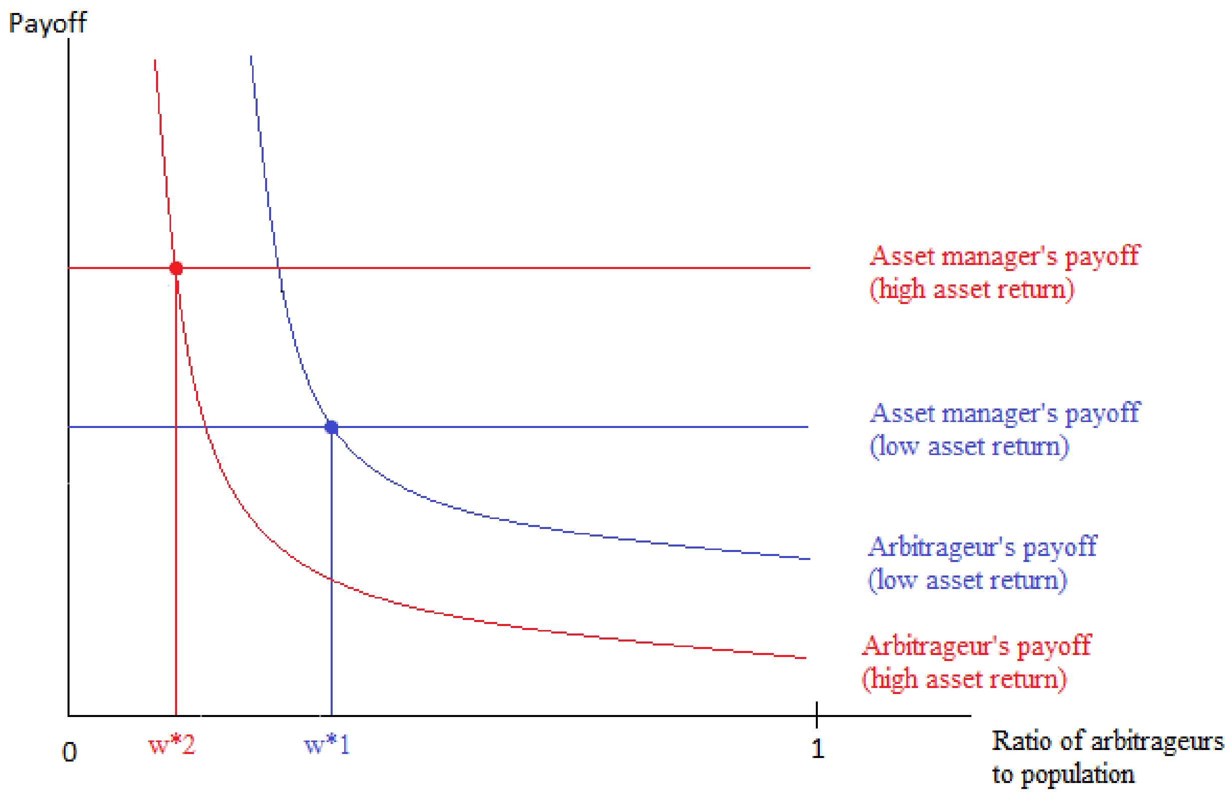


Figure 3-9: Effects of higher asset return (R)

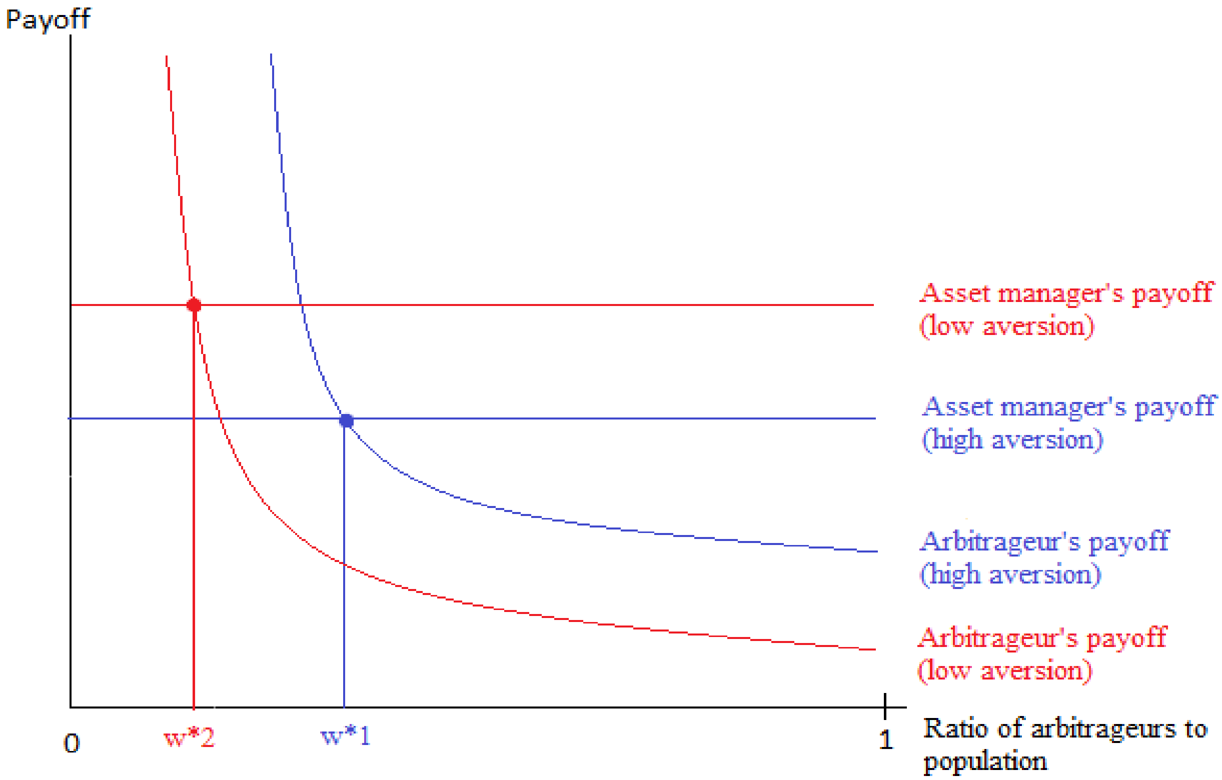


Figure 3-10: Effects of lower relative underperformance aversion (ϕ).

Lower investors' aversion (ϕ)

If investors are less inclined to withdraw from non-conforming funds, asset managers would be more willing to hold assets for any given magnitude of assets sale carried out by their peers; taken as a whole, all managers become less inclined to sell at any given interest rate – the threshold interest rate (r^*) increases, and a fire-sale becomes, self-fulfillingly, less likely to occur.

Arbitrageurs will be detrimented by the development, while asset managers will be benefited. Arbitrage capital decreases as a result, as figure 3-10 shows.

3.3 Related Literature

My Chapter has several points of contact with the literature.

First, my analysis is related to the literature on the "risk-taking channel of monetary policy", which studies how banks may be induced by loose monetary policy to take risks. According to this literature, when the risk-free rate decreases, banks as risk-neutral agents may shift their portfolio from risk-free to risky assets (De Nicolò et al., 2010), or banks may be misled into believing their capacity to take risks has increased (Adrian and Shin, 2010)[18]. Morris and Shin (2014) shift the attention of this literature to the asset management industry, exploring how even unlevered institutions may be induced into chasing yields when monetary policy is loose – and abruptly reverse their positions when policy tightens. My Chapter focuses not so much on the risk-taking impact of monetary policy, but on the inefficiency brought about by it.

Second, my Chapter touches on the question of whether the danger of firesales comes mostly from the manager's portfolio allocation decision, or from the strategic interaction among fund investors, who have incentives to withdraw from funds before others do when asset values are at risk of declining (Chen, Goldstein, and Jiang, 2010). Although I have motivated the Chapter by drawing on fund flows data of investors, my model is effectively one of a closed-end fund, since the manager is assumed to have a fixed amount of AUM.

To ascertain the relative importance of fund flows by end investors versus portfolio rebalancing by fund managers, IMF (2015) carries out an analysis that compares the variances of (1) changes in the return adjusted weights of each security in a fund's portfolio and (2) fund flows. The results indicate that for U.S.-domiciled funds, about 70 percent of the variance of funds' flows into assets is attributable to managers' decisions, with the

[18] Chapter 2 of thesis empirically tests whether US monetary policy affects global banks' risk-taking around the world.

remaining 30 percent attributable to end investors.

At the end of the day the answer matters, since different cases call for different policy responses. If the primary worry is AUM runs on the part of investors, one could at least impose exit fees on open-end funds that are related to the illiquidity of the funds' assets, in an effort to make departing investors more fully internalize the costs that they impose on those who stay behind. If, on the other hand, the primary worry comes from asset managers, then it is harder to see an obvious regulatory response[19]. In that case, monetary policy may need to assume a greater responsibility in managing financial stability risks.

Third, the use of global games to model firesales can be traced back to the bank run literature first described by Diamond and Dybvig (1983). The difference between the global games and the Diamond-Dybvig mechanism is that while the latter features multiple equilibria and conveys a sense of fragility, it has less to say about what underlying variable tips the scales toward a run-like equilibrium. Global games, by contrast, yield a clear prediction of when a run will be set off – in the present context, when short rates increase beyond a threshold level. Other work that applies global games in a bank-run setting includes Goldstein and Pauzner (2005), and Rochet and Vives (2004).

Fourth, my work is related to the debate on the "limits of arbitrage"[20] (Shleifer and Vishny, 1997). Two other papers, both empirical in nature, are similar in spirit to the current work. Giannetti and Kahraman (2014) test how redemption risks may hinder managers' incentives to trade against mispricing. They find that, among other results, closed-end funds purchase more stocks in a fire-sale than open-end funds do. Baker,

[19] In January 2014, the Financial Stability Board published a consultation paper which asked whether fund managers might need to be designated "systematically important financial institutions" or SIFIs, a step that would involve heavier regulation (Economist 2014).

[20] The idea that arbitrageurs wanting to buy assets at steep discounts may also face financing frictions due to principal-agent problems, thus entrenching fire-sale prices for a period of time.

Bradley, and Wurgler (2011) find that institutional investor's mandate to beat a fixed benchmark discourages arbitrage activity in a range of stocks.

Gromb and Vayanos (2010) survey the theoretical developments in the literature on the limits of arbitrage. Relative to this literature, the contribution of my Chapter is to focus on the ex ante capital allocation decisions of investors, and thereby explain the origins of the limited nature of arbitrage (and investment, which is the alternate use of funds in the model) as an equilibrium phenomenon. The welfare implications about arbitrage capital drawn in our model is consistent with Gorton and Huang (2004) who, in a portfolio choice model of firms, show that it is socially inefficient to hold large quantities of safe assets in order to avoid fire sales.

Fifth, the communication of monetary policy in this Chapter is imperfect, but the degree of imperfection is immaterial to our equilibrium outcomes. In practice, however, transparency of monetary policy communication is a subject of vigorous debate. On one hand, greater transparency is believed to increase central bank credibility and help anchor inflation expectations (Davis et al., 2014). On the other hand, too much transparency may stifle committee discussion, be welfare reducing and lead to market overreaction (Morris and Shin, 2002). In a Senate Banking Committee hearing in 1993, Alan Greenspan expressed such views:

"A considerable amount of free discussion and probing questioning by the participants of each other and of key FOMC staff members takes place. In the wide-ranging debate, new ideas are often tested, many of which are rejected... The prevailing views of many participants change as evidence and insights emerge. This process has proven to be a very effective procedure for gaining a consensus ... It could not function effectively if participants had to be concerned that their half-thought-through, but nonetheless potentially valuable, notions would soon be made public. I fear in such a situation the public record would be a sterile set of bland pronouncements scarcely capturing the necessary debates which are required of monetary policymaking." – Greenspan (1993), as reported in Meade and Stasavage (2008).

3.4 Conclusion

This Chapter highlights the interplay between asset managers and arbitrageurs in response to monetary policy announcements. Arbitrageurs' profits depend on the expectation of future crises, the probability of which is influenced by messages of the central bank. If it commits to a loose monetary policy, the likelihood of a fire-sale is remote, and no sensible agent stores arbitrage capital in advance. On the other hand, if the message conveys a contingency of future rate hikes, as the tapering talk in 2013 did, then it becomes plausible that asset managers, in their desire to keep pace with their peers, race to sell assets at the same time. A conceivable fire-sale, in turn, induces investors to store capital. To mitigate the shocks from exiting the low interest rate environment, the model suggests the central bank may retract its prior commitment to loose monetary policy in an unanticipated manner. The method is akin to a sudden abandonment of currency peg to minimise the loss of reserves. Assessing the practicality of such strategy requires a full benefit-cost analysis, which is beyond the scope of this Chapter.

From a welfare standpoint, although firesales can be cushioned by arbitrage capital, its storage foregoes profitable investments and invites inefficiency. To this end, my model suggests that a recovery in assets returns would naturally constrain the allocation of arbitrage capital. An introduction of redemption fees along the lines suggested by IMF (2015) may also dampen its storage. These impacts are contingent on the initial stance of monetary policy. As such, consistent with the views of Feroli et al. (2014) and Stein (2014b), my Chapter implies that there is no general separation principle for monetary and macroprudential policies.

My model has several limitations. It has not considered the relationship between the size of the asset management industry and risk premium, as Morris and Shin (2014) have. Also, the fire-sale in my model is represented by a constant discount of the assets values, which does not properly reflect the downward spiral in price during financial crashes. On the empirical front, my model offers concrete hypotheses for testing, such as a positive relation between monetary stance and arbitrage capital allocation, and a negative relation between arbitrage capital allocation and mutual funds investment. It would be meaningful to refine the model along the lines mentioned, and put it to the data in future.

Chapter 4

Financial Crises and Unemployment

4.1 Introduction

In August 2007, a crisis broke out in the international market for sale and repurchase agreement (repos)[1]. Securities brokers and dealers suddenly found that the collateral they had been pledging for funding was no longer acceptable. With banks relying on the repo market for almost half of their funding needs[2], the closure of the market led to a wave of bank failures in 2008 (Figure 4-1). Measured from peak to trough, the stock of bank credit to GDP had fallen by 7.4%, surpassing even the savings and loan crisis of the 1990s (Figure 4-2). The severity of the breakdown is illustrated by the testimony of Ben Bernanke, then chairman of the Federal Reserve, gave to the Financial Crisis Inquiry Commission (FCIC): "of 13 of the most important financial institutions in the United States, 12 were at risk of failure within a period of a week or two" (p.354 FCIC Report, 2011).

[1] This Chapter is based on material presented in the 4th NZ Macroeconomic Dynamics workshop, Wellington, 18 April 2014; the 54th Annual Conference of the New Zealand Association of Economists, Wellington, 3 - 5 July 2013; Econometric Society Australasian Meeting Conference, Hobart, 1 - 4 July 2014; and the Southern Workshop in Macroeconomics (SWIM), Auckland, 7 - 8 March 2014. The paper was also selected for presentation at the Australian Economics PhD Conference, Australian National University, 7 - 9 November 2013.

[2] Hördahl and King (2008)

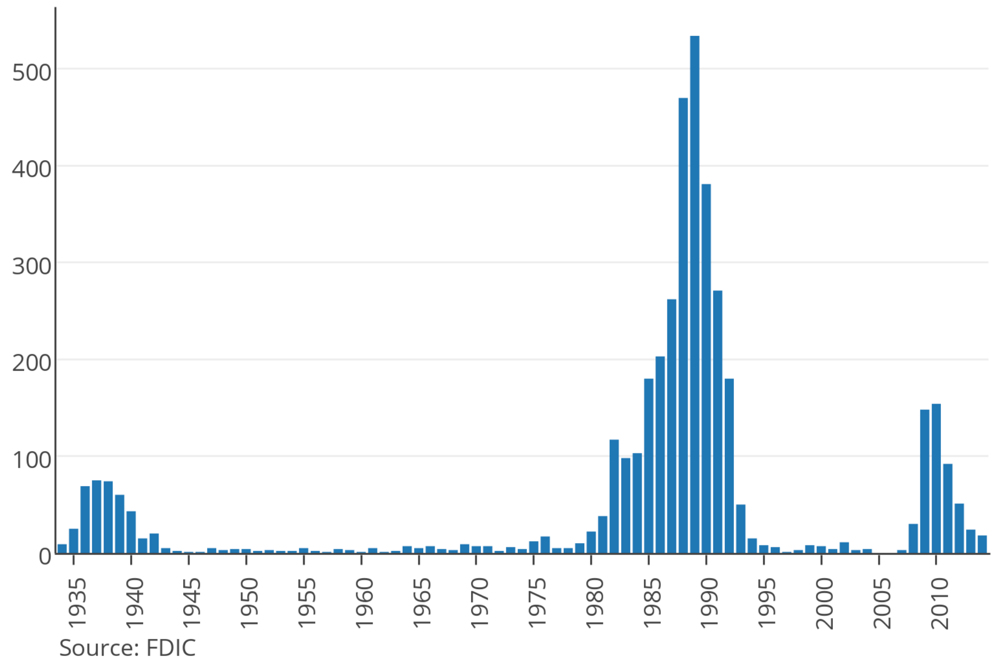


Figure 4-1: Number of bank failures in US

Four months later, the Great Recession ensued. The damage sustained in the US labour market during this period was the gravest since WWII. Job losses during this recession were larger than other recessions (Figure 4-3). The duration of job loss was also longer (Figure 4-4). In other recessions, it takes on average 20.5 weeks for an unemployed worker to regain employment. In the Great Recession, workers took more than 40 weeks to land a new job. Figure 4-5 illustrates the phenomenon.

Although the proximity of the collateral crisis and the subsequent employment loss suggest that the two events may be causally related, explanations of unemployment during the Great Recession have not put collateral at the centre of their analysis. Two explanations are typically offered. In the first, cyclical reasoning is cited. The decline in

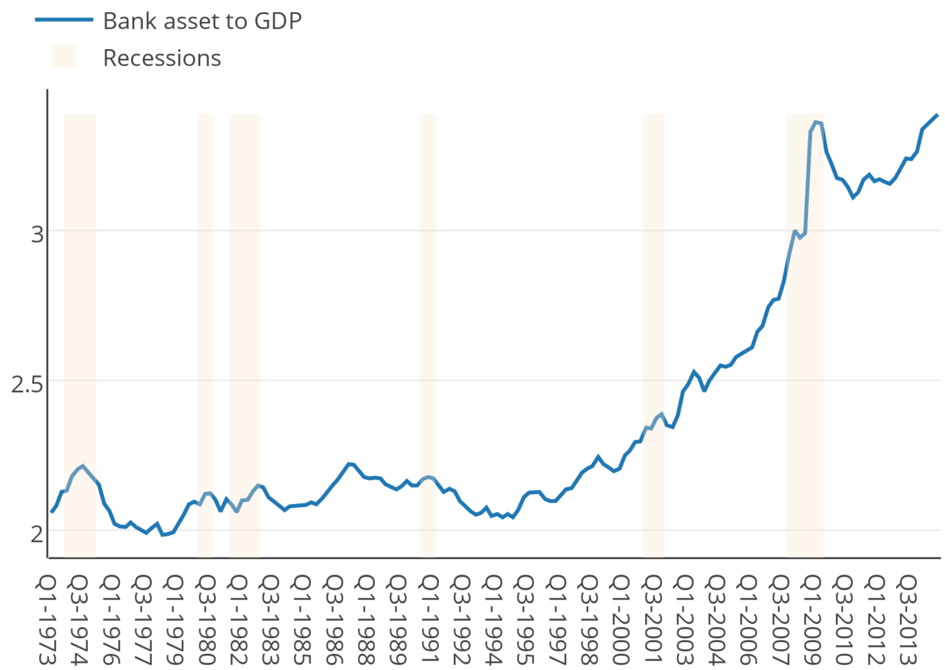


Figure 4-2: Bank asset to GDP ratio, US.

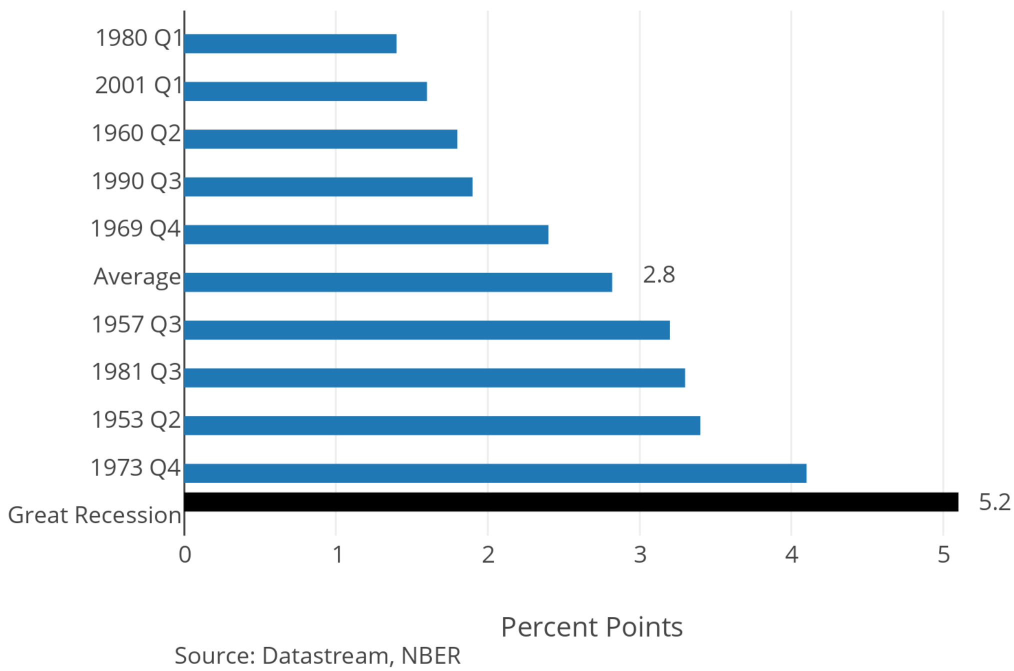


Figure 4-3: Trough to peak increase in unemployment rate, US recessions.

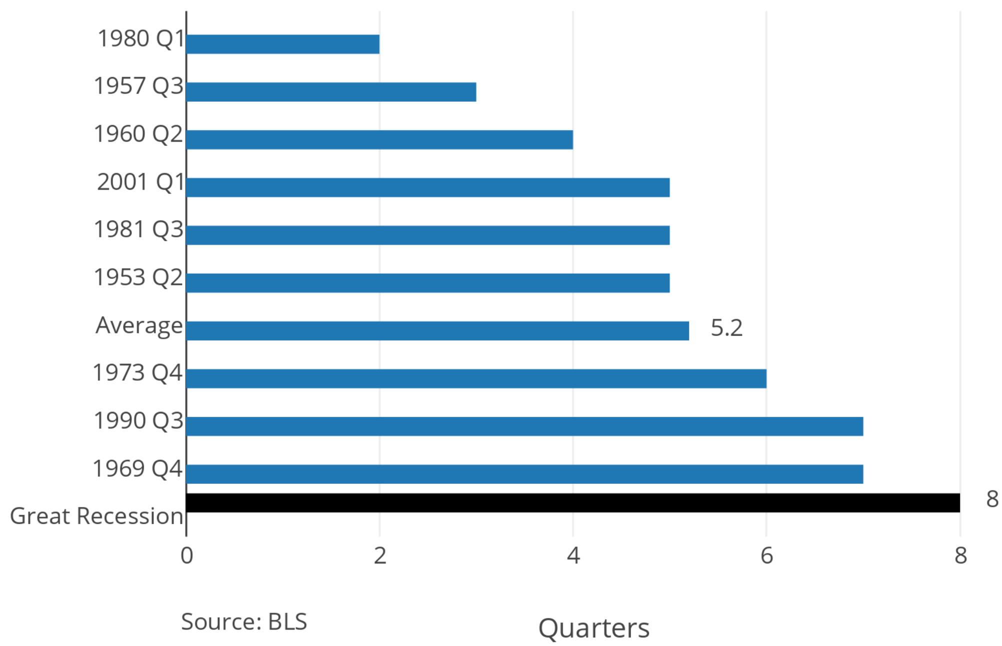


Figure 4-4: Duration of increase in unemployment, US recessions.

