Central Bankers' Dilemma When Banks Are Vulnerable: To Tighten or not to Tighten?

Aleš Bulíř and Martin Čihák [1]

November 2008

Abstract

The paper addresses the question whether and how stabilization policies react to financial sector vulnerability. Drawing on a theory paper by Bauducco, Bulíř, and Čihák (2008), we formulate a testable model of why monetary authorities may decide to conduct loose monetary policy in the face of financial sector vulnerability. Using cross-country panel data estimation, we find support for the hypothesis of deliberately lower policy interest rates when the financial sector appears unstable.

JEL Classification Numbers: E440, E520, G200

Keywords: stabilization policy, financial sector vulnerability, Taylor rule

Author's E-Mail Address: abulir@imf.org and mcihak@imf.org

---

[1] Both International Monetary Fund (IMF). The views expressed in this paper are those of the authors and do not necessarily represent those of the IMF or IMF policy. We would like to thank to Tomáš Holub and to participants of seminars at the International Monetary Fund and the Czech Economic Association for useful comments on earlier drafts. All remaining errors are ours.

Contents Page

"[A] reaction function in which the real funds rate changes by roughly equal amounts in response to deviations of inflation from a target of 2 percent and to deviations of actual from potential output describes reasonably well what this committee has done since 1986."
Janet Yellen at the January 1995 FOMC meeting

"The 1987 stock market crash is a real-world example of how monetary policy aimed at macro stability coupled with other types of policy emphasizing financial stability can minimize the economic fallout of a sharp decline in asset prices."
Ben S. Bernanke, 2002

"[The Asian crisis] was bad news for major investment firms [...] Who came to the rescue? [...] Greenspan started printing money and extending credit, pumping liquidity into the U.S. economy."
Jim Rogers, "For Whom the Closing Bell Tolls," 2003

I. INTRODUCTION

Do monetary authorities alter their policies when they find that the domestic financial sector has become less stable? Do they react by tightening monetary conditions in order to prevent a run or do they loosen monetary conditions to help the affected financial institutions? We argue, building on cross-country evidence, that in the short run monetary easing has been a part of the preferred policy mix against the background of financial system vulnerability.

The optimal monetary policy strategy against the background of financial sector vulnerability has been a contentious issue. On the one hand, it has been argued that by vigorously pursuing the goal of price stability, central banks will in fact best promote financial stability (Schwartz, 1995). Hence, any information about the state of the financial system is useful only to the extent it can be used to improve the inflation forecast. On the other hand, financial systems are inherently fragile and central banks have occasionally compromised the objective of price stability when banks' stability was threatened. Frequently, during financial and banking crises, solvency problems were treated by liquidity injections. Formally, these polar views can be simplified into whether or not to include asset prices in the monetary rule, see Bernanke and Gertler (1999) and Cecchetti and others (2000).

Somewhat surprisingly, explicit discussions of the precedence of financial versus price stability are relatively rare. Brousseau and Detken (2001) present a theoretical example of a possible conflict between short-term price stability and financial stability—if the stability of inflation is linked to the smoothness of the interest rate path, the goals of financial stability and minimizing deviations from the inflation target may not be mutually consistent. Borio and Lowe (2004) estimated empirically modified Taylor rule functions for Australia, Germany, Japan, and the United States, concluding that "central banks either do not respond much to financial imbalances or, to the extent that they do, they respond asymmetrically. Policy appears to be loosened in the face of the unwinding of imbalances beyond what would be suggested by the behaviour of inflation and the output gap alone, but does not seem to be tightened as imbalances build up." Evjen and others (2005) use macroeconomic stress tests for Norway to calculate the loan losses that would result if there were external shocks and the central bank applied a Taylor rule that disregards the financial sector. They find that there is no short-term conflict between financial and monetary stability when the economy is facing a typical negative aggregate demand shock, but such a conflict may arise when there is a cost-push shock resulting from, say, a sudden boost in wages. Driffil and others (2006) find the Federal Reserve reacts to interest rate futures. Ceccheti and Li (2005) attempt to identify a monetary policy strategy that both stabilizes macroeconomic activity and reinforces prudential capital requirements.