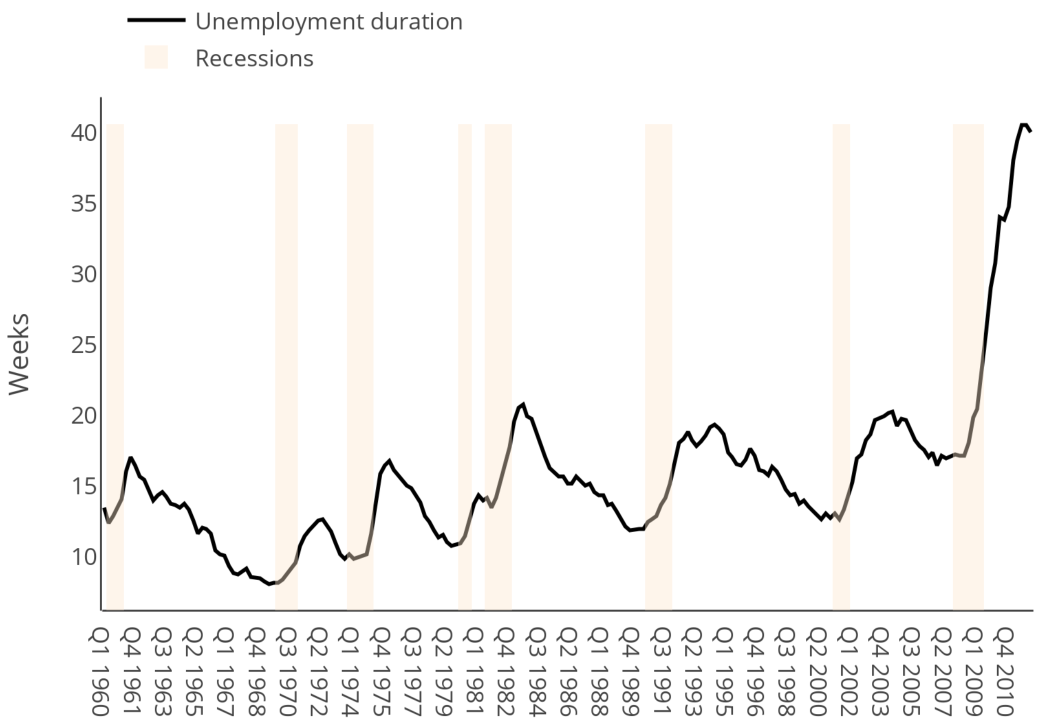


Figure 4-5: Unemployment duration, US.

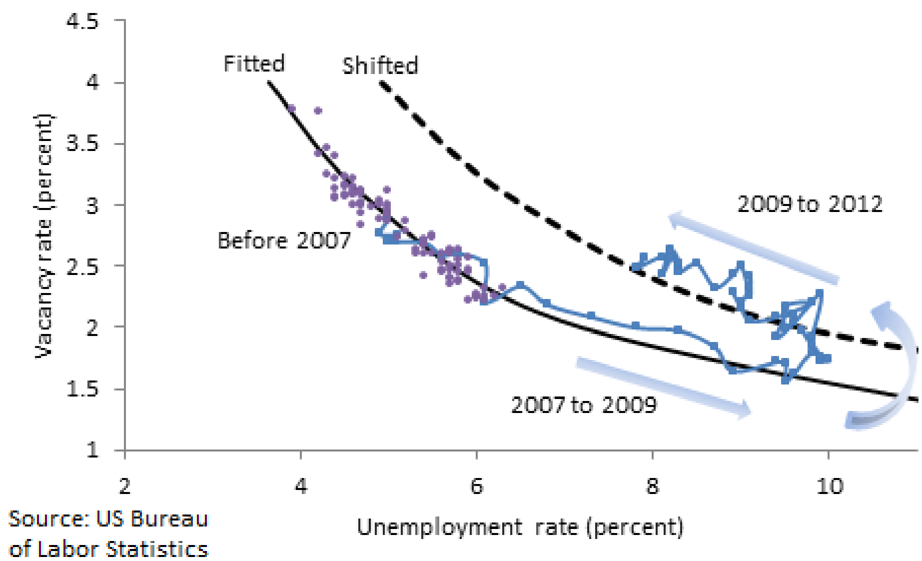


Figure 4-6: Beveridge Curve, US.

house price during 2007 reduced household's wealth and suppressed consumer demand, prompting firms to cut job vacancies (Mian and Sufi, 2014). In the second, structural factors are proposed – skills and geographical locations of job seekers mismatch with the job requirements (Kocherlakota, 2010). The Beveridge Curve, which plots job vacancies against unemployed workers, provides support for both hypotheses (Figure 4-6). Crudely put, a downward sloping curve reflects cyclical unemployment, while a shift of the curve, as observed after 2009, suggests structural unemployment.

Though not directly addressing unemployment, Gorton and Ordoñez (2014) is one of the first papers that describe the global financial crisis as a collateral shortage crisis. The authors depict the outbreak of collateral crisis as a point where agents switch from not producing information about the underlying collateral, to producing information about it. Information production deprives entrepreneurs who hold low quality collateral of funding, even when their business plans are otherwise viable. The switch accounts for the severity of the crisis. In their model, a crisis needs not be caused by a large shock –

even a small shock may trigger agents to produce information.

In this Chapter, I explore the links between breakdowns in collateral-based financial markets and unemployment. Specifically, I introduce the collateral framework of Gorton and Ordoñez (2014) into the search-theoretic labour market model of Wasmer and Weil (2004). In my model, firms pledge collateral to banks for funds needed to open job vacancies. The collateral pledged may be of "*good*" or "*bad*" quality. If banks could observe the underlying quality, they would only lend against *good* collateral. But collateral is opaque, and the quality of a particular piece of collateral is unknown unless checked upon. So it is possible that firms with *bad* collateral also get the funding required to hire and produce. Because the production plan is sound (benefits > costs), unmonitored lending maximises hiring and welfare.

The key insight of my model is the identification of a collateral quality threshold, below which banks turn from unmonitored to monitored lending. Banks produce information about the underlying collateral. Above the threshold, banks do not monitor even when the average quality of collateral deteriorates – they respond to the lower quality by raising the fraction of collateral pledged. As firms have spare collateral initially, they can fulfil the banks' requirement. Banks are content to lend without monitoring, and employment remains at the maximum level.

If the deterioration continues, however, eventually available collateral will be exhausted. At that point, banks have to resort to screening to ensure that their lending breaks-even, and firms with bad collateral will be deprived of the funding to hire.

The threshold allows us to define a collateral crisis in the model. It occurs when banks perceive that average collateral quality is too low (lower than threshold), and produce information accordingly. As information production is triggered only when a large portion of collateral in circulation is of low quality, it implies that, when a crisis does happen, many firms will be holding *bad* assets and be denied funding. The inference leads to the first finding of the Chapter, namely, a worsening in collateral quality needs not lower employment, but when it does, substantial losses ensue.

A second result of the Chapter is that a trade-off exists between the proximity of an economy towards a collateral crisis, and its severity. Proximity is defined by the position of the endogenised collateral threshold. The lower it is, the more depreciation in collateral value an economy can withstand without triggering information production. Following from the reasoning of the first result, a lower threshold implies a more severe, potential, crisis. Policies may affect the trade-off via their influence on banks' financing cost and bargaining power, but they cannot eliminate the trade-off.

The Chapter proceeds as follows. First, I present the model and the main results. Second, I present some stylised evidence in support of the analysis. I then place my findings in the broader context of the literature on financial frictions in macroeconomics. A final section concludes.

4.2 Model

4.2.1 Setting

Time is continuous. The economy is inhabited by three types of agents, each with unit mass – bankers with seed capital, penniless entrepreneurs, and penniless workers. All agents are risk neutral, with discount rate $r > 0$.

Capital and labour markets are imperfect and characterised by search frictions. In order to produce, the entrepreneur must first be matched with a banker, use capital to post a vacancy, and then search for a worker. Matching between a banker and an entrepreneur is described by a constant return-to-scale matching function, $m(\mathcal{B}, \mathcal{E})$, where $\mathcal{B}$ denotes the number of bankers looking for entrepreneurs, and $\mathcal{E}$ the entrepreneurs seeking finance. Let $\phi = \mathcal{E}/\mathcal{B}$ be a measure of credit market tightness from the perspective of the entrepreneur. The instantaneous probability that an entrepreneur will find a suitable banker is thus

$$\frac{m(\mathcal{B}, \mathcal{E})}{\mathcal{E}} = m\left(\phi^{-1}, 1\right) \equiv a(\phi).$$

Labour market matching follows a similar process. Job vacancies posted by firms, $\mathcal{V}$, and unemployed workers seeking for jobs, $\mathcal{U}$, are matched according to the constant returns-to-scale function $h(\mathcal{U}, \mathcal{V})$. Let $\theta = \mathcal{V}/\mathcal{U}$ be the labour market tightness from the perspective of the entrepreneur. Accordingly, the instantaneous probability that an entrepreneur finds a worker is

$$\frac{h(\mathcal{U}, \mathcal{V})}{\mathcal{V}} = h\left(\theta^{-1}, 1\right) \equiv \alpha(\theta).$$

Output is produced after the entrepreneur hires a worker. With probability q, flow output net of wages is y. With probability $(1-q)$, the project fails and yields nothing. I assume that the discounted expected output of the project exceeds financing and hiring costs, so that the net present value of the project is positive.

In addition to search frictions, there is moral hazard. Production is unverifiable, because the entrepreneurs can hide output from bankers. Bankers therefore require collateral to overcome the problem. To fix ideas, following Gorton and Ordoñez (2014), I assume that each entrepreneur is endowed with a piece of land, which is used as collateral. Land is either *good* with probability p, and enables a flow of C units of goods in the production stage. With probability $(1-p)$, land is *bad,* and does not yield output during the production stage. Agents only realise the true value in the production stage, and cannot observe it before then.

Upon meeting, the banker and entrepreneur agree on the fraction of land pledged as

	Bank	Firm
Stage 0	Raise fund and screen for a borrower	Search for a suitable lender
Stage 1	Receive collateral. Finance the matched firm.	Put down collateral in exchange for capital. Use the capital to start a business and search for a worker
Stage 2	Receive repayment from firm	Produce and repay the bank
Stage 3	Relationship with the firm ceases	Relationship with the bank and the worker ceases

Table 4-7: Stages of life of bank and entrepreneur.

	If bank receives:	Good collateral	Bad collateral
If firm's project:	Chances	p	(1-p)
Succeeds	q	xC	0
Failed	(1-q)	xC	0

Table 4-8: Payoff to the bank in stage 2.

collateral, x, and the repayment, R. If R is too high, so that $R > xC$, no entrepreneur will repay, and the banker receives pxc. If the banker sets $R = xC$, entrepreneurs with good collateral will be indifferent between repaying and defaulting, and so the banker also receives pxC in expectation. He will not set $R < xC$, for while all entrepreneurs with good collateral repay, the banker gets less than pxC. Thus, the banker always sets $R \geq xC$, and, without loss of generality, gets back pxC in expectation. Tables 4-7 and 4-8 summarise the stages of production, and the banker's payoff at each stage.

4.2.2 Lending without Monitoring

In the no monitoring regime, bankers lend freely to firms with all types of collateral.

The Value of a Bank

Following Wasmer and Weil (2004), let B_i be the value of a bank in each stage. The Bellman equations describing the evolution of bank values are as follows:

$$rB_0 = -b + \phi a(\phi)(B_1 - B_0) \quad (4.1)$$

$$rB_1 = -k + \alpha(\theta)(B_2 - B_1) \quad (4.2)$$

$$rB_2 = pxC + s(B_3 - B_2). \quad (4.3)$$

Equation (4.1) suggests that at stage 0, the bank incurs an opportunity cost b to search for a firm. The parameter b reflects the flow financial cost incurred by the bank until the firm is found. The instantaneous probability of finding a firm is $m(\mathcal{B}, \mathcal{E})/\mathcal{B} = \phi a(\phi)$. The instantaneous "return" of the bank in stage 0 thus consists of the cash outflow and an expected capital gain from evolving to the next stage.

Equation (4.2) implies that the bank pays out a flow k to finance the firm's posting of a job vacancy. Financing continues until the firm finds a worker, where $\alpha(\theta)$ is an instantaneous probability that the firm finds the worker.

In stage 2, the bank receives pxC until the job is destroyed (equation (4.3)). For simplicity, it is assumed that the destruction of the match between firm and worker occurs with probability s, and entails a loss of specificity of all matches, so that $B_3 = B_0$.

	If bank receives:	Good collateral	Bad collateral
If firm's project:	Chances	p	(1-p)
Succeeds	q	y+C-xC	y
Failed	(1-q)	C-xC	0

Table 4-9: Payoff to the entrepreneur in stage 2.

The Value of a Firm

Let E_i denote the expected steady-state value of a firm in each stage. The value of the firm evolves as follows:

$$rE_0 = -e + a(\phi)(E_1 - E_0) \tag{4.4}$$

$$rE_1 = \alpha(\theta)(E_2 - E_1) \tag{4.5}$$

$$rE_2 = qy - pxC + s(E_3 - E_2). \tag{4.6}$$

Equation (4.4) represents that the firm expends a flow cost, e, in searching for a banker. With probability $a(\phi)$, a banker will be found, and the firm moves on to the recruitment stage.

During recruitment, the firm is fully financed by the bank. With probability $\alpha(\theta)$, a worker is found, and the firm progresses to production (equation (4.5)).

In equation (4.6), $qy - pxC$ is an expected cash flow as viewed from stage 0. The actual income realised by the firm in stage 2 depends on the probability of the collateral is good, p, and the probability of project success, q. If the firm has bad collateral, it gets nothing if the project fails, but captures the entire output if the project is a success. On the other hand, if the firm has good collateral, the firm repays the bank, regardless of the project's outcome. Table 4-9 summarises the firm's payoff in the production stage.

As discussed, the match between firm and worker breaks with probability s, in which case $E_3 = E_0$.

4.2.3 Equilibrium

Assume that it is costless to set up a bank or a firm in stage 0. Free entry of bankers and entrepreneurs in stage 0 ensures that, in equilibrium:

$$B_0 = E_0 = 0. \tag{4.7}$$

Credit Market Tightness

Substituting the zero profit condition (4.7) into (4.1) and (4.4), one gets

$$B_1 = \frac{b}{\phi a\left(\phi\right)}, \tag{4.8}$$

and

$$E_1 = \frac{e}{a\left(\phi\right)}. \tag{4.9}$$

The inverse of the instantaneous probability is a duration measure, and equations (4.8) and (4.9) are the search cost that banks and firms incur at stage 0 before progressing to stage 1. I assume that the parties share the cost, as well as the expected surplus, from the partnership by use of the Nash Bargaining rule. Let $0 \leq \beta \leq 1$ be the bargaining power of the bank and $(1 - \beta)$ that of the firm, the cost borne, and the capital gain shared by the firm, would be $(1-\beta)/\beta$ times those shared by the bank, so that

$$\beta(E_1 - E_0) = (1-\beta)(B_1 - B_0). \tag{4.10}$$

Substituting the capitalised costs (equations (4.8), (4.9) and the free entry condition (4.7) into the bargaining equation (4.10), one can derive the equilibrium credit market tightness as

$$\phi^* = \frac{1-\beta}{\beta}\frac{b}{e}. \tag{4.11}$$

To see how equilibrium market tightness is attained in the credit market, consider an increase in banks' financing cost (b). Holding other factors constant, the Nash Bargaining rule requires that part of the bank's cost be passed to the entrepreneur. This is achieved by the withdrawal of some banks from the credit market, such that fewer banks are chasing entrepreneurs in equilibrium. A lower banks-firms ratio in turn implies a shorter duration for a banker to find an entrepreneur, and vice versa from the entrepreneur's perspective. As such, credit market tightens; $\phi^* = \mathcal{E}/\mathcal{B}$ rises.

Labour Market Tightness

Substituting $E_3 = E_0 = 0$ into equations (4.3) and (4.6),the stage 2 values of bank and firm are

$$B_2 = \frac{pxC}{r+s},$$

and

$$E_2 = \frac{qy - pxC}{r+s}.$$

Substituting these stage 2 values a further step backward, one can derive the stage 1 values of bank and firm, in terms of their discounted future payoff, as

$$B_1 = \frac{1}{r + \alpha(\theta)} \left[-k + \alpha(\theta) \frac{pxC}{r+s} \right], \tag{4.12}$$

and

$$E_1 = \frac{1}{r + \alpha(\theta)} \left[\alpha(\theta) \frac{qy - pxC}{r+s} \right]. \tag{4.13}$$

$B_1 + E_1$ is the total surplus generated from the match. The loan repayment (pxc) is just a redistribution of surplus, and is thus cancelled out. By Nash bargaining, banks and firms share β and $(1-\beta)$ of this surplus, so the discounted future values of a bank and firm at stage 1 can be written as

$$B_1 = \beta \frac{1}{r + \alpha(\theta)} \left[\alpha(\theta) \frac{qy}{r+s} - k \right],$$

and

$$E_1 = (1-\beta) \frac{1}{r + \alpha(\theta)} \left[\alpha(\theta) \frac{qy}{r+s} - k \right].$$

In equilibrium, the expected search costs incurred by banker and firm at stage 0 (equations (4.8) and (4.9)) must equate the expected benefits that will be derived from their matching (4.12 and 4.13). Thus, the equilibrium credit market tightness (ϕ^*) and labour market tightness (θ^*) are the solutions to the pair of equations

$$\begin{aligned} \frac{b}{\phi^* a(\phi^*)} &= \beta \frac{1}{r + \alpha(\theta^*)} \left[\alpha(\theta^*) \frac{qy}{r+s} - k \right] \\ \frac{e}{a(\phi^*)} &= (1-\beta) \frac{1}{r + \alpha(\theta^*)} \left[\alpha(\theta^*) \frac{qy}{r+s} - k \right] \end{aligned} \tag{4.14}$$

A simple example illustrates how ϕ^* and θ^* are determined in equilibrium. The left hand sides of the equations reflect costs to banker and entrepreneur, and the right hand sides their surplus. Suppose output (y) increases exogenously. Holding other factors constant, firms will be enticed into entering the market. Their entrance lowers the probability of firms' searching for workers, and lengthens the hiring duration. The adjustment continues until cost catches up with the increased surplus. The process of the adjustment results in more vacancies per worker, and hence a tighter labour market as viewed by entrepreneurs.

4.2.4 Monitored Lending

The analysis so far has closely followed the Wasmer and Weil (2004) framework. Even allowing for the possibility of collateral and default, the key insights of their model are unchanged if banks do not monitor. I therefore follow Gorton and Ordoñez (2014) and extend the analysis to consider a scenario in which banks screen, and lend only to high quality collateral. The introduction highlights how, on top of the original Wasmer and Weil elements, average collateral quality (p) matters to the labour market. There are three ways in which p exerts its influence.

First, p is inversely related to the equilibrium vacancies in the monitored lending regime. As average quality (p) declines, more firms will have to resort to the costlier method of self-financing. Thus, fewer vacancies will be posted.

Second, p influences the point at which banks switch from unmonitored to monitored lending. In an unmonitored regime, when p drops, banks respond by requesting more collateral to be pledged. If p continues to fall, eventually all pledgeable collateral will be exhausted, forcing banks to lend only against good collateral. In the following, I identify the threshold collateral quality (p_T), below which banks switch to monitoring.

Third, p_T also determines the magnitude of vacancy loss when banks switch to monitoring. By definition, $(1 - p_T)$ represents the number of firms holding bad collateral at monitoring. The lower is the endogenised value of p_T, the larger will be the loss in vacancies at the switching. This result provides for one explanation of the sharp drop in vacancies at the onset of the global financial crisis.

Labour Market Tightness in the presence of Monitoring

At the beginning of stage 1, banks screen and lend only to firms with good collateral. As there are only p good collateral holders, the financing cost of banks is reduced to pk at stage 1. Values of both the bank and the firm in stages 0 and 2 remain unchanged. As noted previously, entrepreneurs, like bankers, do not know the quality of collateral before monitoring.

When an entrepreneur is denied funding, he must bear a self-financing cost (δb) on top of the vacancy posting cost (k). It is assumed that $\delta > 1$, to reflect that firms have higher fund-raising costs than banks. The values of the bank and firm in stage 1 are denoted as $B_{1,m}$ and $E_{1,m}$, subscript m stands for "monitoring":

$$rB_{1,m} = -pk + \alpha(\theta)(B_{2,m} - B_{1,m}) \tag{4.15}$$

$$rE_{1,m} = -(1-p)(k + \delta b) + \alpha(\theta)(E_{2,m} - E_{1,m}) \tag{4.16}$$

The new labour market tightness (θ_m^*) is, thus, the solutions to the pair of equations

$$\frac{b}{\phi^* a(\phi^*)} = \beta(B_{1,m} + E_{1,m}), \tag{4.17}$$

and

$$\frac{e}{a\left(\phi^{*}\right)}=(1-\beta)\left(B_{1,m}+E_{1,m}\right),$$

where $(B_{1,m}+E_{1,m})$ is the total surplus that equals

$$\frac{1}{r+\alpha\left(\theta_{m}^{*}\right)}\left[\alpha\left(\theta_{m}^{*}\right)\frac{qy}{r+s}-k-(1-p)\,\delta b\right]. \tag{4.18}$$

Note that ϕ^{*} in the left hand sides of equation (4.17) is unsubscripted. Credit market tightness remains unchanged in both unmonitored and monitored regimes; its components – bank's cost in searching the firm (b), firm's cost in searching the bank (e), and their respective bargaining powers (β) – are unaffected by monitoring.

Compared to equation (4.14), the new term, $(1-p)\,\delta b$, highlights three differences between the two regimes.

First, while financing cost (b) only affects banks' searching for entrepreneurs in the unmonitored regime, it now also affects firms' recruitment in the monitored regime, as firms with bad collateral need to bear their self-financing cost, which is a function of banks' costs. This can be seen from the double entry of b in equations (4.17) and (4.18). As such, financing cost has a larger influence in the monitored regime.

Second, although screening per se is costless, it eventually hurts profits of banks. Screening inflicts costs on the entrepreneur, and as it is part of the bank-firm consortium that will generate the ultimate surplus, lower entrepreneurs' payoff translates to lower banks' profits.