This paper tries to fill a gap in the empirical literature on the relationship between financial sector vulnerability and inflation stabilization policies. Case studies—e.g., from the South-East Asian crisis of 1997 (Ghosh and others, 2002; Lindgren and others, 1999) and Central European bank restructuring episodes in late 1990s (Anderson and Kegels, 1998)—suggest that country authorities indeed shielded vulnerable domestic financial institutions by accommodative monetary policies. However, the empirical relationship between monetary policy and financial sector vulnerability has not yet been studied systematically. We attempt to bring together two strands of the literature, one outlining responsibility of central banks for financial system stability (Crockett, 1997; Schinasi, 2006) and the other defining central bank reaction function as the so-called monetary policy rule (Taylor, 1993, and Batini, Harrison, and Millard, 2003). This paper is—to our knowledge—the first one to estimate Taylor rules in a panel data setting.

The main contribution of the paper is finding that policy rates are lower when the financial system is under pressure. This empirical finding is based on a database for 28 countries in 23 years (1980–2003). In the absence of a general agreement on the definition of financial sector (in)stability, we use a battery of measures that have been proposed as possible proxies. Across the specifications, we find that monetary policy generally tends to be looser during episodes of increased vulnerability.

The structure of the paper is as follows. The second section reviews selected examples of central banks' responses to instances of observed financial sector vulnerability. The third section introduces a model of monetary policy reaction to financial sector vulnerability. We use this model to address the question why would authorities prefer to accommodate financial sector vulnerability by higher expected inflation rather than keeping price stability. The fourth section presents results of an empirical estimate of the relationship between monetary policy rates and financial sector vulnerability. The fifth section concludes.

II. Financial Sector Vulnerability and Central Bankers: Selected Examples

Central banks' responses to instances of observed financial sector vulnerability varied considerably, depending, among other things, on the choice of the exchange rate regime and political circumstances.

Country authorities' reaction to financial sector vulnerability can take a number of forms. Those can be broadly divided into (i) monetary policy measures, such as changing policy interest rates; (ii) liquidity support, which may be needed in the most severe circumstances; (iii) administrative measures, such as credit ceilings; (iv) prudential (regulatory and supervisory) measures; (v) structural and outreach measures, such as publishing reports that alert market participants and the public to financial sector risks; and (vi) measures to develop markets and institutions, such as creation of credit information sharing mechanisms.[2]

This paper focuses exclusively on the authorities' reaction to financial sector vulnerability through the monetary stance, and does not focus on the other policy measures listed above. It does not follow that we consider the non-monetary other measures as less important. On the contrary, we expect supervisory and market-building measures to be among the first lines of defense. We focus on monetary policy because its role in addressing financial sector vulnerability is less straightforward, and yet more open to theoretical and empirical analysis.

The reaction of monetary authorities to financial sector vulnerability is neither automatic, nor mechanical. In the following four examples we illustrate the range of potential policy responses to various forms of vulnerability. Monetary policy developments ranged from tightening (Norway) to loosening (United States), while the Czech authorities did not alter their stance. Among other things, these examples illustrate that the reaction seems conditional on the exchange rate regime (the scope for monetary loosening is limited under a peg) and political circumstances.

- ***Terrorist attacks of 9-11 (United States and Euro Area, 2001).*** Faced with potentially enormous economic costs, the U.S. Federal Reserve and the Eurosystem took a number

---

[2] Hilbers and others (2005) discuss the macroeconomic, prudential, administrative, and other measures in the context of risks related to rapid credit growth. They reason that the choice of tools should correspond to the nature of risks faced: when the risks are macroeconomic, macroeconomic policy should be used; when the risks are prudential, regulatory and supervisory tools should be used as the first line of defense. In practice, macroeconomic and prudential risks are often intertwined, and a combination of the two types of measures is needed.

of steps that included a massive injection of liquidity and cutting the main interest rates by 50 basis points "to give relief to financial markets" (Schinasi, 2006).

- ***LTCM (United States, 1998–99).*** Long-Term Capital Management (LTCM) was a hedge fund, founded in 1994, which nearly collapsed in 1998, losing $4.6 billion. Although the potential economic losses were negligible, the Federal Reserve Bank of New York orchestrated a bailout by Wall Street firms. On Sep 29, 1999, six days after the bailout, the Fed cut rates by 25 basis points. On Oct 15, 1999, another 25 basis points cut followed, amid rumors that another hedge fund was in trouble.