Third, compared to the unmonitored regime, the monitored regime incurs a lower surplus while maintaining the same expected cost. In order to restore equilibrium, the expected cost has to come down. One way to achieve this is by having fewer vacancies, so that hiring duration could be shortened to reduce costs. The adjustment results in fewer vacancies in the monitored regime. $\theta_m^* < \theta^*$.

Loan Repayment and Collateral Crisis

Substituting in the discounted values of banks and firms (4.12 and 4.13) into the Nash bargaining condition (4.10), one obtains an equation that describes equilibrium loan repayment, and the amount of collateral required for its backing:

$$xpC = \beta qy + (1-\beta)\frac{r+s}{\alpha(\theta^*)}k \tag{4.19}$$

The right hand side of equation (4.19) is the repayment required by the bank for its contribution during the hiring stage (collateral demand). It is a sum of the bank's outlay during the hiring stage (second term), and the final output (first term)[3]. The left hand side of (4.19) is the average collateral value needed to back up the repayment. It consists of the fraction pledged (x), times the average value of one unit of collateral (pC).

If p starts to fall, banks can raise x to maintain the condition in equation (4.19). But since each household has at most one unit of land to pledge, there exists a threshold collateral quality (p_T), below which unconditional lending cannot be sustained, because the average value of collateral cannot fully support the collateral demand. We define this as the point when a *collateral crisis* takes hold.

Definition: A collateral crisis occurs when $x^* > 1$*, and threshold collateral quality* (p_T) *is a point below which* $x^* > 1$.

Figure 4-10 plots the equilibrium vacancy rates, θ^*, against the average collateral

[3] Output is, by definition, the higher of the two terms, and the bank is entitled to it because production could not be carried out without the bank's contribution. The larger is the bargaining power of the bank (β), the more it can tap into output.

quality, p. The maximum value of the x-axis is $p = 1$, representing that all units of collateral held by entrepreneurs are good. A leftward movement represents a decline in average quality.

The vacancy rate schedule comprises the equilibrium rates in the two regimes, as determined by equations (4.14) and (4.17). Equilibrium vacancies in the unmonitored regime is flat with respect to p. When banks do not monitor, entrepreneurs can obtain finance regardless of the quality of their collateral.

On the other hand, the vacancies schedule in the monitored regime slopes downward as p decreases. When banks monitor, a lower p indicates that a larger portion of collateral held by entrepreneurs are bad, hence leading to more of them being deprived of funding. The dotted part of the schedule shows the hypothetical vacancy rates if banks monitor above p_T. At $p = 1$, the two schedules merge, and diverge as p drops.

The figure illustrates how the labour market is influenced by collateral quality. At first, the labour market is robust to collateral deterioration. Then, fragility builds up as p drops from 1 to p_T, and vacancies drop abruptly from the schedule in the unmonitored regime to the curve in the monitored regime at $p = p_T$. At that point, the portion of entrepreneurs who have been able to borrow with bad collateral will be deprived of funding. The arrow depicts the magnitude of vacancies loss during the crisis.

The figure also highlights a trade-off between labour market fragility and the magnitude of a collateral crisis. Although a lower p_T means that full employment, supported by unmonitored lending, can be sustained over a lower range of collateral quality, it also means that the distance between the two regimes will be wider by the time p_T is breached, implying that the economy will experience a sharper fall in vacancies.

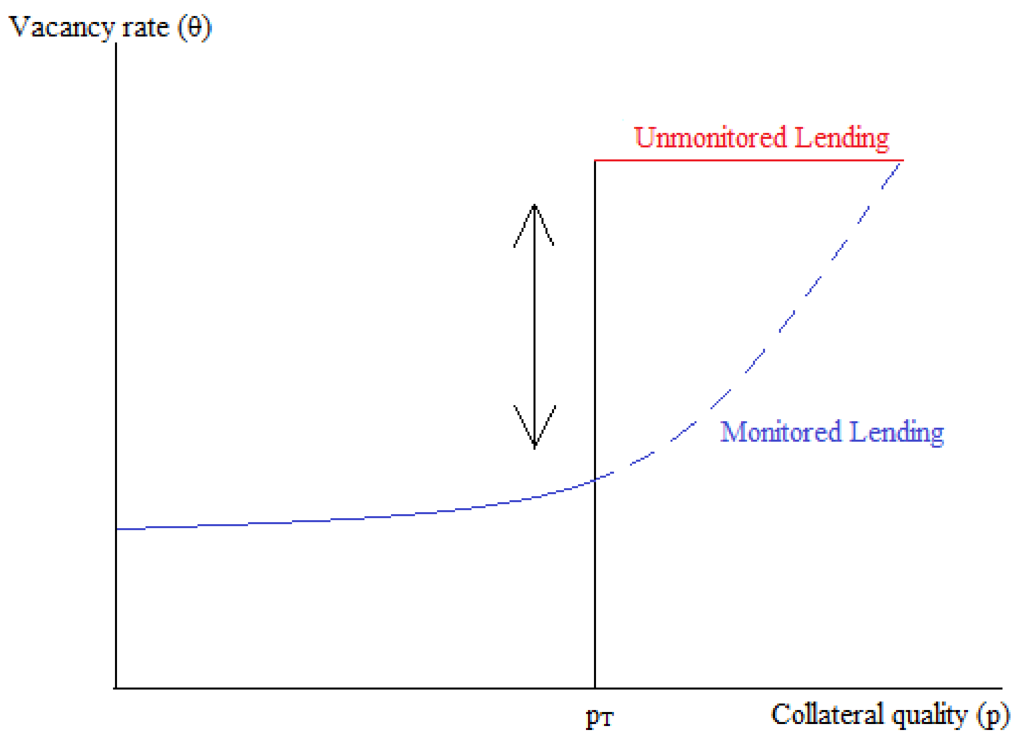


Figure 4-10: Equilibrium collateral quality and vacancy rate.

4.2.5 Comparative Statics

We now consider how vacancy rates and threshold collateral quality change in response to the exogenous parameters of the model.

Change in Bank Financing Cost (b)

Higher financing cost reduces vacancies for any given collateral quality. In the unmonitored regime, higher financing cost causes banks to quit the credit market, indirectly raising the cost of firms. In the monitored regime, higher financing cost adds to the burden of firms holding bad collateral. As discussed, the fall in θ_m^* is larger than that in θ^*, implying that an increase in financing cost magnifies the impact of a collateral crisis.

On the other hand, higher financing cost lowers p_T and makes a collateral crisis less likely. The reasoning is that for any given number of job seekers, fewer vacancies means that the hiring duration is shortened. The corresponding financing duration of banks is also shortened. Banks demand less repayment and collateral as a result.

In turn, lower p_T implies a more severe collateral crisis, because more firms will be holding bad collateral at the lower threshold.

Taken together, the impact of an increase in financing cost can be summarised as follows:

Proposition 5 *An increase in financing costs shortens the hiring duration and lowers the value of collateral demanded by banks. Firms that remain in the market are less likely to face a collateral shortage crisis. But should it occur, its magnitude will be larger for two reasons:*

(a) the θ_m^* schedule would drop by more than the θ^* for any increase in b; and

(b) a lower p_T implies that more firms will be holding bad collateral and be deprived of funding in a collateral crisis.

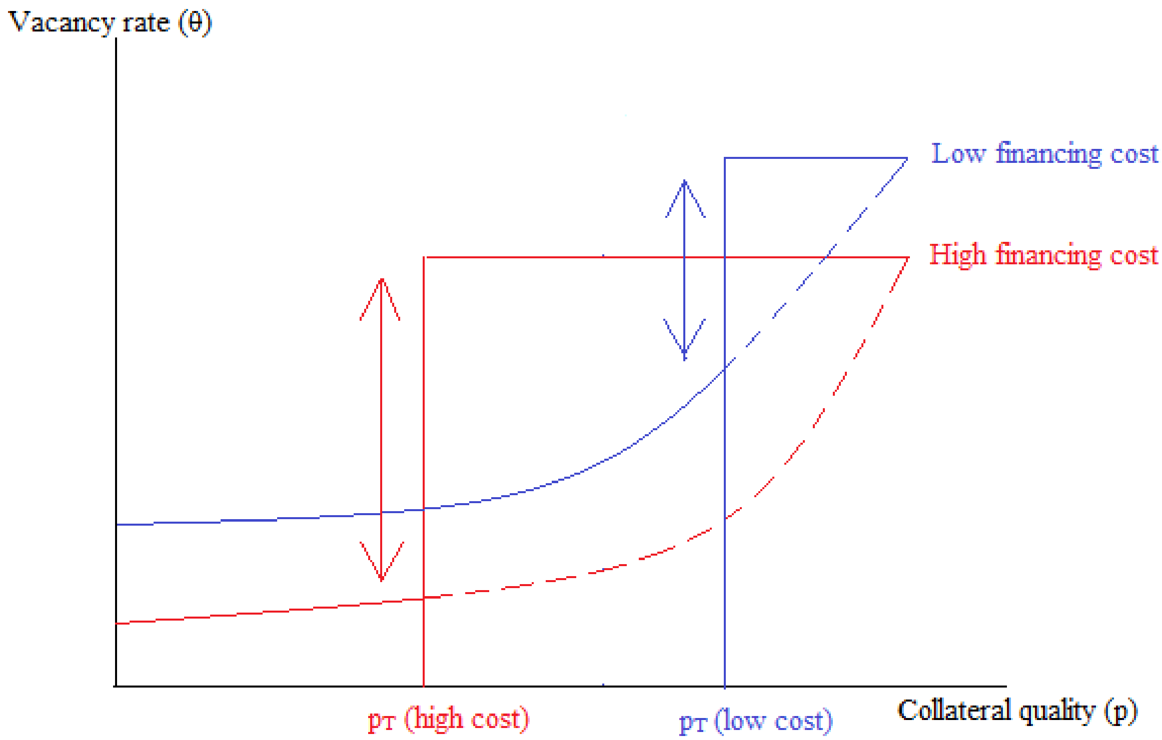


Figure 4-11: Financing costs and vacancy rate.

Figure 4-11 illustrates.

Change in output (y)

Lower output reduces the amount of collateral required by banks in two ways. First, lower output implies a smaller repayment that can be demanded by banks. Second, lower output reduces equilibrium vacancies, resulting in a shorter duration of banks' financing (and firms' hiring). As such, p_T shifts to the left, and a collateral crisis becomes less likely to occur.

Similar to the reasoning above, lower p_T implies a more severe collateral crisis, should one occur. As such, the impact of a decreased output can be summarised as

Proposition 6 *Decreasing output lowers loan repayment and hence, the amount of col-*

lateral required by banks. It also drives some firms out of the market, hence shortening the financing (hiring) duration for the remaining banks (firms). As a result, a collateral crisis becomes less likely, but its magnitude, should it occur, becomes more severe[4].

Change in bank bargaining power (β)

Suppose β decreases. On one hand, a firm receives more surplus from a vacancy, encouraging them to open more positions. On the other hand, lower β induces banks to exit the credit market, and lengthens the credit searching time of an entrepreneur. Which force dominates depends on the relative credit search cost (e) and the total surplus of a vacancy.

If the first force dominates and firms reduce vacancies as a result, then p_T shifts to the left. This is because (a) banks cannot demand as much repayment from output, the higher source of loan repayment; and (b) reduced vacancies shorten the financing duration of banks. On the other hand, if the second force dominates and firms open more vacancies in response to the reduction in β, then it is possible that the increased financing outlay of banks outweighs the decrease in collateral demand due to a weaker bank power.

Proposition 7 *When the bargaining power of banks decreases, firms would open more vacancies if the increased share in vacancy surplus outweighs the increased credit search cost for a banker. If credit search cost dominates and firms reduce vacancies, then* p_T *will decrease, resulting in a lower likelihood and larger magnitude of a collateral crisis. But if firms open more vacancies, then the opposite may happen, if*

(a) output is relatively small,

[4] Although both a decrease in output and an increase in financing cost reduce the likelihood of crisis (and increase its magnitude), it can be shown that impact of the latter dominates when banks' bargaining power is low, and when credit market matching is more sensitive to market tightness than labour market.

(b) financing cost is relatively large

(c) bank bargaining power is relatively low, or

(d) labour market matching w.r.t. tightness is relatively elastic.

Proof. See Appendix. ■

4.3 Some Supportive Evidence

The collateral crisis was centred in the repo market. A repo is a financial contract between two parties. At the initiating date of the contract, the seller sells a piece of collateral to the buyer, along with a promise that he (seller) will buy back the collateral at a higher price, on a later date. Because the duration of the contract is short, the transaction is akin to a short-term debt contract, in which the seller is the borrower, the initial price is the principal of the loan, and the repurchase price the gross repayment of the loan. As it is secured by collateral, the repo loans are considered attaining an equivalent level of security as that of commercial bank deposits, which are federally insured. The two differ, however, in terms of the scale of the participants. Depositors are individuals or retail companies, while repo buyers are pension funds, mutual funds, and institutional investors. Repo sellers are mostly securities brokers and dealers.

In the section, I present some stylised evidence in support of the model. The episode of 2007/9 can be described in 5 stages:

1. Growth of repo.

2. Outbreak of collateral crisis in housing related assets.

3. Transmission of collateral crisis to other asset classes.

4. Transmission of collateral crisis from wholesale to retail banks.

5. Transmission of collateral crisis from retail banks to firms.

4.3.1 Growth of Repo

The emergence of repo as a separate form of safe, short term credit, apart from commercial bank deposits, began in the early 1990s[5]. On the demand side, pension funds, mutual funds, and multinational firms accumulated abundant cash beyond the limit ($500 million) covered by the federal deposit insurance, and repo loans, secured by collateral, provided an alternative destination for deposits. On the supply side, since the deregulations, banks faced increased competitions from money market mutual funds in raising funds, and repo provided an extra source of funding. Banks also manufactured new collateral and sold them off. Known as securitization, the process fulfilled the demand for collateral and provided extra revenues to banks.

The size of the repo market is estimated at roughly $10 trillion on the eve of the crisis, (Singh and Aitken, 2010; Hördahl and King, 2008), which is about the same size as the regulated US banking sector (Gorton, 2009). In Figure 4-12, I plot the ratio of the assets of broker-dealers to those of commercial banks. In early 2008, assets held by the former amounted to forty percent of the latter. To finance these assets, broker-dealers had issued up to three trillion dollars' worth of repo contracts (Figure 4-13). And broker-dealers are but one, albeit major, type of repo sellers; the overall loans issued by all repo sellers would be larger. On the buyers' side, a report of the Money Market Working Group (2009) estimated that the repo assets held by Money Market Mutual funds, one type of lenders in the repo market, amounted to $552 billion in December 2008.

[5] The earliest form of collateralised lending can be found in pawn brokering in the Tang dynasty in China (around 650 A.D.), as described in the book "On the Origins of Wealth," by William Goetzmann and Geert Rouwenhorst (2005, pp 54-64).

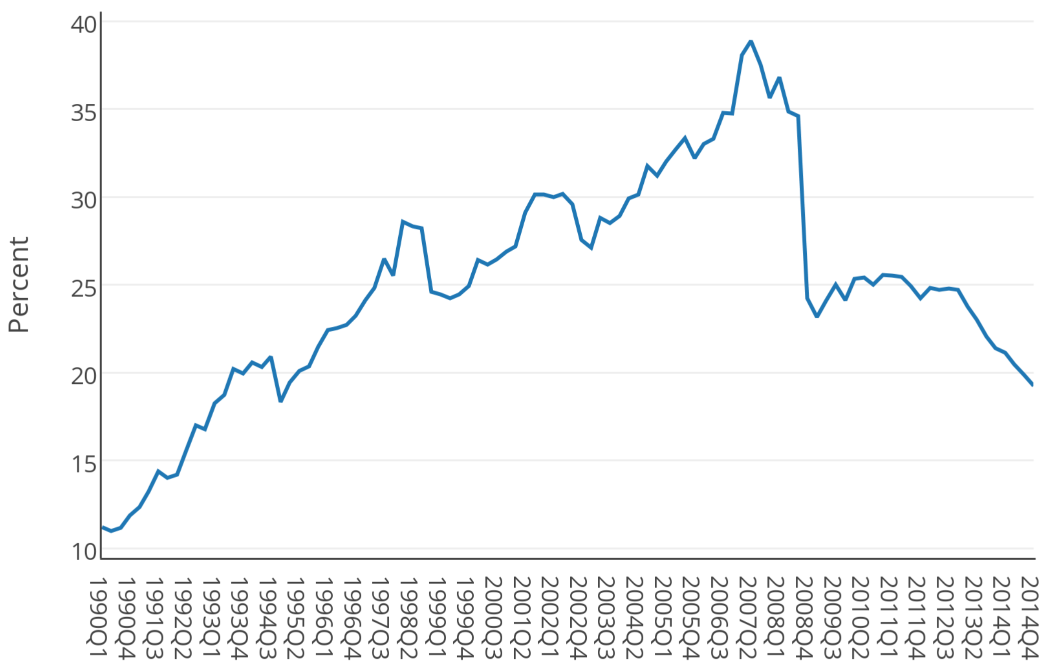


Figure 4-12: Ratio of securities brokers-dealers'assets to commercial banks'assets, US.

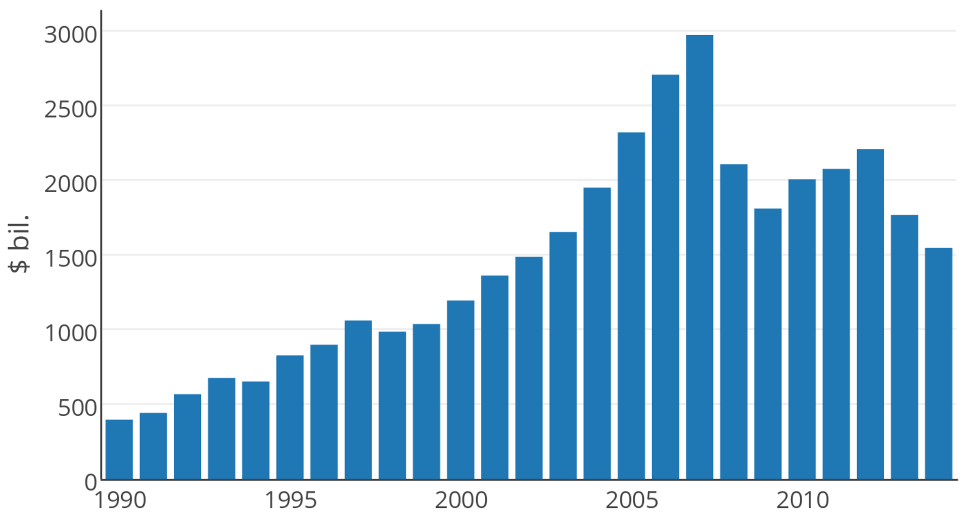


Figure 4-13: Repo liabilities held by US securities broker-dealers.

Date	Event
February 2007	The Federal Home Loan Mortgage Corporation (Freddie Mac) announces that it will no longer buy the most risky subprime mortgages and mortgage-related securities.
April 2007	New Century Financial Corporation, a leading subprime mortgage lender, files for Chapter 11 bankruptcy protection.
June 2007	Bear Stearns suspends redemptions from its High-Grade Structured Credit Strategies Enhanced Leverage Fund.
July 2007	Bear Stearns liquidates two hedge funds that invested in various types of mortgage-backed securities.
August 2007	BNP Paribas, France's largest bank, halts redemptions on three investment funds.

Table 4-14: Selection of housing-related news, April - Septermber 2007.

4.3.2 Outbreak of Collateral Crisis in the Housing Market

By 2006, the fifteen years of uninterrupted growth in house price in US came to an end (Figure 4-15). At first, the repo market remained calm, as shown from the flat repo "haircut" ratio between January and September of 2007 in Figure 4-16. A haircut ratio is the difference between the collateral's worth and the repo loan amount. An increase means that lenders are willing to grant less loan to the borrowers for any given collateral pledged. As shown in the Figure, the ratio began to rise in September 2007. From the perspective of the model in this Chapter, the period before September represents an "information-insensitive" regime, where fundamental, average collateral quality had been worsening, but hadn't reached the point that would trigger information production. During this period, repo lenders continued to accept housing-related derivative products as collateral[6], despite their doubts gradually fuelled by bad news arriving the market day by day. Table 4-14 documents some of these instances between April and September 2007.

[6] Subprime residential mortgage-backed securities (RMBS).

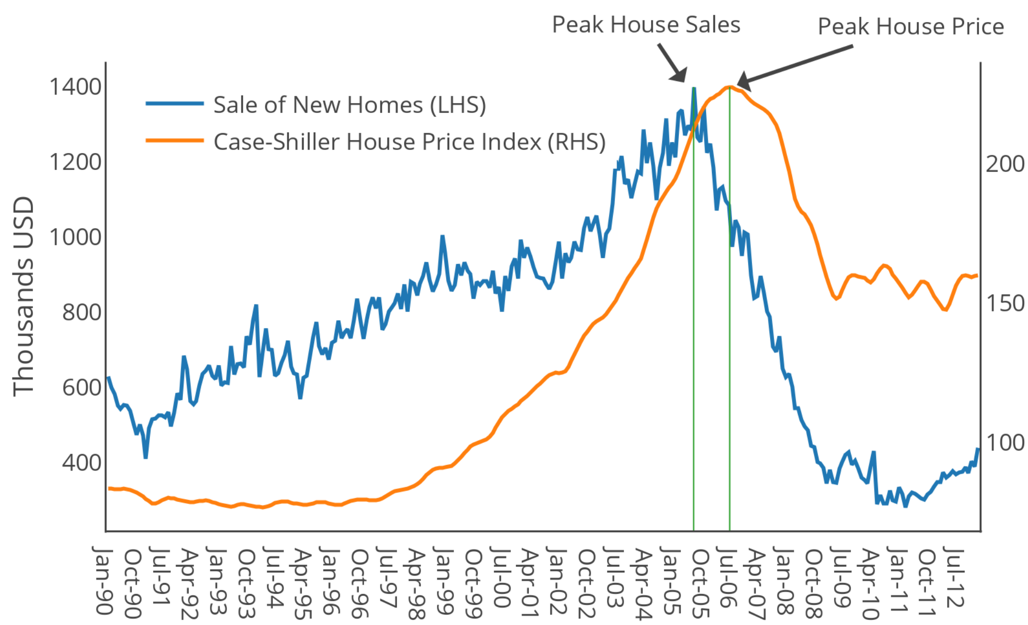


Figure 4-15: House sales and price, US.

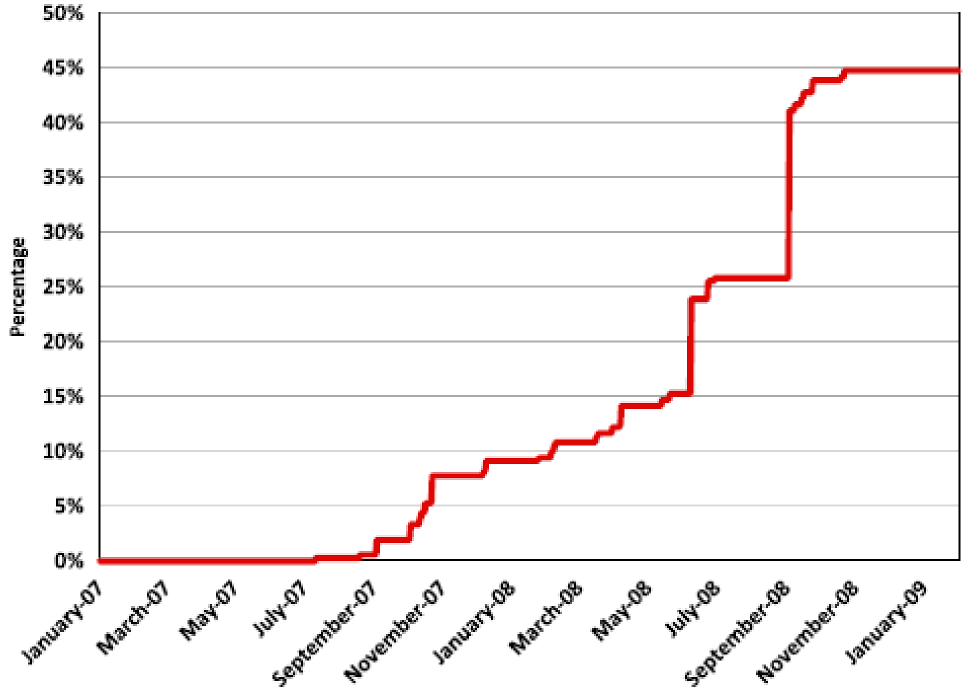


Figure 4-16: Average repo haircut on structured debt (Gorton and Metrick, 2009).

4.3.3 Transmission of Crisis (1): from Housing to Other Asset Classes

If we consider September 2007 be the date when housing-related derivatives were rejected as valid collateral[7], it took approximately one year for the sentiment to spread to other asset classes, such as credit card receivables, auto loans, and student loans. . Gorton and Metrick (2009) document the episode, which I reproduce below (Figure 4-17). The figure plots the ABX index, a credit derivative that tracks the risks of 20 equally weighted RMBS, and the LIBOR-OIS spread, a measure of the counterparty risk in the banking system. While the RMBS as a collateral class had gradually worsened since early 2008, as reflected in the rise of the ABX index from 3,812 to 6,721 basis points (bps) between

[7]September 2007 is the month when Lehman Brothers failed to rollover its short-term liability and went bankrupt. Using the Andrews (2003) test, Bekaert et al. (2014) find that the null hypothesis of no breakpoint in August 2007 is rejected at the 1% significance level.

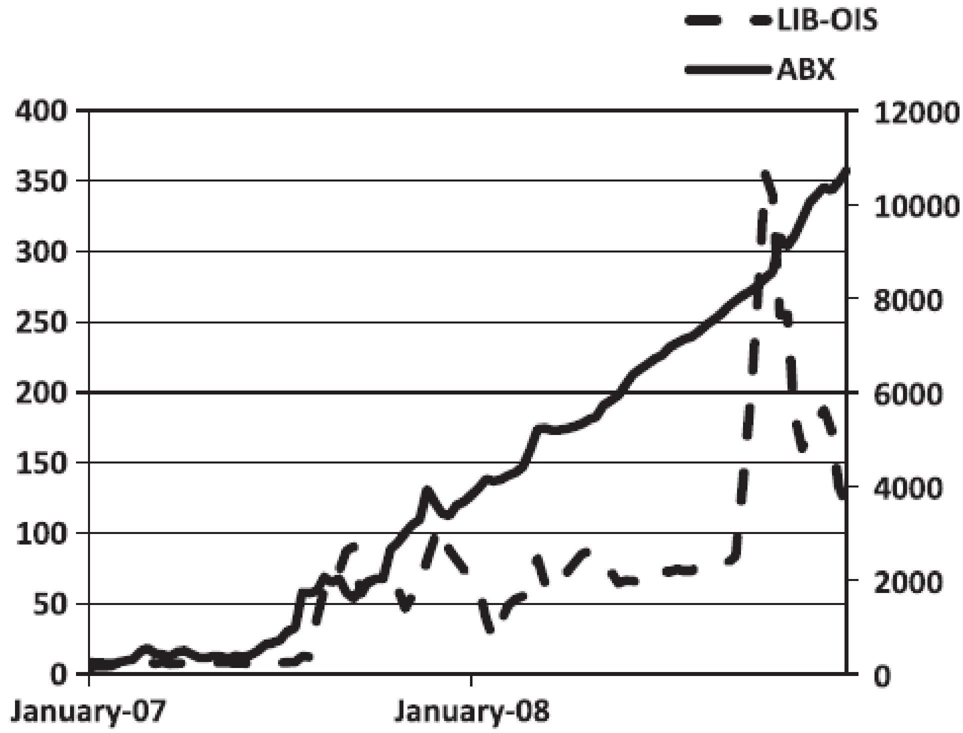


Figure 4-17: LIBOR-OIS spread (left scale) and ABX index (right scale) (Gorton and Metrick, 2009).

January and June, it was not until September that the LIBOR-OIS spread spiked from its steady band between 30 and 90 bps to a record of 100 bps on 15th September, before peaking at 364 bps on 10th October. The authors later verify that the LIBOR-OIS spread was strongly correlated with credit spreads of bonds securitised with other asset classes. From the perspective of my model, information production spread from housing collateral to other asset classes. Even if these asset classes were not tainted by the fall in house price, the production of information exposed the low quality loans out of the general pool, invalidating their status as collateral.

4.3.4 Transmission of Crisis (2): from Wholesale to Retail Credit Market

Evidence exists that wholesale banks passed their funding pressure in the repo market downward to retail banks, which eventually tightened credit to firms. Figure 4-18 is drawn from the response to a survey question conducted by the Federal Reserve[8]. The question is directed to eighty large domestic banks in US and twenty-four branches and agencies of foreign banks. It asks whether they have tightened credit to firms as compared to the previous quarter. The value in the figure, known as net percentage, shows the difference between banks who answer affirmatively and negatively. A rise represents that as compared to the previous quarter, more banks have tightened credit to firms. The figure shows that more banks had tightened credit between 2007 and 2010.

The survey is followed up by another question. It asks banks who have tightened credit, the reason of doing so. Figure 4-19 shows that between 2007 and 2010, 12% of the banks claimed that they tightened credit due to decreased liquidity in the secondary loan market. Another 5% quoted liquidity positions as a concern. These responses reflect doubts of retail banks in securing liquidity from the wholesale banks. The 19% who quoted industry-specific problems may also have alluded to the collateral crisis.

Figure 4-20 presents a similar survey carried out by the Bank of England. The survey asks UK banks whether tightening credit in the wholesale market has contributed to their tightening towards firms. A negative number represents an affirmative answer. As can be seen, between 2007 and 2009, more banks have reported that pressure in the wholesale market was contributive to their tightening towards firms.

[8]Federal Reserve Survey on Bank Lending Practices.

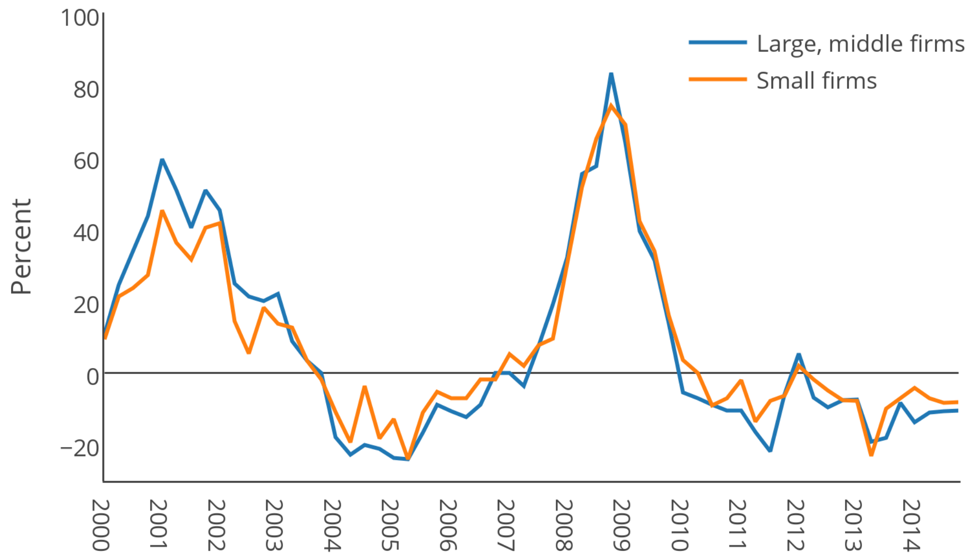


Figure 4-18: Net percentage of domestic banks tightening standards for Commercial and Industrial loans.

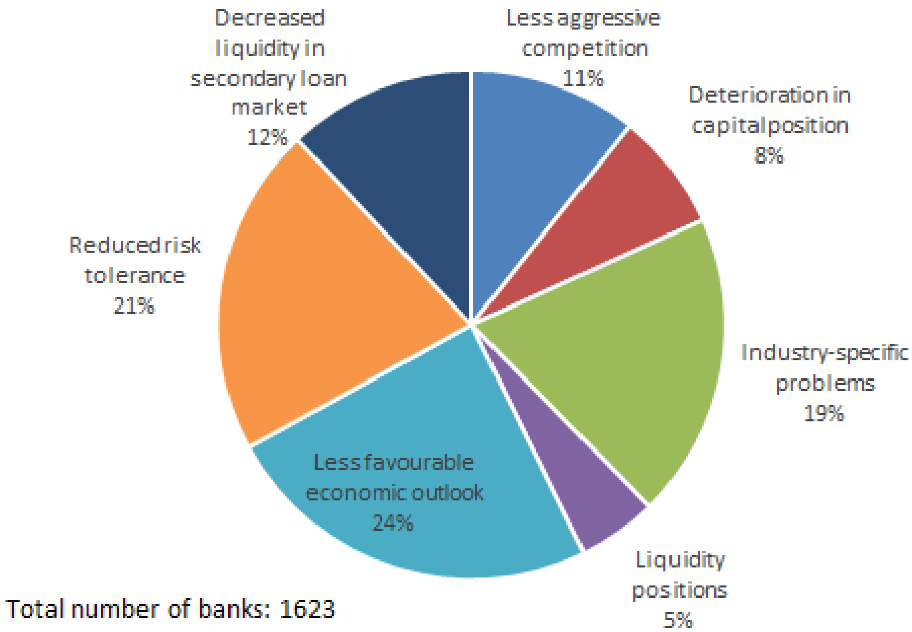


Figure 4-19: Reasons for tightening credit to firms, 2007 - 2010, US.

4.3.5 Transmission of Crisis (3): from Retail Banks to Job Vacancies

Campello, Graham, and Harvey (2010) survey 1,050 Chief Financial Officers (CFOs) in US, Europe, and Asia to assess whether credit constraints during the Global Financial Crisis has affected their firms' spending plans[9]. The authors find that, compared to unconstrained firms, constrained firms planned deeper cuts in tech spending, employment, and capital spending. Conditional on a variety of factors, as of 2008, financially constrained firms retired 8.2% more labours than unconstrained firms.

To supplement their findings, I have compiled a separate study on the relationship between retail credit and job vacancies. What makes my study different is my use of a data series that tracks commercial banks' credit tightening due to increased risk on

[9] Popov and Rocholl (2015) and Duygan-Bump et al. (2015) also find that credit constraints lower job vacancies.

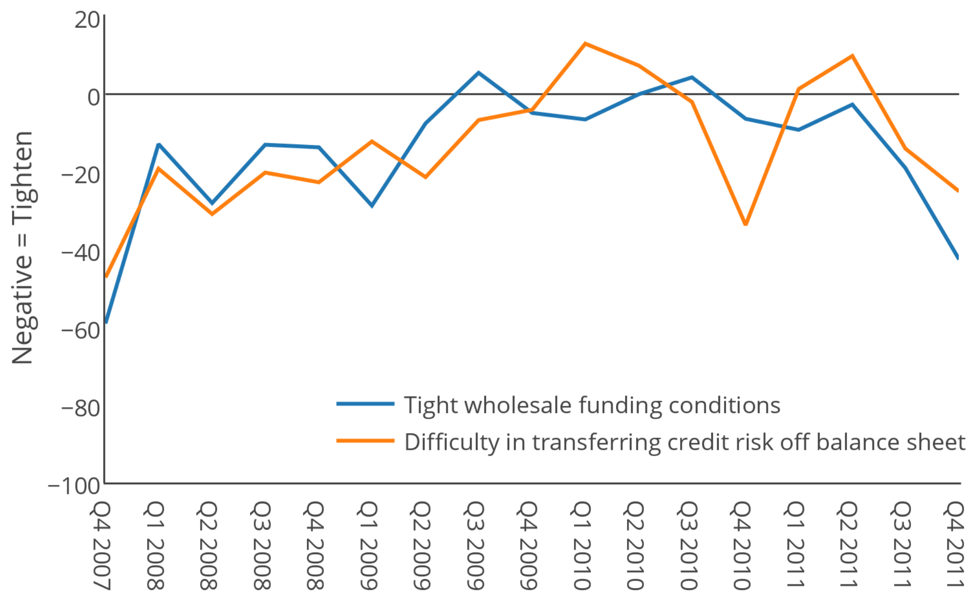


Figure 4-20: Reasons of tightening credit to firms, UK.

collateral pledged. The negative relationship between this credit tightening series and job vacancies, to be shown below, suggests that information production on collateral also happened at the retail level between commercial banks and firms.

Regression Analysis: Retail Credit Tightening and Job Vacancies

This section illustrates the causal relation between collateral quality and job vacancies. The variable of interest is obtained from a quarterly credit condition survey carried out by the European Central Bank (ECB) since 2003 Q1. In the survey, the ECB asks a representative sample of banks whether they have tightened credit standard on enterprises over the past three months, and if so, why. Ten options are available to be chosen by the banks (see Appendix for all options), and one in particular is credit tightening due to an increased risk on collateral demanded. Response is presented as a net percentage change. It is the difference between the share of banks reporting that credit standards have been tightened and the share reporting eased. To the extent that banks do not systematically misreport, a positive reading indicates that a larger proportion of banks has tightened credit standards towards firms, because of *a perceived increase in collateral risk* [10].

The sample covers four Euro Area countries – Spain, Portugal, the Netherlands, and Luxembourg – over the period from 2003Q1 to 2013Q3. The choice of countries was made so as to maximise the number of observations of the panel[11]. As of 2013Q3, there were 132 banks participating in the survey, and the response rate was 99%. Panels (a) to (f) of figure 4-21 plot the collateral-credit tightening series with the job vacancy rate series for the four countries plus US and Euro Area as a whole[12].

[10] That ECB is a supervisory authority of banks may also lessen the potential for intentional misreporting.

[11] These four countries, together with Germany and Italy, are the only six countries whose credit tightening data begin at 2003 in the ECB database. Most other countries have their data's starting date at 2007 Q2. Germany and Italy are not included because their job vacancy rate data, our key dependent variable in the regression, are unavailable.

[12] Collateral-credit tightening of US is drawn from the response of a similar survey question from the

4.3.6 Hypothesis and Empirical Strategy

The hypothesis is that increased collateral risk will tighten credit and in turn lower job vacancies. The basic empirical specification is formulated as follows,

$$VR_{c,t} = \gamma_0 + \gamma_1 \times CC_{c,t-1} + \gamma_2 \times X_{c,t-1} + \varepsilon_{c,t}$$

where $VR_{c,t}$ is the job vacancy rate in country c for period t, $CC_{c,t-1}$ is net credit tightening due to increased collateral risk, $X_{c,t-1}$ is a matrix of control variables inspired by the equilibrium vacancy rate equation (equation 4.14 above), and $\varepsilon_{c,t}$ is the error term. γ_0, γ_1, and γ_2 are slope coefficients. The standard errors are adjusted to control for clustering at the country level. Because CC is lagged by one period, the hypothesis is that CC causes a drop in vacancies.

The primary benefit of using the survey series is that it readily separates credit supply from demand since, in practice, their interrelation is hard to observe or measure via market based variables. The regression above may also be compromised if CC is endogenous or if there are omitted variables (i.e. the possibility that $cov(VR, \varepsilon) \neq 0$). Two approaches are deployed to tackle this potential complication. First, theory-inspired control variables, together with constant state and time factors, are added to capture as much of the error term as possible. Second, in addition to the benchmark regression, an instrument variable is used to capture the exogenous movements of CC. Credit tightening

Federal Reserve Bank Lending Survey. US data is however not included in the regression for the sake of data consistency. In any case, the negative correlation seems to be the strongest in US among the six panels, so by omitting US data we are erring on the side of caution.

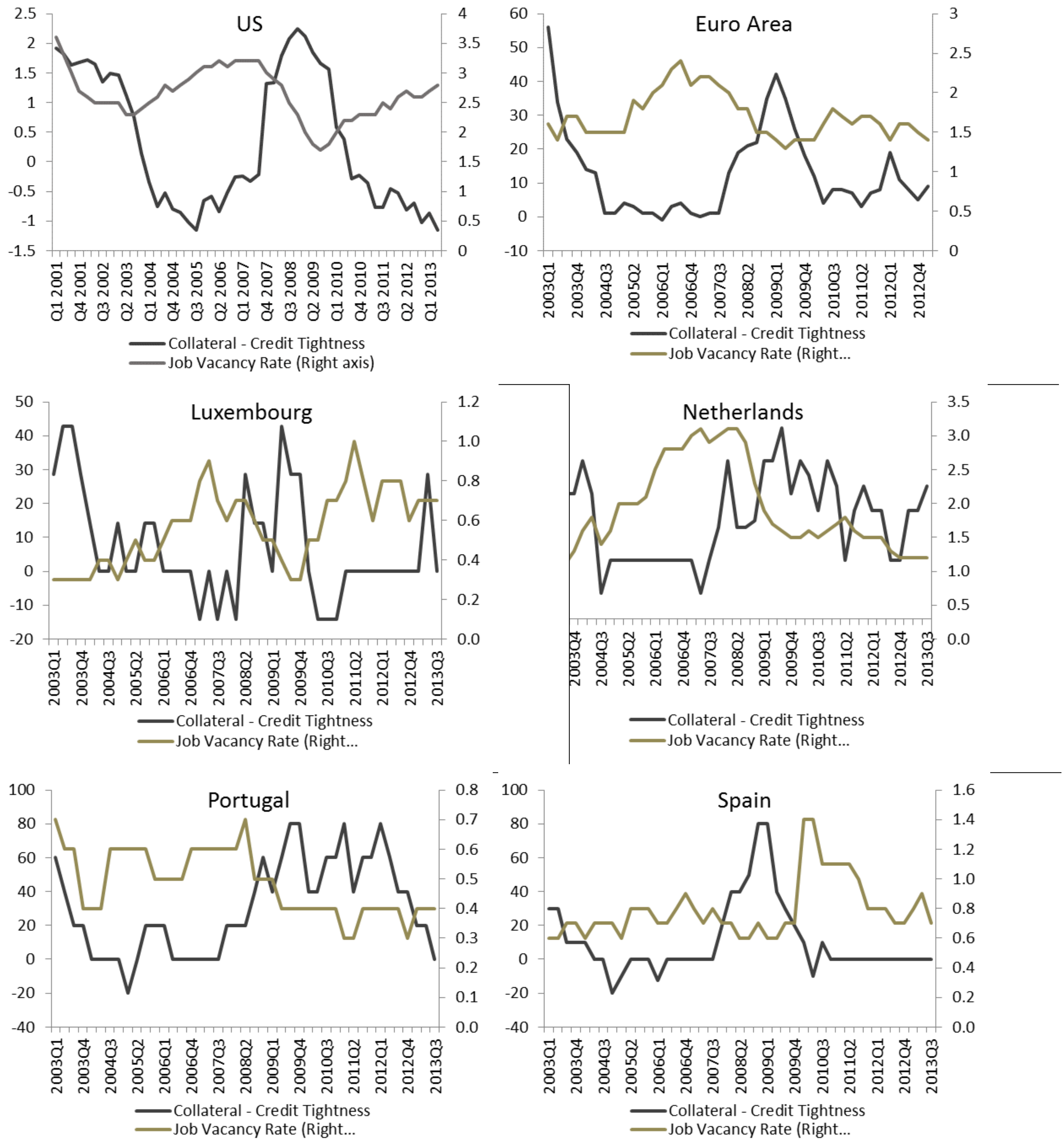


Figure 4-21: Collateral credit tightness and job vacancies, US and Europe.

in each country is instrumented by the average credit standard of all countries within the Euro area. To the extent that credit conditions around the world are sufficiently interrelated while labour market is more localised and is only affected by a country's own credit condition, the two assumptions required of a valid instrument – relevance and exogeneity – are fulfilled.

Other control variables include output per worker, real output, the start-up cost of a business, and the bank deposit rate. The first two are the empirical counterparts of the variable y in the theoretical model of section 4.2. Since agents are of mass 1 in the theory, both can be considered to represent y. Business start up cost is measured as a percentage of Gross National Income by the World Bank. It captures all related costs that need to be made before a worker can be employed to produce, and so approximate the recruiting cost (k) used in the model below, while the deposit rate relates to the cost of finance of the banks (b).

In addition, state and time fixed effects are added to the benchmark regression. The former controls for factors that differ across countries but constant over time, and the latter constant across countries but varies over time.

4.3.7 Results

Table 4-22 presents the results. There are several points to note. Firstly, state effects account for a significant portion of vacancy rate variations. Models (I) and (II) in table 4-22 differ only in the inclusion of state effects in the latter model, but the difference in adjusted R^2 is marked: it increases from 0 in (I) to 0.77 in (II). Secondly, the impact of credit tightening due to collateral risk is significant. The benchmark regression shows that a one unit increase in credit tightening due to collateral risk is associated with a 0.6 percentage point drop in job vacancy rate. Adjusted R^2 also rises by 6 percentage points between (II) and (III). The explanatory power of collateral risk persists even after other variables are controlled for in models (IV) to (VI).

Other explanatory variables also turn up with the expected signs. For example, an increase in financing cost, as proxied by the log of deposit rates, leads to lower vacancy rate in model (V), and a 1% increase in productivity leads to an increase in job vacancy rate by 1% – 3% in models (IV) – (VI). On the other hand, business start-up cost and credit demand seem to exhibit no influence on job vacancies.

As a robustness check, model (VII) replaces the major independent variable, CC, with an instrumental variable. Using a two-stage-least-square method, I first regress CC of each country on the average credit standard of the Euro Area countries. I then use the fitted values in the first regression in place of CC in the benchmark regression. The coefficient on the instrument is negative and significant at 10%.

Lastly, model (VIII) adds in an interactive term between collateral credit tightening and productivity. It is shown that the marginal impact of a collateral tightening is increasing in productivity. In other words, the more productive a country is, the more loss in jobs a given increase in collateral risk would bring.

In all versions, state and time effects are significant. Table 4-23 presents the coefficients. Dummies associated with Portugal and Netherlands return a positive figure, while those with Luxembourg and Spain a negative figure. One interpretation of the state effects is that it reflects the differing bargaining power of banks over borrowers (β) in each country, as as measured by a Herfindahl Index. The Herfindahl Index is a measure of industry concentration and competition that ranges from 0 to 1, the higher it is, the more concentrated market share is within the banking industry. It can be viewed as a rough and ready indicator of the relative bargaining power between banks and borrowers (see, for example, Fabbri and Klapper (2015)). Figure 4-24 plots the Herfindahl

Job Vacancy Rate is the number of job openings divided by the sum of openings and occupied jobs, expressed as a percentage. Collateral – Credit Tightness is drawn from the ECB Credit Condition Survey. A positive reading means that more banks have tightened credit towards firms over the past three months due to an increased risk in collateral received. Deposit Rate is used as a proxy for financing cost of banks. Business Start-up Cost is drawn from the World Bank database and is expressed as a percentage of GNI. Credit Demand is also drawn from the survey. Except for Collateral Tightness, Credit Demand (which contain negative numbers), and the Interactive Terms, all variables are in log form. White Period Robust Standard Errors are applied to control for serial correlation. *** means that the P-value is less than 0.01, **, 0.05, and *, 0.1.