- ***Banking crisis (Norway, 1988–92).*** Macroeconomic factors (oil price decline, high wage demands, and devaluation pressures) combined with financial sector risks (rapid growth in non-financial sector debt and asset prices, weak supervision in a deregulated financial sector) turned the financial boom into a bust. Facing substantial loan losses in the largest banks, the authorities injected capital, equivalent to 3 percent of GDP, into the banks. The initially loose monetary stance, guided by the ECU peg, was tightened during the crisis for external stability reasons, deepening the crisis further (Steigum, 2003).

- ***IPB (Czech Republic, 2000).*** Investiční a poštovní banka (IPB) was one of the three largest local banks. Its fast growth and appetite for risk eventually led to substantial losses. Amidst a deposit run in June 2000, the authorities imposed a conservatorship on IPB, and agreed to its takeover by another large bank, promising to compensate the new owner for the difference between the value of audited IPB's assets and liabilities. Policy rates remained unchanged, even though short-term market rates temporarily increased by about 20 basis points.

- ***2007-08 Global financial crisis***

III. A Model of Monetary Policy Adjustment to Financial Sector Vulnerability

We outline a formal model linking financial sector vulnerability with the monetary stance model that suggests that central banks may have motivation to inflate if the financial system appears unstable. The motivation to inflate is primarily fiscal in our model, unlike in Cecchetti and Li (2005), where the motivation stems from optimal monetary policy in the context of procyclical capital requirements.

A. Financial Sector Vulnerability, Interest Rates, and the Monetary Authorities

The monetary policy stance and financial sector vulnerability can be represented by a short-term policy rate, i, and an index of financial sector vulnerability, v, respectively. We will argue that for a given set of exposures in the financial system and for a given set of central bank's preferences, there is an equilibrium that determines simultaneously the level of financial sector vulnerability and policy rates.

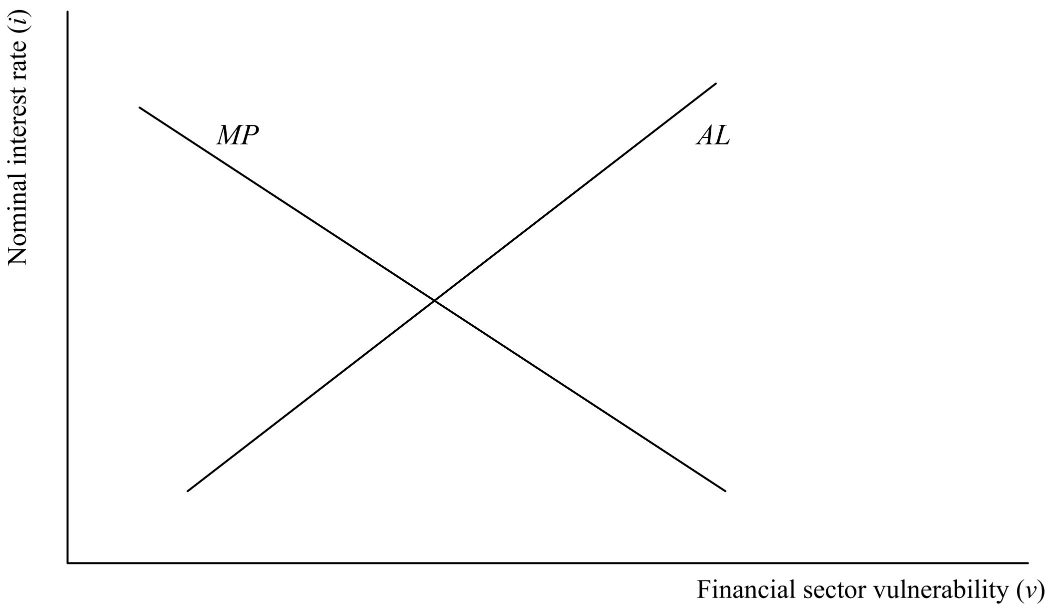
The first nexus concerns the “supply” of financial sector vulnerability and we expect vulnerability to be increasing in the policy rate. Balance sheets of financial institutions with a duration mismatch between assets and liabilities tend to be negatively affected by an increase in nominal interest rates through several channels. One channel of the negative balance sheet impact is the default risk of the marginal lending project increases owing to moral hazard and adverse selection processes (Stiglitz and Weiss, 1981; Kashyap and Stein, 2000). Another channel is based on the so-called duration gap that approximates the elasticity of the market values of assets and liabilities to the respective rates of return (International Monetary Fund, 2003). Several individual country studies found statistically significant relationship between the duration gap and interest rates.[3] Thus, if the market interest rate increase is large or unexpected, financial sector balance sheets may worsen and the whole sector may become unstable. This sensitivity of the interest rate-to-vulnerability nexus (the asset-liability line) is illustrated in Figure 1 by the slope of the *AL* line (AL standing for the asset-liability mismatch). While in countries with large asset-liability mismatches or with strong adverse selection processes the slope of *AL* can be steep, in others it can be relatively flat, for example, if interest rate increases result in widening of interest spreads, offsetting the impact on the quality of the asset portfolio. Given that our focus in this paper is on the monetary policy response rather than on the asset-liability mismatches, we relegate a formal derivation of the AL line to Appendix I.