Dependent Variable: Log (Job Vacancy Rate)								
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
Versions:	Constant	Fixed Effects	Benchmark	Controls	Time Effects	GDP and Credit Demand	Instrument Variable	IV and Interactive Terms
Regressors								
Collateral - Credit Tightness			-0.006 ***	-0.006***	-0.005 ***	-0.005 ***	-0.006 *	-0.04 *
Log (Deposit Rate)				-0.02	-0.25 **	-0.18 *	-0.31 ***	-0.17 *
Log (Productivity)				1.25 **	3.24 ***	2.92 ***	3.44 **	3.42 ***
Log (Business Start-up Cost)				0.07	-0.08	-0.11	-0.11	-0.24
Log (Real GDP)						0.9	0.91	
Credit Demand						0	0	
Collateral - Credit Tightness ?Productivity								-0.01 **
Collateral - Credit Tightness ?Start-up Cost								0.002
Constant	-0.26	-0.26 ***	-0.15 ***	-3.77 **			-19.23	-8.49 ***
Observations	172	172	168	168	168	168	168	168
Adjusted R-squared	0	0.77	0.83	0.85	0.88	0.88	0.87	0.88
State Effects?	no	yes	yes	yes	yes	yes	yes	yes
Time Effects?	no	no	no	no	yes	yes	yes	yes

Table 4-22: Regression results

Index of credit institutions in the four countries between 2003 and 2013[13]. It can be seen that although the Index varies over time within each country, the order of the countries remains unchanged: Netherlands and Portugal have always had a more concentrated banking industry than Luxembourg and Spain. Taking this into consideration, therefore, the state effects could reflect that a country whose banking industry is more concentrated and can exercise greater power over borrowers is associated with more job vacancies[14].

In sum, a joint reading of this regression study with Gorton and Metrick (2009) suggests that information on collateral was produced at both the wholesale and retail levels. This observation lends support to my model; although in the theoretical analysis, wholesale and retail banks are compressed as one representative bank for tractability.

[13] Data is only available in annual frequency and hence cannot be used in regression.
[14] Of course, the state effects may also have captured factors other than bargaining power.

State Effects							
	Luxembourg		Netherlands		Portugal		Spain
	-2.1		0.1		2.4		-0.5
Time Effects							
Q2 2003	0.8	Q1 2006	0.1	Q4 2008	0.3	Q2 2011	-0.2
Q3 2003	0.5	Q2 2006	0.3	Q1 2009	0	Q3 2011	-0.4
Q4 2003	0.5	Q3 2006	0.2	Q2 2009	0.1	Q4 2011	-0.4
Q1 2004	0.2	Q4 2006	0.5	Q3 2009	-0.3	Q1 2012	-0.5
Q2 2004	0.5	Q1 2007	0.2	Q4 2009	-0.4	Q2 2012	-0.3
Q3 2004	0.3	Q2 2007	0.4	Q1 2010	-0.4	Q3 2012	-0.5
Q4 2004	0.4	Q3 2007	0.2	Q2 2010	-0.3	Q4 2012	-0.5
Q1 2005	0.2	Q4 2007	0.3	Q3 2010	-0.4	Q1 2013	-0.7
Q2 2005	0.5	Q1 2008	0.2	Q4 2010	-0.2	Q2 2013	-0.5
Q3 2005	0.2	Q2 2008	0.4	Q1 2011	-0.5	Q3 2013	-0.8
Q4 2005	0.3	Q3 2008	0.2				

Table 4-23: State and time effects.

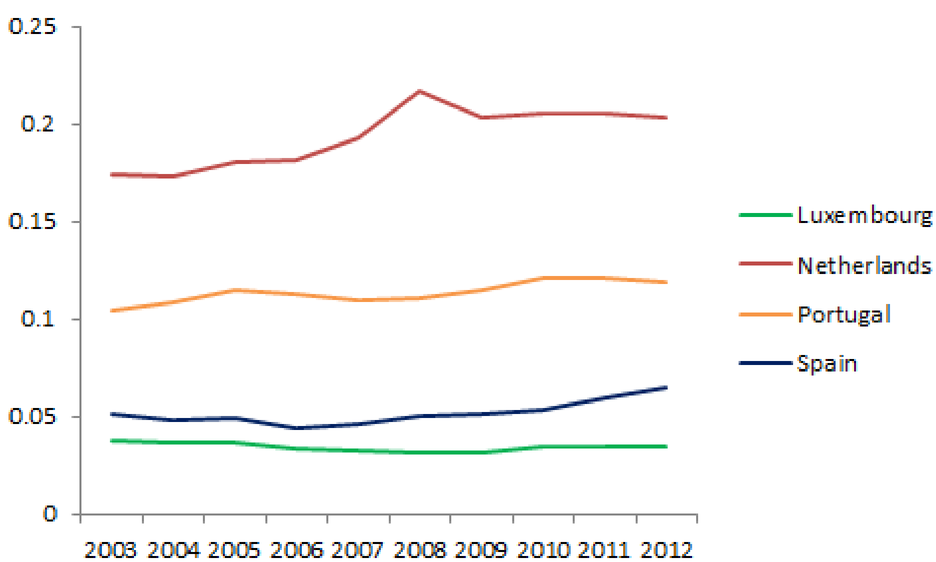


Figure 4-24: Herfindahl Index of credit institutions.

4.4 Related Literature

My Chapter is an effort to embed a "financial accelerator" into a model of unemployment. The financial accelerator refers to the mechanism in which financial frictions enlarge the impact of shocks on the economy. Recently, empirical evidence has documented how financial frictions magnify the impact of shocks within the labour market (Christensen and Dib, 2008; Giroud and Mueller, 2015).

The financial accelerator was originally proposed by Bernanke and Gertler (1989), and formalised in Bernanke et al. (1999). In their framework, lenders have less information than borrowers, and their interests are misaligned. To protect themselves, then, lenders charge borrowers a cost in the form of *external finance premium*[15]. Borrowers may reduce the cost if they bring in collateral – their own net worth – upfront; having more "skin in the game" coheres borrowers' incentive with lenders' in the pursuance of low risk projects. As net worth and external premium are inversely related, in a recession, when net worth goes down, finance premium goes up. Borrowers invest less as a result, exacerbating the downfall of the economy and their net worth.

Mumtaz and Zanetti (2013), and Liu, Miao, and Zha (2013) are two papers that have applied this framework. They merge the Bernanke and Gertler framework with the canonical labour search model of Diamond (1982), Mortensen (1982), and Pissarides (1985) (DMP hereafter). In brief, DMP specifies that job creation is a joint function of workers' decisions to search and firms' decisions to post vacancies. These decisions are in turn driven by fundamental variables. In a recession, value of jobs goes down. Fewer jobs are created, resulting in unemployment.

My Chapter departs from the above settings. The financial amplification in the model

[15] Defined as the difference between the cost of funds raised externally and opportunity costs internal to the firm (Bernanke, Gertler and Gilchrist, 1999:1345*)*

results from a sudden informational regime change. The idea can be traced back to Gorton and Pennacchi (1990) and Dang, Gorton, and Holmström (2015)[16]. In this setting, bank debts, such as money, are used for trading purposes. To facilitate transaction, the value of debts should be stable. And to maintain this stability, banks tend to design their assets, which are used to back the debts, in an opaque way, so that their values are unknown unless being checked upon. The absence of information turns out to be optimal, for then all parties can transact without spending resources examining the debts.

But the opacity of assets does not mean their values are unknowable. Whether information is produced depends on agents' perception of their values. If the initial perception is such that the values are mediocre and questionable, then even a small bad news may trigger information production by some agents. Information production will screen out the bad collateral from the good one, restraining the portion of firms that hold low quality collateral from borrowing and producing. The interpretation of financial accelerator as a sudden regime switch is different from the feedback effects to collateral value over time in the Bernanke and Gertler (1989), Kiyotaki and Moore (1997) frameworks.

The results in this Chapter differ from Mumtaz and Zanetti (2013) and Liu et al. (2013) in two further respects. First, while amplification always results when a shock hits the economy in their papers, in the Chapter, a shock is not necessarily amplified; it depends on whether the perception threshold is breached. Second, amplification arises through a decrease in the *values* of collateral in their papers; in this Chapter, it is a consequence of a decrease in the *units* of collateral available. These differences arise naturally due to the different modelling approach.

Another major departure of my Chapter is in the use of the Wasmer and Weil (2004) framework, rather than the DMP framework, as the basis of labour market. Wasmer

[16] See also Dang et al. (2014); Holmström (2014); Gorton (2009).

and Weil is a double search model that features both matching between financiers and entrepreneurs in the credit market, and entrepreneurs and workers in the labour market. Different from DMP, the Wasmer and Weil itself contains a financial accelerator. To use their words:

"Credit market frictions reduce the number of financiers. This discourages entry by firms, who find it harder to finance themselves. The reduced number of firms in turn discourages financiers from entering the credit market, as it is more difficult for banks to find an entrepreneur. This discourages entry by firms, which discourages entry by financiers, and so on."

As such, the financial amplification is driven by the inherent interactions between credit and labour markets, and not by the net worth effects at the heart of Kiyotaki and Moore (1997) or Bernanke et al. (1999).

It should be noted that although a shock needs not lead to a financial amplification in my model, it does not mean that amplification is undetermined or rests on multiple equilibria. Examples of the latter include Farmer (2013) and Miao et al. (2014). In their papers, high or low employment is driven by self-fulfilling beliefs in the sustainability of an asset bubble. If agents believe a bubble can be sustained, it will be sustained, and employment will be high. Else, credit will be tightened, and employment falls. In my work, whether information is produced is uniquely determined by fundamentals.

4.5 Conclusion

I conjecture that the global financial crisis and the ensuing Great Recession are related to each other due to a "crisis of collateral". Following Gorton and Ordoñez (2014), I define collateral crisis as a sudden informational regime change around a collateral quality threshold, below which screening will be triggered and firms holding *bad* collateral will be ruled out of credit. Under this setting, a deterioration in collateral quality needs not trigger a collateral crisis, but when it does, a substantial portion of employers will lack the fund to hire, resulting in large job loss. Viewing the incidents of 2008 through this lens, it seems that the deteriorating housing market had brought the economy to a critical threshold by September; the bankruptcy of Lehman Brothers on 15 September provided the straw which broke the camel's back.

My model derives two insights of relevance to the design of macroprudential policies. First, a collateral crisis may come from an unexpected angle. Apart from financial factors, real factors, such as productivity and agents' bargaining power, also determine the collateral quality threshold, and hence the triggering point of a collateral crisis. An increase in productivity, for instance, may raise the repayments required by banks. If additional collateral cannot be called upon to back the required repayments, then even a productivity boost may result in a collateral shortage crisis. Second, a trade-off exists between the fragility of an economy as it moves towards a collateral crisis, and the severity of the crisis. Deepening our understanding of this trade-off seems an important area for future work on financial crises.

Chapter 5

Conclusion

My thesis covers three aspects of the global financial crisis: the build-up of fragility amidst loose monetary policy in US, the market mayhem caused by the subsequent tapering talk, and the withdrawal of credit from employers in the wake of revised perceptions on the quality of collateral. Each Chapter contains some tentative implications for policy, which I collate below.

Chapter 2 documents the influence of US monetary policy on risk-taking attitudes of banks around the world. Given the large stakes, it would be ideal for the US Federal Reserve to take into account the implications of its actions on global financial stability[1]. But to the extent that the domestic mandate of the Federal Reserve and global considerations cannot be fully reconciled, the Chapter advocates the imposition of capital controls on the part of small, open economies to fend off inflows of disruptive capital induced by US monetary policy.

[1] Previously, members of the Federal Reserve Board held the opinion that monetary policy (especially that in US) and financial instability are not causally related (Yellen, 2009; Bernanke, 2010). Yellen (2009) remarks: "But they [loose monetary policies] were not the only factor, since such bubbles appeared in many countries that did not have highly accommodative monetary policies". Similarly, Bernanke (2010) points to the lack of correlation between policy rates and housing prices to disclaim the causal roles of monetary policies.

The results of Chapter 2 are sympathetic to the application of preemptive, tightening monetary policy to curb credit bubbles in advance. Kohn (2006, 2008) lists three conditions for the consideration of such policy: (1) timely detection of credit bubbles; (2) efficacy of moderate monetary tightening; and (3) sizable improvement in economic performance as a result of less expansive bubbles. Chapter 2, and other recent work on the identification of credit cycles (Borio, 2014; Drehmann et al., 2012), point towards a partial, if not complete, fulfilment of Kohn's requirements.

A proposition for preemptive tightening may be especially relevant in light of the recent trends in the US Federal Reserve's policy setting – not only has it refused to lean against a credit bubble, as a "risk management" measure[2], it has actively eased monetary policy before bubbles burst[3]. Viewed from the perspective of dynamic control theory[4], which studies the perturbation of complicated systems, such an asymmetric stance is prone to resulting in ever sharper successive cycles[5][6]. Balancing the (preemptive) easing

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[2]See "Monetary Policy under Uncertainty" by Alan Greespan, Jackson Hole, Wyoming August 29^{th}, 2003:

"At times, policy practitioners operating under a risk-management paradigm may be led to undertake actions intended to provide some insurance againstg the emergence of especially adverse outcomes. For example, following the Russian debt default in the fall of 1998, the Federal Open Market Committee eased policy despite our perception that the economy was expanding at a satisfactory pace and that, even without a policy initiative, was likely to continue to do so. We eased policy because we were concerned about the low-probability risk that the default might severely disrupt domestic and international financial markets, with outsized adverse feedback to the performance of the U.S. economy."

[3]Notably, in the Asian crisis of 1997, monetary policy was not tightened even though all traditional indicators said it should have been.

[4]Dynamic control theory specifies that the best way to sustain a system under perturbations is to allow it to deviate from equilibrium. It has been applied to design of the London Millenium Bridge, Eurofighter jet, and steam engine "governors". See Maxwell (1868), Philips (1957), and Cooper (2008).

[5]An asymmetric monetary policy displays, at best, an inconsistent application of economic principles. A refusal to lean implies trusting the objectivity of markets, as enshrined by the Efficient Market Hypothesis (EMH). The subsequent easing implies switching to the Keynes/Minsky view that markets are inefficient and requires the stabilisation of central banks.

At worst, the asymmetry may be regarded as a calculated corruption in the form of generous financial transactions put in place by the U.S. Treasury and the New York Fed for the benefit of large domestic and foreign banks deemed vulnerable to an AIG collapse (Salter, 2013; Johnson, 2009; Stockman, 2013).

[6]See also von Mises (1980): "No very deep knowledge of economics is usually needed for grasping the

with tightening stance cannot ensure the perfect efficiency of the financial market, but it strives to keep deviations from equilibrium within acceptable limits, thus enhancing the sustainability of our financial system[7].

Chapter 3 highlights the allocative inefficiency stemming from a reversal in loose monetary policy. The inefficiency comes from agents' storage of capital in anticipation of a fire-sale which, in turn, is triggered by a tightening in monetary policy. Two approaches are suggested to mitigate the inefficiency. First, central banks may raise interest rate unexpectedly. Second, exit fees may be imposed on investors; the measure would reduce their sensitivity to short-term fund performance. Damage to central banks' reputation constitutes a major shortcoming of the first measure[8], and the reluctance of the fund management industry to be labelled as destabilising, let alone to be regulated[9], poses obstacles to the second. Further work is needed to assess the practicality of these suggestions.

Chapter 4 identifies a trade-off between the frequency and severity of a collateral shortage crisis. The key insight is that monetary and macroprudential policies alike may manipulate the trade-off, but they cannot eliminate a crisis. For instance, a lowering of banks' bargaining power lessens the likelihood of a crisis, but increases its severity, should one happen. The latter result raises doubts on the efficacy of limiting banks' autonomy post the global financial crisis (e.g. Dodd-Frank Act) – it may just replace a less frequent outbreak for a more severe crisis.

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immediate effects of a measure; but the task of economics is to foretell the remoter effects, and so to allow us to avoid such acts as attempt to remedy a present ill by sowing the seeds of a much greater ill for the future."

[7] Consider also balancing the "risk management paradigm" of Alan Greenspan with the remark of William McChesney Martin, the longest serving chairman of Federal Reserve: "The job of the Federal Reserve is to take away the punchbowl just when the party gets going."

[8] Which is crucial for anchoring inflation expectations (Davis et al., 2014).

[9] See responses of Investment Company Institute, the industry lobbying group, to regulations proposed by Financial Stability Oversight Council, available at <<https://www.ici.org/financial_stability>>.

Taken as a whole, my thesis makes a case for the complementary use of monetary and macroprudential policies (capital controls, exit fees, banks' bargaining power controls, etc.) to foster financial stability. Given the intricacy between monetary policies and incentives of agents, however, each type of policy should not be confined to the individual goals of price and financial stability[10]. Furthermore, in case of conflicts[11], it is not necessarily obvious that price stability concerns should prevail over financial stability in the conduct of monetary policy. Understanding the interaction between monetary policy and macroprudential policy is an exciting area for further work.

The crude abstractions used in this thesis suffer from many deficiencies. In particular, although I have sought to describe the causal relation between monetary policy and risk-taking, I have not contemplated the optimal amount of risks our society should bear or, indeed, if capital controls are to be imposed, what criteria determine the optimal level of global capital flows, and how international coordination can achieve it. Also, in Chapter 3, I have not considered the downward spirals in price during a fire-sale, although, it is conceivable that their inclusion would exacerbate the allocative inefficiency and, as such, serve to strengthen my recommendations. Chapter 4 has not considered the welfare implications across different loan monitoring regimes, the analysis of which would facilitate the public discussion on the optimal trade-off between frequency and severity of crisis our economy should settle in. Overcoming these shortcomings is an important next step.

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[10] As is currently practised in US. The Federal Reserve is assigned the roles to price and economic stability, while the Financial Stability Oversight Council is responsible for financial stability considerations.

[11] As in Japan in the late 1980s; US in the 1920s, 1990s (White, 2009), and the Great Moderation before global financial crisis. See also Schwartz (1995); Bordo (2007); Calomiris and Gorton (1991) for arguments for *positive* relationship between price and financial stability. See Borio and Lowe (2002); Borio et al. (2003), Blinder (1999); Shirakawa (2012) for arguments for *negative* relationship between the two goals.

Appendix A

A.1 Appendix to Chapter 2

A.1.1 Information criteria in lag

Lag	AIC/BIC
1	2.55E-28
2	1.57E-25
3	1.70E-27
4	2.13E-27

Table A-1: Information criteria in lag selection.

A.1.2 Banks in sample

Country	Name	Total asset ('000 USD)
Argentina	BBVA Banco Frances SA	9133
	Banco Macro SA	9220
Austria	BKS Bank AG	9390
	Oberbank AG	24315
	Bank fuer Tirol & Vorarlberg AG	13129
	Erste Group Bank AG	268512
	Volksbank Vorarlberg e Gen	3092
Australia	National Australia Bank Ltd	837498
	Australia & New Zealand Banking Group Ltd	732056
	Commonwealth Bank of Australia	750411
	Bank of Queensland Ltd	44472
Belgium	KBC Groep NV	335386
	Dexia SA	338048
Brazil	Banco Bradesco SA	422222
	Itau Unibanco Holding SA	511505
	Banco da Amazonia SA	5635
	Itausa - Investimentos Itau SA	22051
	Banco do Brasil SA	579996
Canada	Bank of Montreal	552317
	Bank of Nova Scotia	755926
	Canadian Imperial Bank of Commerce	389288
	Canadian Western Bank	19336
	Laurentian Bank of Canada	32697
	National Bank of Canada	192746
	Pacific & Western Credit Corp	1354
	Royal Bank of Canada	882483
	Toronto-Dominion Bank	886416
Cyprus	Hellenic Bank PCL	10330
China	Ping An Bank Co Ltd	352564
	Shanghai Pudong Development Bank	676587
Chile	Banco Santander Chile	55308
	Grupo Security SA	13891
	Sociedad Matriz Banco de Chile	50076
	Banco de Credito e Inversiones	43115
	Banco de Chile	50076
Colombia	Banco de Bogota SA	61266
	BanColombia SA	76980

Country	Name	Total Assets ('000 USD)
Czech Republic	Komercni Banka AS	47513
Denmark	Danske Bank A/S	633517
	Spar Nord Bank A/S	14462
	Kreditbanken	439
	Djurslands Bank A/S	1219
	Nordjyske Bank A/S	1629
	Gronlandsbanken AB	890
	Hvidbjerg Bank A/S	167
	Jyske Bank A/S	99381
	Ostjydsk Bank A/S	984
	Ringkjoebing Landbobank A/S	3896
	Skjern Bank	988
	Sydbank A/S	27945
	Lan & Spar Bank	2512
Finland	Bank of Aland PLC	5872
France	BNP Paribas SA	2842274
	CIC	336077
	Caisse Regionale de Credit Agricole	49609
	Caisse Regionale Credit Agricole Mutuel	14013
	Natixis	807671
	Societe Generale SA	1789513
	Credit Agricole du Morbihan	12461
	Credit Agricole Toulouse 31	12283
	Credit Agricole Loire Haute-Loire	13236
	Credit Agricole de la Touraine	16094
	Credit Agricole Sud Rhone Alpes	21047
	Caisse Regionale de Credit Agricole	22052
United Kingdom	Barclays PLC	2327111
	HSBC Holdings PLC	4514256
	Royal Bank of Scotland Group PLC	1800745
	Arbuthnot Banking Group PLC	2479
	Standard Chartered PLC	1244035
Germany	Commerzbank AG	762782
	HSBC Trinkaus & Burkhardt AG	30338
	DVB Bank SE	33530
	IKB Deutsche Industriebank AG	30656
	Oldenburgische Landesbank AG	19337
	Comdirect Bank AG	20751
Greece	Alpha Bank AE	99772
	Attica Bank	5412
	Piraeus Bank SA	122144
	Eurobank Ergasias	103305

Country	Name	Total assets ('000 USD)
Hong Kong	Bank of East Asia Ltd	102695
	Hang Seng Bank Ltd	163094
	Public Financial Holdings Ltd	5490
	Dah Sing Financial Holdings Ltd	25988
	Chong Hing Bank Ltd	13941
Indonesia	Bank Internasional Indonesia Tbk PT	12082
	Bank Pan Indonesia Tbk PT	14549
	Bank Negara Indonesia Persero Tbk PT	35117
	Bank Central Asia Tbk PT	46569
India	State Bank of Bikaner & Jaipur	17026
	State Bank of India	449382
	Federal Bank Ltd	13799
	Oriental Bank of Commerce	38365
	HDFC Bank Ltd	101040
	IDBI Bank Ltd	59238
	Kotak Mahindra Bank Ltd	24728
	Bank of Baroda	122157
	Dena Bank	21623
	Bank of India	104067
	Corp Bank	37617
	IndusInd Bank Ltd	18160
	State Bank of Travancore	17574
	Jammu & Kashmir Bank Ltd	13084
	South Indian Bank Ltd	9839
	Axis Bank Ltd	77764
	Syndicate Bank	50658
Ireland	Allied Irish Banks PLC	146993
	Bank of Ireland	177560
Italy	Banca Popolare di Milano Scarl	66034
	Banca Popolare di Sondrio SCARL	48725
	Banca Popolare dell'Emilia Romagna SC	82970
	Intesa Sanpaolo SpA	884281
	Credito Emiliano SpA	47597
	Banca Carige SpA	52406
	Banco di Desio e della Brianza SpA	17186
	Banca Monte dei Paschi di Siena SpA	250942
	Banca Popolare dell'Etruria e del Lazio	22496
Japan	77 Bank Ltd	84595
	Aichi Bank Ltd	29886
	Akita Bank Ltd	28403
	Aomori Bank Ltd	26235
	Awa Bank Ltd	30411

Country	Name	Total assets ('000 USD)
Japan	Bank of Iwate Ltd	34927
	Bank of Kyoto Ltd	81313
	Bank of Nagoya Ltd	34549
	Bank of Okinawa Ltd	20102
	Bank of Saga Ltd	22697
	Bank of the Ryukyus Ltd	21592
	Bank of Yokohama Ltd	151469
	Chiba Bank Ltd	127746
	Chiba Kogyo Bank Ltd	24651
	Chugoku Bank Ltd	75063
	Chukyo Bank Ltd	18879
	Daisan Bank Ltd	19334
	Daishi Bank Ltd	51157
	Daito Bank Ltd	7872
	Ehime Bank Ltd	24104
	Eighteenth Bank Ltd	27394
	Fukui Bank Ltd	23911
	Fukushima Bank Ltd	7550
	Gunma Bank Ltd	74375
	Hachijuni Bank Ltd	78939
	Minato Bank Ltd	33659
	Higashi-Nippon Bank Ltd	20731
	Higo Bank Ltd	46731
	Hiroshima Bank Ltd	77981
	Hokkoku Bank Ltd	41170
	Hokuetsu Bank Ltd	25776
	Hyakugo Bank Ltd	52544
	Hyakujushi Bank Ltd	45458
	Iyo Bank Ltd	64767
	Joyo Bank Ltd	89293
	Juroku Bank Ltd	59970
	Kagoshima Bank Ltd	40150
	Tsukuba Bank Ltd	22675
	Keiyo Bank Ltd	42851
	Kita-Nippon Bank Ltd	14451
	Michinoku Bank Ltd	20925
	Miyazaki Bank Ltd	25849
	Musashino Bank Ltd	41931
	Nanto Bank Ltd	52486
	Nishi-Nippon City Bank Ltd	84648
	Ogaki Kyoritsu Bank Ltd	50803
	Oita Bank Ltd	30308

Country	Name	Total assets (‘000 USD)
	San-In Godo Bank Ltd	47102
	Shiga Bank Ltd	49219
	Shikoku Bank Ltd	29041
	Shimizu Bank Ltd	15680
	Shizuoka Bank Ltd	110647
	Suruga Bank Ltd	42206
	Towa Bank Ltd	20295
	Tochigi Bank Ltd	27222
	Toho Bank Ltd	57851
	Tomato Bank Ltd	11754
	Yamagata Bank Ltd	24298
	Yamanashi Chuo Bank Ltd	31085
	Bank of Toyama Ltd	4723
	Chikuho Bank Ltd	7257
	Mie Bank Ltd	18874
	Miyazaki Taiyo Bank Ltd	6353
	Tottori Bank Ltd	9603
	Nagano Bank Ltd	10940
	Tohoku Bank Ltd	8331
Malaysia	Affin Holdings Bhd	20786
	AMMB Holdings Bhd	41716
	BIMB Holdings Bhd	16533
	CIMB Group Holdings Bhd	129121
	RHB Capital Bhd	68388
	Hong Leong Financial Group Bhd	59291
	Malayan Banking Bhd	199626
	Alliance Financial Group Bhd	16568
	Public Bank Bhd	107785
	Hong Leong Bank BHD	53110
Mexico	Grupo Elektra SAB DE CV	15034
	Grupo Financiero Inbursa SAB de CV	29608
Netherlands	ING Groep NV	1358179
	Van Lanschot NV	23610
Norway	Sparebanken Ost	5673
	Sparebanken More	9124
	Sparebanken Vest	23833
	Sparebank 1 Nord Norge	13481
	SpareBank 1 SMN	20427
	SpareBank 1 SR Bank ASA	28348
	Sandnes Sparebank	4670
	Totens Sparebank	2273
	Skue Sparebank	915

Country	Name	Total assets ('000 USD)
Poland	Mbank	38768
	Bank Millennium SA	19958
	ING Bank Slaski SA	32812
	Bank Handlowy w Warszawie SA	16378
	Bank Ochrony Srodowiska SA	6466
	Bank Pekao SA	55078
Philippines	Philippine National Bank	14348
	China Banking Corp	10804
	Metropolitan Bank & Trust Co	36810
	Rizal Commercial Banking Corp	10505
	Union Bank of Philippines Inc	10228
	Security Bank Corp	9112
Portugal	Banco Comercial Portugues SA	104458
	Banco BPI SA	58320
South Africa	Barclays Africa Group Ltd	92811
	Standard Bank Group Ltd	178135
	Sasfin Holdings Ltd	765
Korea	Industrial Bank of Korea	217230
	Pureun Mutual Savings Bank	2159
Spain	Banco Bilbao Vizcaya Argentaria SA	864466
	Banco Santander SA	1732232
	Banco Popular Espanol SA	220865
	Bankinter SA	78429
Sweden	Skandinaviska Enskilda Banken AB	410769
	Svenska Handelsbanken AB	438052
	Swedbank AB	329906
	Nordea Bank AB	104097
Switzerland	Bank Linth LLB AG	6611
	Banque Cantonale Vaudoise	47417
	Banque Cantonale du Jura	2902
	Basellandschaftliche Kantonalbank	24517
	Basler Kantonalbank	48367
	Bank Coop AG	18274
	Luzerner Kantonalbank AG	33097
	Zuger Kantonalbank AG	15582
	Banque Cantonale de Geneve	19718
	Berner Kantonalbank AG	30495
	Valiant Holding AG	28548
Taiwan	Chang Hwa Commercial Bank	60747
	Taichung Commercial Bank	17731
	King's Town Bank	7871
	Far Eastern International Bank	17461

Country	Name	Total assets ('000 USD)
	Union Bank Of Taiwan	16274
	Ta Chong Bank Ltd	15812
	Entie Commercial Bank	11209
	Taiwan Business Bank	46580
	Bank of Kaohsiung	9000
Thailand	Bangkok Bank PCL	85037
	Bank of Ayudhya PCL	37414
	Krung Thai Bank PCL	84405
	Siam Commercial Bank PCL	83183
	Kasikornbank PCL	73614

Country	Name	Total assets ('000 USD)
US	Wells Fargo & Co	1849181995
	JPMorgan Chase & Co	2423808066
	Citigroup Inc	1800967029
	Bank of America Corp	2185497936
	US Bancorp	428638011
	PNC Financial Services Group Inc	360985002
	BB&T Corp	212404994
	SunTrust Banks Inc	190816993
	Regions Financial Corp	125539000
	Fifth Third Bancorp	142429995
	M&T Bank Corp	124625633
	KeyCorp	98402001
	Huntington Bancshares Inc/OH	72644968
	Zions Bancorporation	59669524
	Comerica Inc	69007000
	TCF Financial Corp	21321101
	First Niagara Financial Group Inc	39917998
	Commerce Bancshares Inc/MO	24506952
	People's United Financial Inc	39181001
	Umpqua Holdings Corp	23921531
	Synovus Financial Corp	29171257
	Associated Banc-Corp	28178866
	First Horizon National Corp	26963681
	Cullen/Frost Bankers Inc	28567118
	BancorpSouth Inc	13926398
	FirstMerit Corp	25524605
	Hancock Holding Co	22809371
	Wintrust Financial Corp	23488168
	UMB Financial Corp	19094245
	Fulton Financial Corp	18122254
	New York Community Bancorp Inc	48515572
	Prosperity Bancshares Inc	22037215
	MB Financial Inc	15575653
	Webster Financial Corp	24935510
	Trustmark Corp	12678896
	Valley National Bancorp	21612616
	International Bancshares Corp	11772869
	East West Bancorp Inc	33109168
	FNB Corp/PA	17557662
	Old National Bancorp/IN	11991527
	Community Bank System Inc	8552669
	Bank of Hawaii Corp	15455016
	SVB Financial Group	43573903
	Glacier Bancorp Inc	9089232
	Northwest Bancshares Inc	8951899

Country	Name	Total assets ('000 USD)
US	Simmons First National Corp	7559658
	Banner Corp	9796298
	United Community Banks Inc/GA	9626108
	Columbia Banking System Inc	8951697
	Washington Federal Inc	14670823
	First Midwest Bancorp Inc/IL	10728922
	NBT Bancorp Inc	8262646
	United Bankshares Inc/WV	12577944
	Banc of California Inc	8235555
	PacWest Bancorp	21031008
	Bank of the Ozarks Inc	11427419
	Astoria Financial Corp	15076211
	Home BancShares Inc/AR	9289122
	First Financial Bancorp	8147411
	Texas Capital Bancshares Inc	20210893
	Ameris Bancorp	5588940
	First Financial Bankshares Inc	6665070
	PrivateBancorp Inc	17259422
	First Commonwealth Financial Corp	6566890
	Cathay General Bancorp	13262019
	Signature Bank/New York NY	34897773
	Sterling Bancorp/DE	11955952
	S&T Bancorp Inc	6318354
	Pinnacle Financial Partners Inc	9262344
	Independent Bank Corp/Rockland MA	7210038
	Tompkins Financial Corp	5689995
	Provident Financial Services Inc	8911657
	BBCN Bancorp Inc	8068305
	Boston Private Financial Holdings Inc	7413663
	City Holding Co	3714059
	Cardinal Financial Corp	4029921
	LegacyTexas Financial Group Inc	7562126
	Westamerica Bancorporation	5168875
	Central Pacific Financial Corp	5131288
	TrustCo Bank Corp NY	4734992
	Southside Bancshares Inc	5162076
	Brookline Bancorp Inc	6042338
	Hanmi Financial Corp	4310748
	CVB Financial Corp	7920836
	Wilshire Bancorp Inc	4720401
	Bank Mutual Corp	2502167
	Walker & Dunlop Inc	3514991
	BofI Holding Inc	6662215
	Dime Community Bancshares Inc	5032872
	LendingTree Inc	295781
	Northfield Bancorp Inc	3202584
	Oritani Financial Corp	3512991

A.1.3 Panel regression results with US banks

Variables	(9) Baseline model	(10) Alternative risk measure (CAPM
PD	0.736***	
	(0.066)	
RISK		0.955***
		(0.163)
	(0.017)	(0.377)
Log(GDP)	-0.693**	-9.901*
	(0.32)	(5.957)
PDF	0.018	0.940
	(0.028)	(0.693)
Log(SM)	0.228**	-1.725
	(0.102)	(2.169)
Log(VIX)	0.135	-2.370
	(0.087)	(1.912)
Log(EXDEP)	0.519**	10.44*
	(0.254)	(5.423)
Log(ER)	0.536	7.772
	(0.611)	(8.148)
Observations	10,571	9,857
Number of banks	347	318
Sample Period	2001 Q1 – 2008 Q4	2001 Q1 – 2008 Q4
Number of Instruments	29	25
Test for AR(1) Pr > z =	0.074	0
Test for AR(2) Pr > z =	0.369	0.976
Hansen Test Pr > Chi2 =	0.492	0.081

Table A-2: Regression results with the inclusion of US banks.

Variables	(11) Alternative monetary policy stance (Federal funds rate)	(12) Full sample
PD	0.75***	0.567***
	(0.065)	(0.036)
FFR	-0.034***	
	(0.012)	
USGAP		-0.047***
		(0.011)
	(0.293)	(0.229)
PDF	0.033	0.185***
	(0.029)	(0.014)
Log(SM)	0.266***	0.145
	(0.087)	(0.165)
Log(VIX)	0.077	0.028
	(0.118)	(0.058)
Log(EXDEP)	0.559**	0.683**
	(0.231)	(0.284)
Log(ER)	0.657	0.169
	(0.627)	(0.18)
Observations	10,571	17,540
Number of banks	347	349
Sample Period	2001 Q1 – 2008 Q4	2001 Q1 – 2013 Q4
Number of Instruments	29	38
Test for AR(1) Pr > z =	0.051	0
Test for AR(2) Pr > z =	0.262	0.493
Hansen Test Pr > Chi2 =	0.607	0.728

Variables	(13) Interaction terms (Natural rate gap)	(14) Interaction terms (Federal funds rate)
PD	0.567***	0.567***
	(0.033)	(0.038)
USGAP	-0.561*	
	(0.32)	
$USGAP^2$	-0.004	
	(0.008)	
USGAP × Log(EXDEP)	0.039	
	(0.024)	
USGAP × BEL	-0.002	
	(0.01)	
FFR		-0.234
		(0.261)
FFR^2		-0.018
		(0.012)
FFR × Log(EXDEP)		0.023
		(0.02)
FFR × BEL		-0.004
		(0.003)
Log(GDP)	-0.801***	-0.834***
	(0.286)	(0.301)
PDF	0.193***	0.194***
	(0.015)	(0.018)
Log(SM)	0.205	0.185
	(0.2)	(0.178)
Log(ER)	0.235	0.205
	(0.291)	(0.298)
Log(VIX)	0.004	0.0109
	(0.039)	(0.044)
Log(EXDEP)	0.714***	0.773**
	(0.268)	(0.326)
BEL	-0.004	0.009
	(0.009)	(0.012)
Observations	17,540	17,540
Number of banks	349	349
Sample Period	2001 Q1 – 2013 Q4	2001 Q1 – 2013 Q4
Number of Instruments	49	47
Test for AR(1) Pr > z =	0	0
Test for AR(2) Pr > z =	0.618	0.606
Hansen Test Pr > Chi2 =	0.959	0.938

Variables	(15) Exchange rate and capital mobility regimes (Natural rate gap)	(16) Exchange rate and capital mobility regimes (Federal funds rate)
PD	0.564***	0.574***
	(0.028)	(0.034)
Log(GDP)	-0.485**	-0.562
	(0.227)	(0.355)
PDF	0.194***	0.178***
	(0.015)	(0.011)
Log(SM)	0.12	0.032
	(0.098)	(0.16)
Log(ER)	0.76	0.248
	(0.564)	(0.243)
Log(VIX)	-0.007	0.002
	(0.055)	(0.06)
Log(EXDEP)	0.727***	0.696**
	(0.259)	(0.286)
USGAP	0.096	
	(0.072)	
Dummy_float	-9.987	-3.004
	(9.969)	(3.923)
Dummy_float × USGAP	-0.832**	
	(0.349)	
Dummy_open	4.497	1.132
	(8.175)	(2.682)
Dummy_open × USGAP	0.734**	
	(0.347)	
FFR		-0.067
		(0.049)
Dummy_float × FFR		0.064
		(0.045)
Dummy_open × FFR		0.005
		(0.039)
Observations	17,540	17,540
Number of banks	349	349
Sample Period	2001 Q1 – 2013 Q4	2001 Q1 – 2013 Q4
Number of Instruments	52	49
Test for AR(1) Pr > z =	0	0
Test for AR(2) Pr > z =	0.573	0.733
Hansen Test Pr > Chi2 =	0.977	0.989

A.1.4 PVAR Results with a Different Ordering

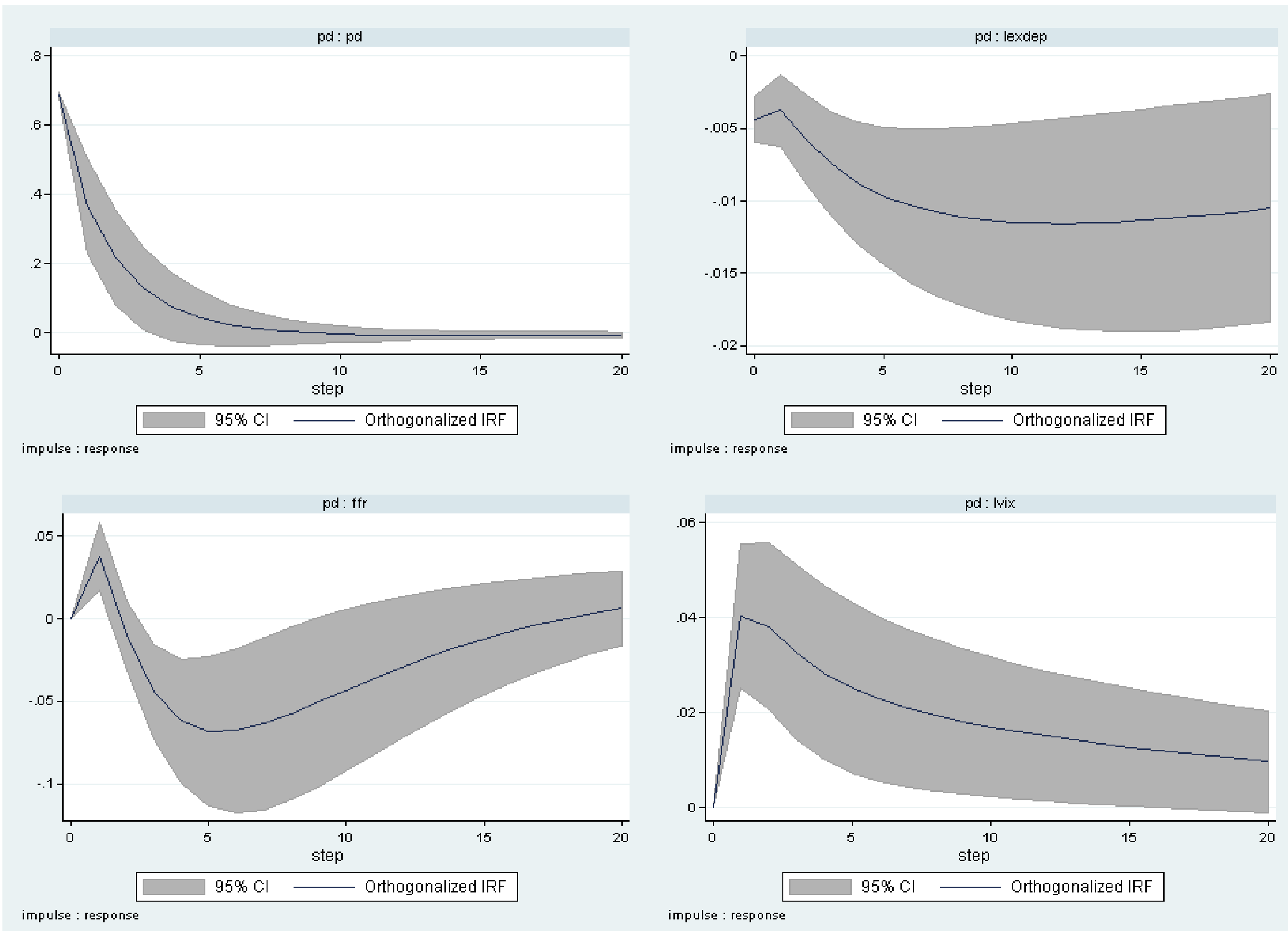

Figure A-3: Response to increase in banks' default risks.

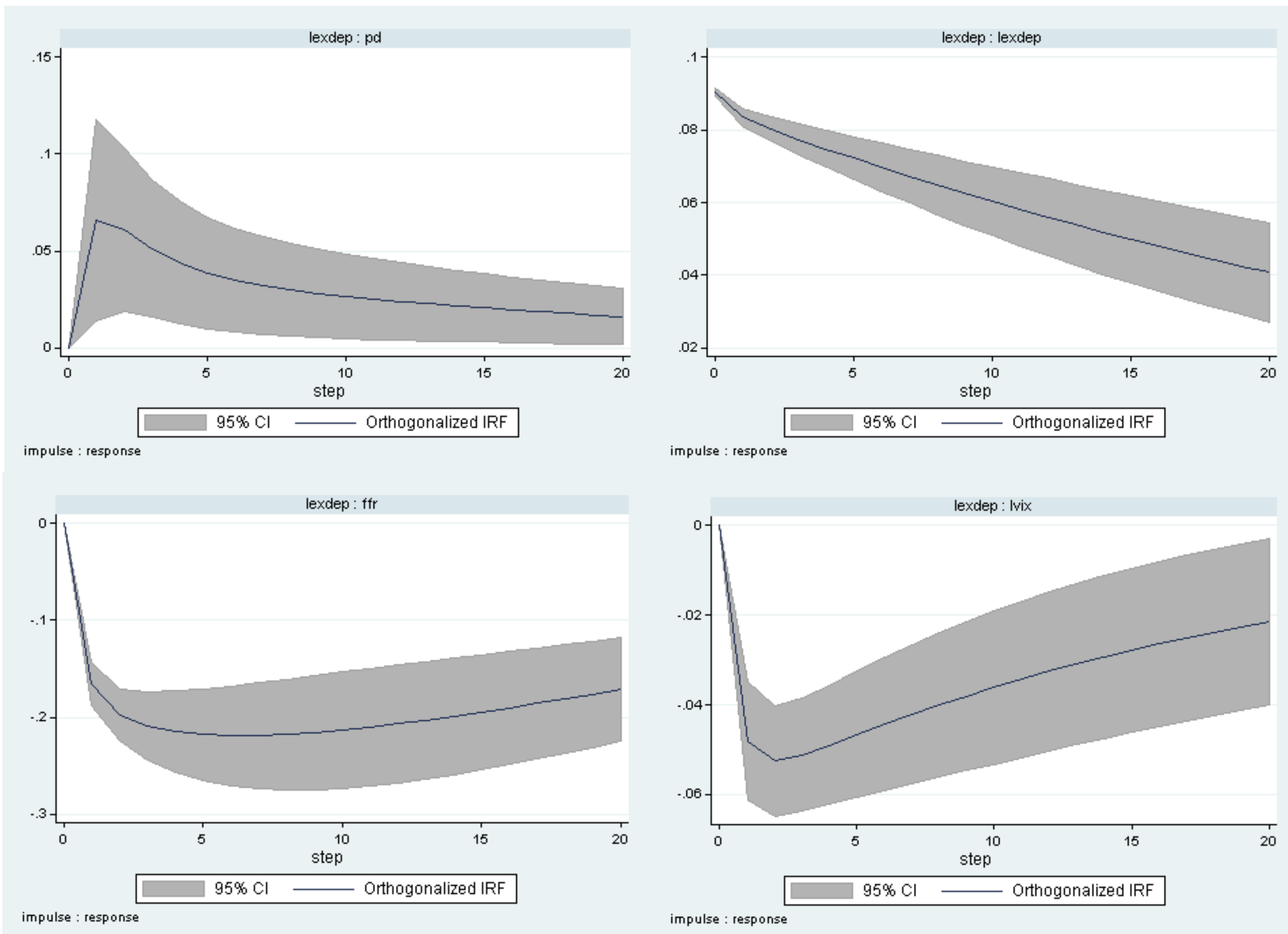

Figure A-4: Response to increase in capital inflows.