The second nexus between financial sector vulnerability and short-term interest rates is the monetary policy reaction function and we the expect policy to be declining in vulnerability. A vulnerable financial system raises policymakers’ subjective probability of a future bailout or banking crisis. Bailouts and crises are costly for the economy and for the central bankers—if nothing else, their reputation suffers—and they seem motivated to avoid them (Section II). In the short run, the authorities could err on the side of caution and presume that what they see are temporary liquidity problems, even though they know that the preferred permanent solutions are strict supervision and speedy closure of insolvent banks. Hence, myopic authorities are likely to react by lowering the economy-wide rate of interest and inflating the economy.

---

[3] For instance, for Hong Kong SAR, Shu (2002) estimated that an increase in nominal interest rates by 1 percentage point leads to a rise in the classified loan ratio by 0.2 percentage points with a lag of 2 quarters.

Figure 1. Interest Rates and Financial Sector Vulnerability



It could be argued that there are some valid reasons for an initial injection of liquidity. First, the central bank may genuinely believe that it is faced with a liquidity crisis and the affected institutions will almost certainly present their cases in this way. Second, the central bank may want to gain additional time to explore options it may have in addressing the eventual impact of the observed vulnerability. Irrespective of the final systemic solution, the short run reputation cost of waiting seem small.[4] Finally, as we will show in Section III.C, it may be welfare optimizing to split the "financing" of the bailout between the government budget and inflation tax. This vulnerability-to-interest rate nexus, or monetary policy line (*MP* line), is illustrated in Figure 1 as the downward sloping line.

The authorities' autonomy to manipulate policy rates in response to vulnerability is clearly constrained. In fact, under perfect capital mobility and fixed exchange rates such an autonomy may not exist at all and the *MP* line is horizontal. The authorities are likely to lean on this nexus sparingly, "suspending" the Taylor rule only in the context of "crisis management" (Evjen and others, 2005 and Poole, 2006). Moreover, under fiscal dominance the authorities may have

[4] Central banker's motivation to act swiftly differs country by country. While the U.S. authorities tend to resolve financial system failures in a matter of days and are generally shielded from political interference, in a number of other countries these operations last much longer and are politically constrained.