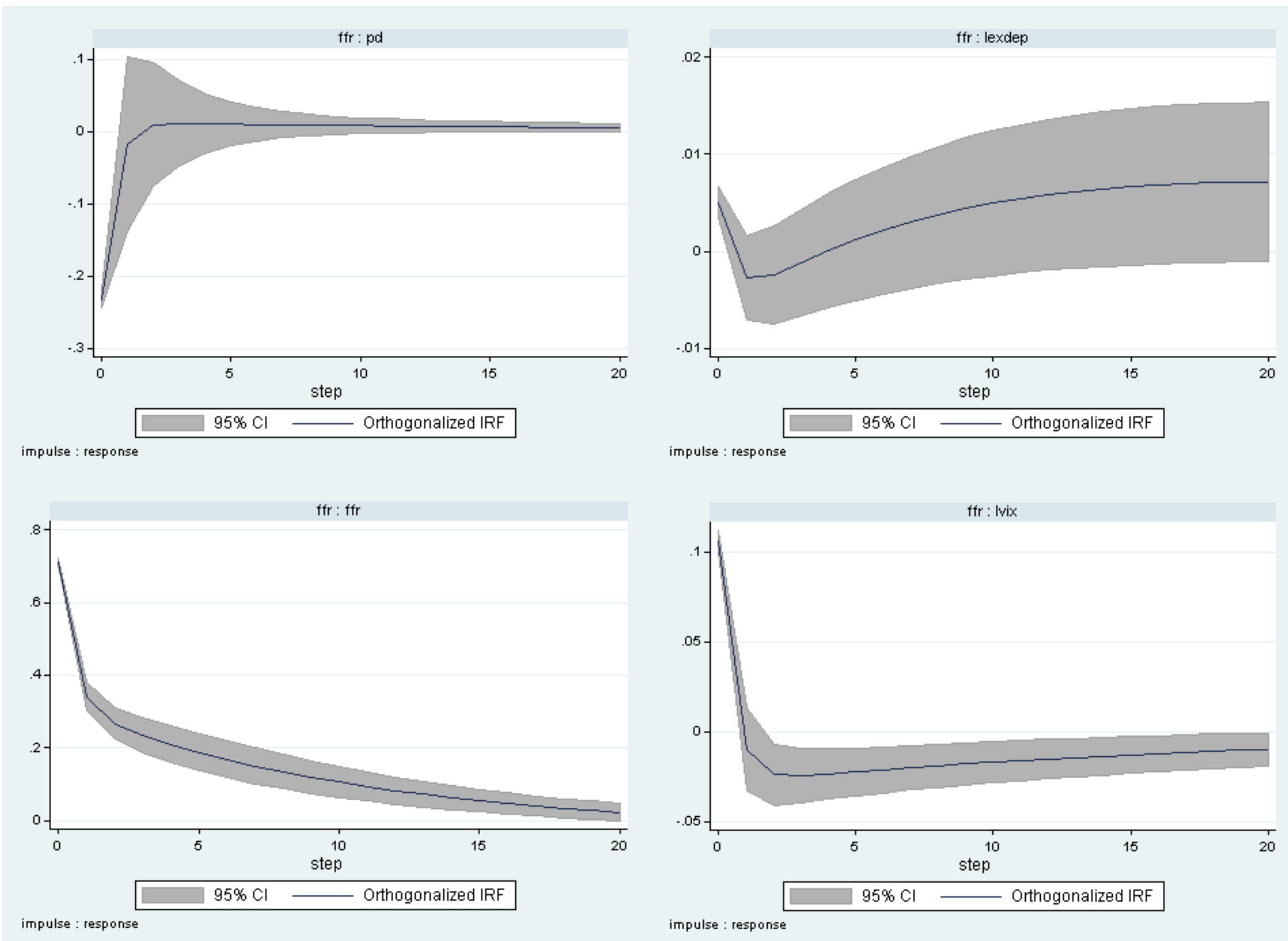

Figure A-5: Response to increase in federal funds rate.

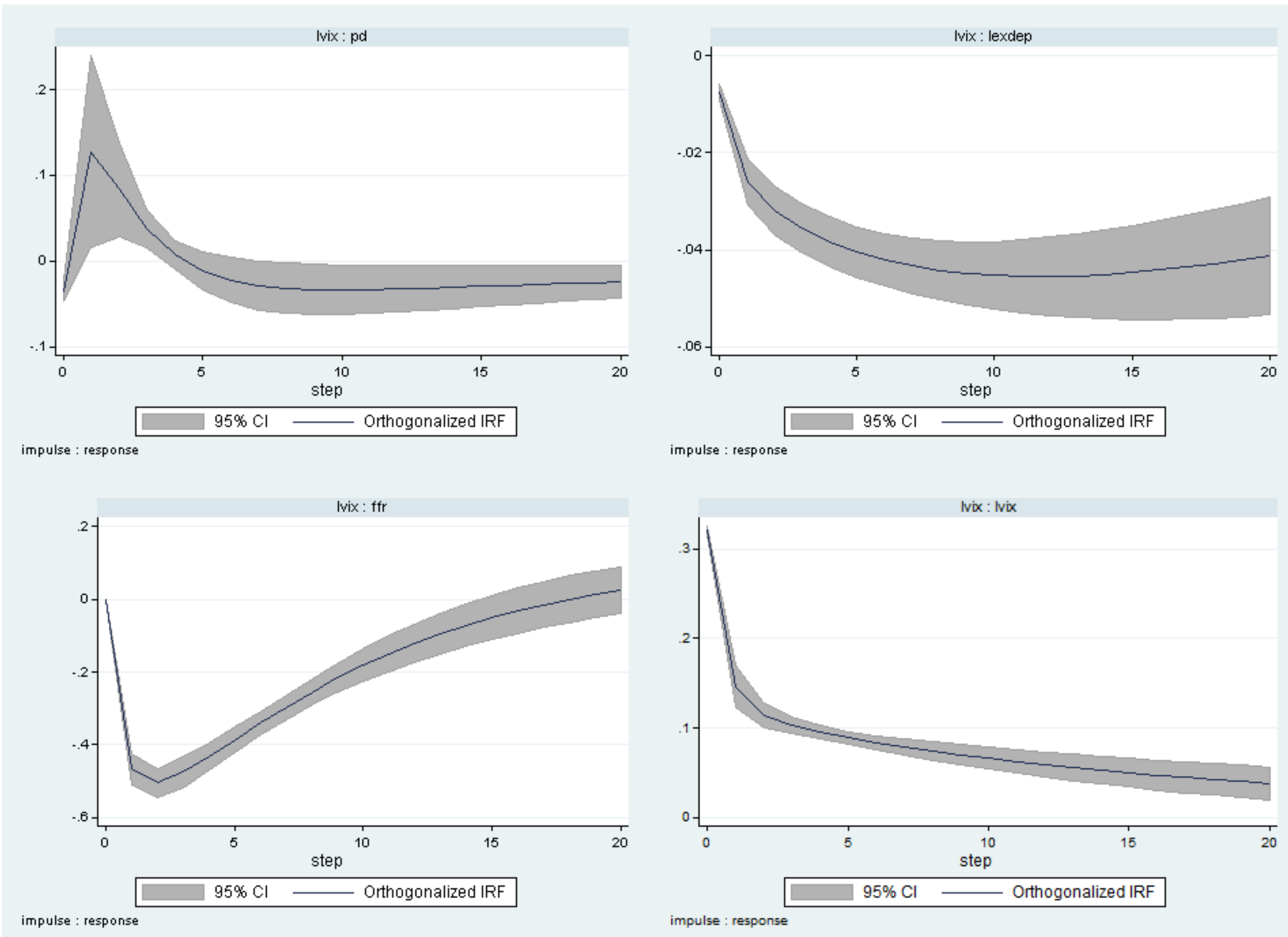

Figure A-6: Response to increase in VIX.

A.2 Appendix to Chapter 3

A.2.1 Largest banks (by assets) and asset managers (by assets under management), end 2012

Bank	Country	Assets ($bn)	% of total	Manager	Country	AUM ($bn)	% of total
ICBC	China	2,789	2.5%	BlackRock	US	3,792	5.6%
Mitsubishi UFJ Financial	Japan	2,709	2.4%	Allianz	Germany	2,448	3.6%
HSBC Holdings	UK	2,693	2.4%	Vanguard	US	2,215	3.3%
Deutsche Bank	Germany	2,655	2.4%	State Street	US	2,086	3.1%
Credit Agricole	France	2,649	2.4%	Fidelity	US	1,888	2.8%
BNP Paribas	France	2,516	2.2%	AXA	France	1,475	2.2%
JP Morgan Chase & Co	US	2,359	2.1%	JPMorgan Chase	US	1,431	2.1%
Barclays	UK	2,351	2.1%	Bank of New York Mellon	US	1,385	2.0%
China Construction Bank	China	2,221	2.0%	BNP Paribas	France	1,303	1.9%
Bank of America	US	2,212	2.0%	Deutsche Bank	Germany	1,247	1.8%
TOP 10		25,154	22.4%	TOP 10		19,270	28.3%

Sources: The Banker Database “Top 1000 World Banks ranking” (2013), Towers Watson "The World's 500 Largest Asset Managers" (2012)

A.2.2 Top 10 exchange-traded funds by fund outflows and inflows, 19-30 June.

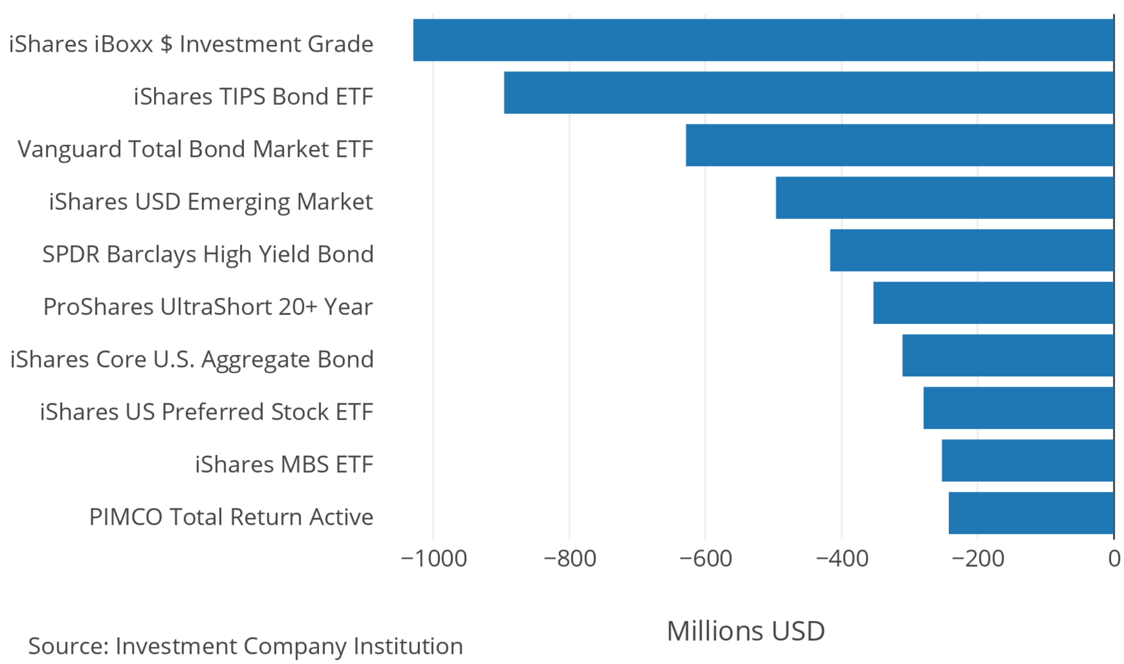

Figure A-3: Top 10 exchange-traded funds by fund redemptions, 18 - 30 June 2013.

A.2.3 Proofs of Comparative Statics

Higher interim asset price (λ)

Let AB be the payoff of arbitrageurs.

$$
\begin{aligned}
AB &= \frac{1+\widehat{r}}{2} + \frac{1}{\widehat{r}}\frac{1-w}{w}\int_{r^*}^{\widehat{r}} (R-\lambda r)\, dr \\
&= \frac{1+\widehat{r}}{2} + \frac{1-w}{w}\left(1-\frac{r_T}{\widehat{r}}\right)R - \frac{1}{\widehat{r}}\frac{1-w}{w}\frac{\lambda}{2}\left(\widehat{r}^2 - r^{*2}\right)
\end{aligned}
$$

$$
= \tfrac{1+\widehat{r}}{2} \quad \underbrace{+\frac{1-w}{w}\left(1-\frac{r^*}{\widehat{r}}\right)R}_{A} \quad \underbrace{-\frac{1}{\widehat{r}}\frac{1-w}{w}\lambda\left(\frac{\widehat{r}-r^*}{\widehat{r}}\right)\frac{\widehat{r}+r^*}{2}}_{B}
$$

Let the second term be A and the third term be B.

$$
\begin{aligned}
\frac{\partial A}{\partial \lambda} &= \frac{1-w}{w}R \cdot -\frac{1}{\widehat{r}}\frac{\partial r^*}{\partial \lambda} \\
&= \frac{1-w}{w}\frac{R^2}{\lambda^2\widehat{r}}\left(1-\frac{\phi}{2}\right) \\
&= \frac{1-w}{w}\frac{R}{\lambda\widehat{r}}r^*.
\end{aligned}
$$

$$
\begin{aligned}
\frac{\partial B}{\partial \lambda} &= -\frac{1-w}{w}\frac{1}{\widehat{r}}\frac{1}{2}\left[\left(\widehat{r}^2 - r^{*2}\right) + \lambda \cdot -2r^* \cdot \frac{\partial r^*}{\partial \lambda}\right] \\
&= -\frac{1-w}{w}\frac{1}{\widehat{r}}\frac{1}{2}\left(\widehat{r}^2 + r^{*2}\right).
\end{aligned}
$$

$$
\begin{aligned}
\frac{\partial AB}{\partial \lambda} &= \frac{\partial A}{\partial \lambda} + \frac{\partial B}{\partial \lambda} \\
&= \frac{1-w}{w}\frac{R}{\lambda \widehat{r}} r^{*} - \frac{1-w}{w}\frac{\widehat{r}}{2} - \frac{1-w}{w}\frac{r^{*2}}{2\widehat{r}} \\
&= \frac{1-w}{w}\frac{R^2}{\lambda^2}\frac{\left(1-\frac{\phi}{2}\right)}{\widehat{r}}\left[1-\frac{1}{2}\left(1-\frac{\phi}{2}\right)\right] - \frac{1-w}{w}\frac{\widehat{r}}{2} \\
&= \frac{1-w}{w}\frac{R^2}{\lambda^2}\frac{1}{\widehat{r}}\left(1-\frac{\phi}{2}\right)\left(1+\frac{\phi}{2}\right)\frac{1}{2} - \frac{1-w}{w}\frac{\widehat{r}}{2} \\
&= \frac{1-w}{w}\frac{1}{2}\left[\frac{R^2}{\lambda^2}\frac{1}{\widehat{r}}\left(1-\frac{\phi^2}{4}\right) - \widehat{r}\right].
\end{aligned}
$$

As we can see, $\partial AB/\partial \lambda$ will be positive if $\widehat{r}$ is low.

Let AM be the payoff of asset managers.

$$
AM = \frac{r^*}{\widehat{r}}R + \lambda\left(\frac{\widehat{r}-r^*}{\widehat{r}}\right)\frac{\widehat{r}+r^*}{2}
$$

$$
= \underbrace{\frac{r^*}{\widehat{r}}R}_{I} \quad + \underbrace{\frac{\lambda}{2\widehat{r}}\left(\widehat{r}^2 - r^{*2}\right)}_{II}.
$$

Let I be the first term and II be the second term.

$$
\begin{aligned}
\frac{\partial I}{\partial \lambda} &= \frac{R}{\widehat{r}}\frac{\partial r^*}{\partial \lambda} \\
&= \frac{R}{\widehat{r}}R\left(1-\frac{\phi}{2}\right)\cdot -\frac{1}{\lambda^2}
\end{aligned}
$$

$$
\begin{aligned}
\frac{\partial II}{\partial \lambda} &= \frac{1}{2\widehat{r}}\left[\left(\widehat{r}^2 - r^{*2}\right) + \lambda \cdot -2r_T\frac{\partial r^*}{\partial \lambda}\right] \\
&= \frac{1}{2\widehat{r}}\left[\widehat{r}^2 + \frac{R^2}{\lambda^2}\left(1-\frac{\phi}{2}\right)^2\right] \\
&= \frac{\widehat{r}}{2} + \frac{1}{2\widehat{r}}\frac{R^2}{\lambda^2}\left(1-\frac{\phi}{2}\right)^2.
\end{aligned}
$$

Therefore,

$$
\begin{aligned}
\frac{\partial AM}{\partial \lambda} &= \frac{\partial I}{\partial \lambda} + \frac{\partial II}{\partial \lambda} \\
&= -\frac{R^2}{\lambda^2}\frac{1}{\widehat{r}}\left(1-\frac{\phi}{2}\right) + \frac{\widehat{r}}{2} + \frac{1}{2\widehat{r}}\frac{R^2}{\lambda^2}\left(1-\frac{\phi}{2}\right)^2 \\
&= \frac{R^2}{\lambda^2}\frac{1}{\widehat{r}}\left(1-\frac{\phi}{2}\right)\left(-\frac{\phi}{2}-\frac{1}{2}\right) + \frac{\widehat{r}}{2} \\
&= -\frac{R^2}{2\widehat{r}\lambda^2}\left(1-\frac{\phi}{2}\right)(1+\phi) + \frac{\widehat{r}}{2}.
\end{aligned}
$$

Contrary to $\partial AB/\partial\lambda$, $\partial AM/\partial\lambda$ is negative if $\widehat{r}$ is low.

Higher asset return R

$$
\begin{aligned}
\frac{\partial A}{\partial R} &= \frac{1-w}{w}\left[\left(1-\frac{r^*}{\widehat{r}}\right) + R \cdot -\frac{1}{\widehat{r}}\frac{\partial r^*}{\partial R}\right] \\
&= \frac{1-w}{w}1 - 2\frac{r^*}{\widehat{r}}.
\end{aligned}
$$

$$
\begin{aligned}
\frac{\partial B}{\partial R} &= \frac{1-w}{w}\lambda\frac{r^*}{\widehat{r}}\frac{\partial r^*}{\partial R} \\
&= \frac{1-w}{w}\frac{r^*}{\widehat{r}}\left(1-\frac{\phi}{2}\right).
\end{aligned}
$$

$$
\begin{aligned}
\frac{\partial AB}{\partial R} &= \frac{\partial A}{\partial R}+\frac{\partial B}{\partial R} \\
&= \frac{1-w}{w}\left[1-2\frac{r^*}{\widehat{r}}+\frac{r^*}{\widehat{r}}\left(1-\frac{\phi}{2}\right)\right] \\
&= \frac{1-w}{w}\left[1-\frac{r^*}{\widehat{r}}\left(1+\frac{\phi}{2}\right)\right] \\
&= \frac{1-w}{w}\left[1-\frac{R}{\lambda\widehat{r}}\left(1-\frac{\phi^2}{4}\right)\right].
\end{aligned}
$$

When $\widehat{r}$ is low, $\partial AB/\partial R$ is negative.

$$
\begin{aligned}
\frac{\partial I}{\partial R} &= \frac{1}{\widehat{r}}\left[\frac{\partial r^*}{\partial R}R+r^*\right] \\
&= 2\frac{r^*}{\widehat{r}}.
\end{aligned}
$$

$$
\begin{aligned}
\frac{\partial II}{\partial R} &= -\lambda\frac{r^*}{\widehat{r}}\cdot\frac{\partial r^*}{\partial R} \\
&= -\frac{r^*}{\widehat{r}}\left(1-\frac{\phi}{2}\right).
\end{aligned}
$$

$$
\begin{aligned}
\frac{\partial AM}{\partial R} &= \frac{\partial I}{\partial R} + \frac{\partial II}{\partial R} \\
&= 2\frac{r^*}{\widehat{r}} - \frac{r^*}{\widehat{r}}\left(1 - \frac{\phi}{2}\right) \\
&= \frac{r^*}{\widehat{r}}\left(1 + \frac{\phi}{2}\right),
\end{aligned}
$$

which is larger than zero.

Lower relative underperformance aversion (ϕ)

$$
\begin{aligned}
\frac{\partial A}{\partial \phi} &= \frac{1-w}{w} \cdot -\frac{1}{\widehat{r}}\frac{\partial r^*}{\partial \phi} \\
&= \frac{1-w}{w}\frac{R^2}{2\widehat{r}}.
\end{aligned}
$$

$$
\begin{aligned}
\frac{\partial B}{\partial \phi} &= -\frac{1-w}{w}\lambda\frac{r^*}{\widehat{r}} \cdot -r_T\frac{\partial r^*}{\partial \phi} \\
&= -\frac{1-w}{w}\frac{R^2}{2\widehat{r}}\frac{1}{\lambda}\left(1 - \frac{\phi}{2}\right).
\end{aligned}
$$

$$
\begin{aligned}
\frac{\partial AB}{\partial \phi} &= \frac{\partial A}{\partial \phi} + \frac{\partial B}{\partial \phi} \\
&= \frac{1-w}{w}\frac{R^2}{2\widehat{r}}\left[1 - \frac{1}{\lambda}\left(1 - \frac{\phi}{2}\right)\right],
\end{aligned}
$$

which is positive, as by definition, a run is plausible to occur only when $\lambda > (1 - \phi/2)$

(see proposition 1).

$$\begin{aligned}\frac{\partial I}{\partial \phi} &= \frac{R}{\widehat{r}}\frac{\partial r^*}{\partial \phi} \\ &= -\frac{R^2}{2\lambda\widehat{r}}.\end{aligned}$$

$$\begin{aligned}\frac{\partial II}{\partial \phi} &= -\lambda\frac{r^*}{\widehat{r}} \cdot \frac{\partial r^*}{\partial \phi} \\ &= \frac{R^2}{2\lambda\widehat{r}}\left(1 - \frac{\phi}{2}\right).\end{aligned}$$

$$\begin{aligned}\frac{\partial AM}{\partial \phi} &= \frac{\partial I}{\partial \phi} + \frac{\partial II}{\partial \phi} \\ &= \frac{R^2}{2\lambda\widehat{r}}\left(2 - \frac{\phi}{2}\right),\end{aligned}$$

which is positive, as $\phi \leq 1$.

A.3 Appendix to Chapter 4

A.3.1 Proof for Proposition 3

Let $r = 0$, from 4.14,

$$\begin{aligned} \frac{k}{\alpha(\theta^*)} &= \frac{qy}{s} - \frac{e}{(1-\beta)\,a(\phi^*)} \\ \frac{sk}{\alpha(\theta^*)\,pC} &= \frac{qy}{pC} - \frac{se}{(1-\beta)\,a(\phi^*)\,pC} \end{aligned}$$

Substitute into 4.19,

$$\begin{aligned} x^* &= \beta\frac{qy}{pC} + (1-\beta)\frac{qy}{pC} - \frac{se}{(1-\beta)\,a(\phi^*)\,pC} \\ &= \frac{1}{pC}\left[qy - \frac{s}{(1-\beta)}\frac{e}{a(\phi^*)}\right] \end{aligned}$$

or

$$p_T = \frac{1}{C}\left[qy - \frac{s}{(1-\beta)}\frac{e}{a(\phi^*)}\right]$$

$$\begin{aligned} \frac{\partial p_T}{\partial b} &= \frac{\frac{se}{1-\beta}}{a(\phi^*)^2}\cdot a'(\phi^*)\,\frac{\partial\phi^*}{\partial b} \\ &= \frac{s}{\beta}\frac{a'(\phi^*)}{a(\phi^*)^2} \end{aligned}$$

From 4.19,

$$\begin{aligned}
\frac{\partial p_T}{\partial y} &= \beta q + (1-\beta)\, sk \cdot -1\alpha\left(\theta^*\right)^{-2} \cdot \alpha'\left(\theta^*\right) \frac{\partial \theta^*}{\partial y} \\
&= \beta q - (1-\beta)\, sk \frac{\alpha'\left(\theta^*\right)}{\alpha\left(\theta^*\right)^2} \frac{\partial \theta^*}{\partial y}
\end{aligned}$$

So, $\mid \partial p_T/\partial b \mid$ tends to be larger than $\mid \partial p_T/\partial y \mid$ if β is small and $\frac{a'(\phi^*)}{a(\phi^*)^2}$ is relatively large compared to $\frac{\alpha'(\theta^*)}{\alpha(\theta^*)^2}$.

A.3.2 Proof for Proposition 4

Let $r = 0$. From 4.19,

$$\begin{aligned}
\frac{\partial p_T}{\partial \beta} &= qy + sk\left[-1\alpha\left(\theta^*\right)^{-1} - (1-\beta)\,\alpha\left(\theta^*\right)^{-2} \cdot \alpha'\left(\theta^*\right) \frac{\partial \theta^*}{\partial \beta}\right] \\
&= qy - \frac{sk}{\alpha\left(\theta^*\right)}\left[1 + (1-\beta) \frac{\alpha'\left(\theta^*\right)}{\alpha\left(\theta^*\right)^2} \frac{\partial \theta^*}{\partial \beta}\right]
\end{aligned}$$

Since $qy > sk/\alpha\left(\theta^*\right)$ by definition (expected output is larger than discounted recruiting cost), $\partial p_T/\partial \beta > 0$ if $\partial \theta^*/\partial b > 0$, for labour market tightness and matching function are negatively related ($\alpha'\left(\theta^*\right) < 0$). But if $\partial \theta^*/\partial b < 0$, then $\partial p_T/\partial \beta$ may be smaller than zero if the second term outweighs the first. This would happen if the conditions in Proposition 4 prevail.

A.3.3 Reasons for Credit Tightening as reported in the ECB Bank Lending Survey

- Cost of funds and balance sheet constraints

  - Costs related to your bank's capital position
  - Bank's ability to access market financing
  - Bank's liquidity position

- Pressure from competition
  - Competition from other banks
  - Competition from non-banks
  - Competition from market financing

- Perception of risk
  - General economic situation and outlook
  - Industry or firm-specific situation and outlook
  - **Risk related to the collateral demanded**

- Bank's risk tolerance

Bibliography

[1] Abreu, D. and M. K. Brunnermeier (2003). Bubbles and Crashes. *Econometrica 71*(1), 173–204.

[2] Acharya, V. V., H. S. Shin, and T. Yorulmazer (2013). A Theory of Arbitrage Capital. *Review of Corporate Finance Studies 2*(1), 62–97.

[3] Adrian, T. and H. Shin (2008). Financial Intermediaries, Financial Stability and Monetary Policy. *Federal Reserve Bank of New York Staff Report*.

[4] Adrian, T. and H. S. Shin (2010). Liquidity and Leverage. *Journal of Financial Intermediation 19*(3), 418–437.

[5] Altunbas, Y., L. Gambacorta, and D. Marques-Ibanez (2014). Does Monetary Policy Affect Bank Risk? *International Journal of Central Banking 10*(1), 95–135.

[6] Andrews, D. W. K. (2003). End-of-sample Instability Tests. *Econometrica 71*(6), 1661–1694.

[7] Arellano, M. and O. Bover (1995). Another Look at the Instrumental-Variable Estimation of Error-components Models.

[8] Baker, M., B. Bradley, and J. Wurgler (2011). Benchmarks as Limits to Arbitrage: Understanding the Low-volatility Anomaly. *Financial Analysts Journal 67*(1), 40–54.

[9] Bank for International Settlements (2009). Chapter 2 : Roles and Objectives of Modern Central Banks. *Issues in the Governance of Central Banks*, 17–55.

[10] Bank of Japan (2011). Functions and Operations of the Bank of Japan. Technical report.

[11] Basak, S., A. Pavlova, and A. Shapiro (2008). Offsetting the Implicit Incentives: Benefits of Benchmarking in Money Management. *Journal of Banking and Finance 32*(9), 1883–1893.

[12] Ben S Bernanke (2010). Monetary Policy and the Housing Bubble. *Speech by Mr Ben S Bernanke, Chairman of the Board of Governors of the Federal Reserve System, at the Annual Meeting of the American Economic Association, Atlanta, Georgia, 3 January 2010.*.

[13] Bernanke, B. S. and M. Gertler (1989). Agency Costs, Net Worth, and Business Fluctuations. *The American Economic Review 79*(1), pp. 14–31.

[14] Bernanke, B. S. and M. Gertler (1999). Monetary Policy and Asset Price Volatility. *Economic Review (Fed of Kansas City)*, 17–51.

[15] Bernanke, B. S., M. Gertler, and S. Gilchrist (1999). Chapter 21 The Financial Accelerator in a Quantitative Business Cycle Framework.

[16] Bernanke, B. S., V. R. Reinhart, and B. P. Sack (2004). Monetary Policy Alternatives at the Zero Bound: An Empirical Assessment. *Finance and Economics Discussion Series, Divisions of Research & Statistics and Monetary Affairs, Federal Reserve Board, Washington, D.C.* (48).

[17] Blinder, A. (1999). General Discussion: Monetary Policy and Asset Price Volatility. *Fed of Kansas City Economic Review 4*, 139–140.

[18] Bordo, M. D. (2007). The Crisis of 2007: The Same Old Story Only the Players have Changed. *Globalization and systemic risk.*, 39–50.

[19] Borio, C. (2014). The Financial Cycle and Macroeconomics: What have We Learnt? *Journal of Banking and Finance 45*(1), 182–198.

[20] Borio, C. and H. Zhu (2012). Capital Regulation, Risk-taking and Monetary Policy: A Missing Link in the Transmission Mechanism? *Journal of Financial Stability 8*(4), 236–251.

[21] Broner, F. A., R. Gaston Gelos, and C. M. Reinhart (2006). When in Peril, Retrench: Testing the Portfolio Channel of Contagion. *Journal of International Economics 69*(1 SPEC. ISS.), 203–230.

[22] Bruno, V. and H. S. Shin (2015). Capital Flows and the Risk-taking Channel of Monetary Policy. *Journal of Monetary Economics 71*, 119–132.

[23] Calomiris, C. W. and G. Gorton (1991). The Origins of Banking Panics : Models , Facts , and Bank Regulation. In *Financial Markets and Financial Crises*, Number January, pp. 109 – 174. University of Chicago Press.

[24] Calvo, G. A. and E. G. Mendoza (2000). Rational Contagion and the Globalization of Securities Markets. *Journal of International Economics 51*(1), 79–113.

[25] Campello, M., J. R. Graham, and C. R. Harvey (2010). The Real Effects of Financial Constraints: Evidence from a Financial Crisis. *Journal of Financial Economics 97*(3), 470–487.

[26] Carlsson, H. and E. van Damme (1993). Global Games and Equilibrium Selection. *Econometrica 61*(5), 989–1018.

[27] Cashman, G. D., D. N. Deli, F. Nardari, and S. Villupuram (2012). Investors Do Respond to Poor Mutual Fund Performance: Evidence from Inflows and Outflows. *Financial Review 47*(4), 719–739.

[28] Chen, Q., I. Goldstein, and W. Jiang (2010). Payoff Complementarities and Financial Fragility: Evidence from Mutual Fund Outflows. *Journal of Financial Economics 97*(2), 239–262.

[29] Chevalier, J. and G. Ellison (1997). Risk Taking by Mutual Funds as a Response to Incentives. *Journal of Political Economy 105*(6), 1167–1200.

[30] Chinn, M. D. and H. Ito (2006). What Matters for Financial Development? Capital Controls, Institutions, and Interactions. *Journal of Development Economics 81*(1), 163–192.

[31] Christensen, I. and A. Dib (2008). The Financial Accelerator in an Estimated New Keynesian Model. *Review of Economic Dynamics 11*(1), 155–178.

[32] Criste, A. and I. Lupu (2014). The Central Bank Policy between the Price Stability Objective and Promoting Financial Stability. *Procedia Economics and Finance 8*, 219–225.

[33] Dang, T. T. V., G. Gorton, and B. Holmström (2015). The Information Sensitivity of a Security.

[34] Dang, T. V., G. Gorton, B. R. Holmström, and G. Ordonez (2014). Banks as Secret Keepers. *NBER Working Paper Series*.

[35] Davis, J. S., A. Mack, and M. A. Wynne (2014). Central Bank Transparency Anchors Inflation Expectations. *Economic Letter 9*.

[36] De Nicolò, G., G. D. Ariccia, L. Laeven, and F. Valencia (2010). Monetary Policy and Bank Risk Taking. *Review Literature And Arts Of The Americas* (July).

[37] Diamond, D. W. and P. H. Dybvig (1983). Bank Runs, Deposit Insurance, and Liquidity. *Journal of Political Economy 91*(3), 401–419.

[38] Diamond, P. A. (1982). Aggregate Demand Management in Search Equilibrium. *Journal of Political Economy 90*(5), 881–894.

[39] Didier, T., C. Hevia, and S. L. Schmukler (2012). How Resilient and Countercyclical were Emerging Economies during the Global Financial Crisis? *Journal of International Money and Finance 31*(8), 2052–2077.

[40] Drehmann, M., C. Borio, and K. Tsatsaronis (2012). Characterising the Financial Cycle: Don't Lose Sight of the Medium Term! *BIS Working Papers* (380), 1–38.

[41] Duan, J. C. and E. Van Laere (2012). A Public Good Approach to Credit Ratings - From Concept to Reality. *Journal of Banking and Finance 36*(12), 3239–3247.

[42] Duygan-Bump, B., A. Levkov, and J. Montoriol-Garriga (2015). Financing Constraints and Unemployment: Evidence from the Great Recession. *Journal of Monetary Economics 75*, 89–105.

[43] El-Erian (2015, jan). Understanding the Chaotic End to Switzerland's Currency Peg. *Financial Times*.

[44] Fabbri, D. and L. F. Klapper (2015). Bargaining Power and Trade Credit. *Journal of Corporate Finance*.

[45] Farmer, R. E. A. (2013). Animal Spirits, Financial Crises and Persistent Unemployment. *Economic Journal 123*(568), 317–340.

[46] Feroli, M., A. K. Kashyap, K. L. Schoenholtz, and H. S. Shin (2014). Market Tantrums and Monetary Policy. *SSRN Electronic Journal 1*(February).

[47] Financial Crisis Inquiry Commission (2011). Financial Crisis Inquiry Report. Technical Report May.

[48] Gambacorta, L. (2009). Monetary Policy and the Risk-taking Channel. *BIS Quarterly Review*, 43–53.

[49] Geanakoplos, J. D. (2009). The Leverage Cycle. In D. Acemoglu, K. S. Rogoff, and M. Woodford (Eds.), *NBER Macroeconomics Annual*, Number 1715, pp. 1–66. University of Chicago Press.

[50] Giroud, X. and H. M. Mueller (2015). Capital and Labor Reallocation Within Firms. *Journal of Finance 70*(4), 1767–1804.

[51] Goetzmann, W. N., L. Li, and K. G. Rouwenhorst (2005). Long Term Global Market Correlations. *The Journal of Business 78*(1), 1–38.

[52] Goldstein, I. and A. Pauzner (2005). Demand-deposit Contracts and the Probability of Bank Runs. *Journal of Finance 60*(3), 1293–1327.

[53] Gorton, G. (2009). Information, Liquidity, and the (Ongoing) Panic of 2007. *American Economic Review 99*(2), 567–572.

[54] Gorton, G. and L. Huang (2004). Liquidity, Efficiency, and Bank Bailouts. *American Economic Review 94*(3), 455–483.

[55] Gorton, G. and G. Ordonez (2014). Collateral Crises. *American Economic Review 104*(2), 343–378.

[56] Gorton, G. and G. Pennacchi (1990). Financial Intermediaries and Liquidity Creation. *Journal of Finance 45*(1), 49–71.

[57] Greenspan, A. (1993). Comments on FOMC Communication. *in Hearing before the Committee on Banking, Finance and Urban Affairs, 103rd Congress, October 19, ed. by US House of Representatives*.

[58] Greenspan, A. (2003). Monetary Policy Under Uncertainty. *Speech before symposium sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole*.

[59] Gromb, D. and D. Vayanos (2010). Limits of Arbitrage. *Annual Review of Financial Economics 2*(1), 251–275.

[60] Haldane, A. (2014). The Age of Asset Management? *Speech at the London Business School's Asset Management Conference*.

[61] Hayek, F. A. (1967). *Studies in Philosophy, Politics, and Economics.* London and Henley: Routledge and Kegan Paul.

[62] Holmström, B. (2014). Understanding the Role of Debt in the Financial System. *paper delivered at the 13th BIS Annual* (January 2012), 1–48.

[63] Hördahl, P. and M. R. King (2008). Developments in Repo Markets during the Financial Turmoil. *BIS Quarterly Review* (December), 37–53.

[64] IMF (2015). The Asset Management Industry and Financial Stability. In *Global Financial Stability Report: Navigating Monetary Policy Challenges and Managing Risks*, Chapter 3, pp. 93–135.

[65] Ioannidou, V., S. Ongena, and J. L. Peydro (2015). Monetary Policy, Risk-taking, and Pricing: Evidence from a Quasi-natural Experiment. *Review of Finance 19*(1), 95–144.

[66] Jiménez, G., S. Ongena, J.-L. Peydró, and J. Saurina Salas (2014). Hazardous Times for Monetary Policy: What do Twenty-three Million Bank Loans Say about the Effects of Monetary Policy on Credit Risk Taking? *Econometrica 82*(2), 463–505.

[67] Johnson, S. (2009). The Quiet Coup. *The Atlantic* (May), 1–12.

[68] Joyce, M., D. Miles, A. Scott, and D. Vayanos (2012). Quantitative Easing and Unconventional Monetary Policy - an Introduction. *The Economic Journal 122*, 564.

[69] Joyce, M. A. S., A. Lasaosa, I. Stevens, and M. Tong (2011). The Financial Market Impact of Quantitative Easing in the United Kingdom. *International Journal of Central Banking 7*(3), 113–161.

[70] Keynes, J. M. (1936). The General Theory of Employment Interest and Money. The Collected Writings of John Maynard Keynes Vol. VII. *Journal Of The Czech Geological Society 49*, 161–172.

[71] Kindleberger, C. P. and R. Z. Aliber (2005). Manias, Panics, and Crashes: A History of Financial Crises. *The Economic Journal 5th*(2), 309.

[72] Kiyotaki, N. and J. Moore (1997). Credit Cycles. *Journal of Political Economy 105*(2), 211–248.

[73] Kocherlakota, N. (2010). Inside the FOMC. *Speech at Marquette, Michigan.*

[74] Kohn, D. L. (2006). Monetary Policy and Asset Prices. *Economic and Financial Review 13*(3), 135.

[75] Kohn, D. L. (2009). Monetary Policy and Asset Prices Revisited. *Speech at the Cato Institute's 26th Annual Monetary Policy Conference, Washington, D.C.*.

[76] Korinek, A. (2011). Hot Money and Serial Financial Crises. *IMF Economic Review 59*, 306 – 339.

[77] Krishnamurthy, A. and A. Vissing-Jorgensen (2011). The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy. *Brookings Papers on Economic Activity 2011*(2), 215–287.

[78] Liu, Z., J. Miao, and T. Zha (2013). Land Prices and Unemployment. *NBER Working Paper Series*.

[79] Love, I. and L. Zicchino (2006). Financial Development and Dynamic Investment Behavior: Evidence from Panel VAR. *The Quarterly Review of Economics and Finance 46*(2), 190–210.

[80] Maxwell, J. C. (1867). On Governors. *Proceedings of the Royal Society of London 16*, 270–283.

[81] McKinsey Global Institute (2013). Financial Globalisation: Retreat or Reset?

[82] Meade, E. E. and D. Stasavage (2008). Publicity of Debate and the Incentive to Dissent: Evidence from the US Federal Reserve. *Economic Journal 118*(528), 695–717.

[83] Mian, A. and A. Sufi (2014). What Explains the 2007-2009 Drop in Employment? *Econometrica 82*(6), 2197–2223.

[84] Miao, J., P. Wang, and L. Xu (2016). Stock Market Bubbles and Unemployment. *Economic Theory 61*(2), 273–307.

[85] Michael Bordo (2007). The Crisis of 2007: Some Lessons from History. In *The First Global Financial Crisis of the 21st Century*, pp. 51–54.

[86] Minsky, H. P. (1989). Comment on "Economic Implications of Extraordinary Movements in Stock Prices" by B.M. Friedman and D.A. Laibson. *Brookings Papers on Economic Activity 2*(3), 173–189.

[87] Mises, L. V. (1953). *The Theory of Money and Credit*. New Haven: Yale University Press, 1953.

[88] Morris, S. and H. S. Shin (1998). Unique Equilibrium in a Model of Self-Fulfilling Currency Attacks. *American Economic Review 88*(3), 587–597.

[89] Morris, S. and H. S. Shin (2002). Social Value of Public Information. *American Economic Review 92*(5), 1521–1534.

[90] Morris, S. and H. S. Shin (2003). Global Games: Theory and Applications. *Econometric Society Monographs 35*, 56—-114.

[91] Morris, S. and H. S. Shin (2014). Risk-Taking Channel of Monetary Policy: A Global Game Approach. *Working Paper Series I*, 1–22.

[92] Mortensen, D. T. (1982). Property Rights and Efficiency in Mating, Racing, and Related Games. *The American Economic Review 72*(5), 968–979.

[93] Mumtaz, H. and F. Zanetti (2013). The Impact of the Volatility of Monetary Policy Shocks. *Journal of Money, Credit and Banking 45*(4), 535–558.

[94] Office of Financial Research (2014). Asset Management and Financial Stability.

[95] Ostry, J. D. (2012). Managing Capital Flows: What Tools to use? *Asian Development Review 29*(1), 82–88.

[96] Ostry, J. D., A. R. Ghosh, M. Chamon, and M. S. Qureshi (2012). Tools for Managing Financial-stability Risks from Capital Inflows. *Journal of International Economics 88*(2), 407–421.

[97] Patinkin, D. (1956). *Money, Interest, and Prices: An Integration of Monetary and Value Theory*. Row, Peterson.

[98] Phillips, A. (1957). Stabilisation Policy and the Time Form of Lagged Responses. *Economic Journal 67*, 265–277.

[99] Pissarides, C. A. (1985). Short-Run Equilibrium Dynamics of Unemployment, Vacancies, and Real Wages. *American Economic Review 75*(4), 676–690.

[100] Rajan, R. G. (2005). Has Financial Development made the World Riskier?

[101] Rebelo, S. and C. A. Vegh (2008). When is it Optimal to Abandon a Fixed Exchange Rate? *Review of Economic Studies 75*(3), 929–955.

[102] Reinhart, C. M. and V. R. Reinhart (2008). Capital Flow Bonanzas: an Encompassing View of the Past and Present. *NBER Working Paper Series*, 1–68.

[103] Reinhart, C. M. and K. S. Rogoff (2014). Recovery from Financial Crises: Evidence from 100 Episodes. *American Economic Review 104*(5), 50–55.

[104] Rey, H. (2013). Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence. *Jackson Hole Symposium*, 1–41.

[105] Rochet, J.-C. and X. Vives (2004). Coordination Failures and the Lender of Last Resort: Was Bagehot Right After All? *Journal of the European Economic Association 2*(December), pp. 1116–1147.

[106] Roodman, D. (2009). How to do Xtabond2: An Introduction to Difference and System GMM in Stata. *Stata Journal 9*(1), 86–136.

[107] Sahay, R., V. Arora, T. Arvanitis, H. Faruqee, P. N'Diaye, and T. Mancini-Griffoli (2014). Emerging Market Volatility: Lessons from the Taper Tantrum. *IMF Staff Discussion Note*.

[108] Salter, M. (2013). Annals of Crony Capitalism: Revisiting the AIG Bailout. *Edmon J. Safra Working Papers 32*.

[109] Sargan, J. D. (1958). The Estimation of Economic Relationships Using Instrumental Variables. *Econometrica 26*(3), 393.

[110] Sarno, L. and M. Taylor (2008). *The Economics of Exchange Rates*. Cambridge, UK: Cambridge University Press.

[111] Schumpeter, J. (1934). Depressions. Can we Learn from Past Experience? In *Economics of the Recovery Program*.

[112] Shirakawa, M. (2012). Deleveraging and Growth: Is the Developed World Following Japan's Long and Winding Road? *Lecture at the LSE, co-hosted by the Asia Research Centre and STICERD, LSE.*.

[113] Shleifer, A. and R. Vishny (1997). The Limits to Arbitrage. *Journal of Finance 52*, 35–55.

[114] Singh, M. and J. Aitken (2009). Counterparty Risk, Impact on Collateral Flows and Role for Central Counterparties. *IMF Working Papers*, 1–15.

[115] Skidelsky, R. (2006). Hayek versus Keynes: The Road to Reconciliation. *Voprosy Ekonomiki* (6), 47–66.

[116] Speciale, A. (2016, feb). ECB Debated Preemptive Action to Counter Rising Global Risks.

[117] Stark, J. (2009). Monetary Policy Before, During and After the Financial Crisis. *Speech at the University of Tubingen (Germany)*.

[118] Stein, J. (2014a). Challenges for Monetary Policy Communication. *Speech at the Money Marketeers of New York University*.

[119] Stein, J. (2014b). Comments on "Market Tantrums and Monetary Policy". *Remarks prepared for 2014 Monetary Policy Forum*.

[120] Stockman, D. (2013). *The Great Deformation: the Corruption of Capitalism in America*. Public Affairs.

[121] Thao, T. and K. Daly (2012). The Impacts of the Global Financial Crisis on Southeast Asian Equity Markets Integration. *International Journal of Trade Economics and Finance 3*(4), 299–304.

[122] The CityUK (2013). Fund Management.

[123] Van Huyck, J. B., R. C. Battalio, and R. O. Beil (1990). Tacit Coordination Games, Strategic Uncertainty, and Coordination Failure. *American Economic Review 80*(1), 234–248.

[124] Vayanos, D. (2004). Flight To Quality , Flight To Liquidity , and the Pricing of Risk. *System* (February), 1–53.

[125] Wasmer, E. and P. Weil (2004). The Macroeconomics of Labor and Credit Market Imperfections. *American Economic Review 94* (4), 944–963.

[126] White, W. R. (2009). Should Monetary Policy "Lean or Clean"? *Working Paper, Globalisation and Moonetary Policy Institute, Federal Reserve Bank of Dallas. 41* (34), 1–24.

[127] Yellen, J. L. (2009). A Minsky Meltdown: Lessons for Central Bankers. *FRBSF Economic Letter* (2009-15), 1–8.