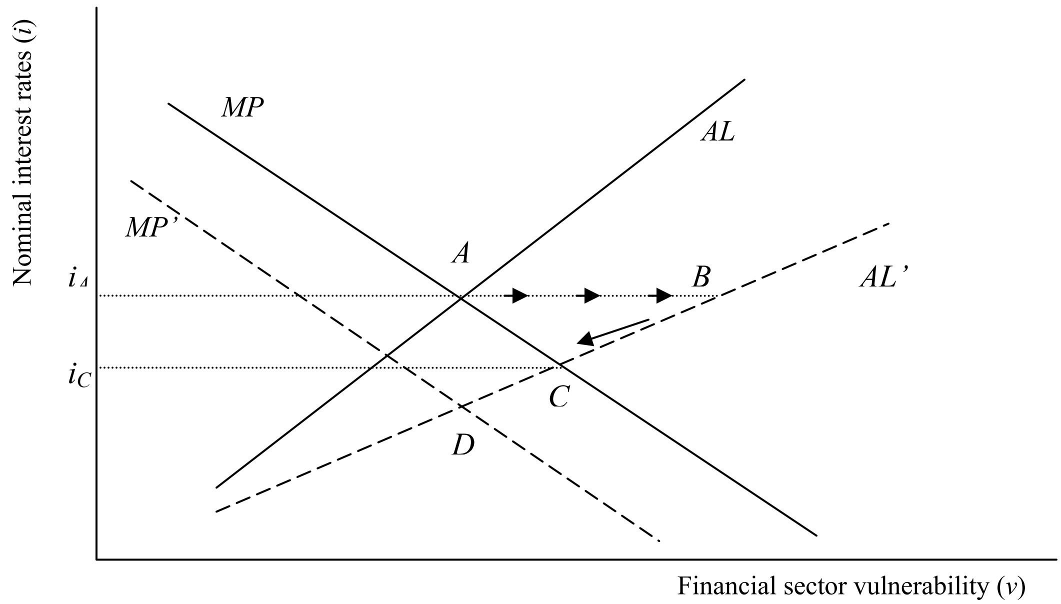
limited space to manipulate policy rates (Kumhof, Nunes, and Yakadina, 2006). Nevertheless, the omission of financial sector vulnerability in formally designed monetary rules is surprising (Batini, Harrison, and Millard, 2003).

B. Risk-Taking Behavior and the Authorities Reaction

Large enough financial sector vulnerability could result in temporary lower policy rates. Let us assume that financial institutions start taking additional risk, say, through larger interest rate exposures, and their portfolios become more vulnerable to interest rate changes. Graphically, the *AL* line pivots at the intercept (*AL'*). Other things being equal, the authorities would observe financial sector vulnerability increasing from point *A* to point *B* at the prevailing interest rate, i_A. Consequently, to mitigate the potential costs of vulnerability, the authorities may lower policy rates to i_C . The new equilibrium (point *C*) is characterized by a degree of vulnerability that is higher than in the old equilibrium (point *A*), but lower than it would be in the absence of monetary policy reaction (point *B*). It is a nonlinear, discrete, and short-run intervention: first, the authorities react only to a sizable increase in vulnerability, second, these interventions cannot be repeated too often, and, finally, they cannot last indefinitely—the policy would end in accelerating inflation (Barro and Gordon, 1983).

The *MP* line can also move. It will respond to changes in other Taylor rule variables. For example, if the economy were below its potential and unemployment above its NAIRU, the monetary authorities would be less concerned about inflation and more concerned about output consequences of disintermediation should vulnerability evolve into a financial crisis. In such a case, the *MP* line would shift downward to *MP'*, with commensurately lower equilibrium policy rate and lower equilibrium vulnerability (assuming that the system is in the new equilibrium in point *C*, it would move further to point *D*).

Figure 2. Risk Taking Behavior and the Authorities Reaction



C. A Model of the MP Line

This section builds on the Bauducco, Bulíř, and Čihák (2008) paper that extends the standard dynamic stochastic general equilibrium model of Galí (2002) to include a stylized financial system. The extension includes, first, financial intermediaries that supply external financing to some firms and, second, firms that are sensitive to the supply of loans and the interest rate and that are linked with the remaining firms through a productivity nexus. The economy contains five types of agents: households; goods-producing firms that are monopolistic competitors; innovative firms that are freely competitive; financial intermediaries, which are freely competitive as well; and a central bank.

The economy is populated with a continuum of infinitely-lived and identical households that derive utility from consumption of goods and leisure, and invest their savings in a financial intermediary that pays a nominal rate r_t for one-period deposits made at time t-1. The problem of the representative household can be written as $\max_{c_t, n_t} \; E_o \sum_{t=0}^{\infty} \beta^t U(c_t, n_t)$,

subject to its period-by-period budget constraint (in nominal terms) $P_t c_t + P_t d_t = P_t w_t n_t + r_t P_{t-1} d_{t-1} + P_t \Pi_t + P_t T_t$, where d_t are deposits, w_t is the wage rate, n_t is labor, Π_t are dividends, and T_t are lump sum taxes; all these variables are in real terms.

The first segment of the corporate sector is a continuum of infinitely-lived firms acting as monopolistic competitors. These firms produce a single perishable, differentiated good with a technology $y_t(j) = a_t n_t(j)$, where a_t is a technology shifter common to all firms. The competitive factor market guarantees that all firms pay the same nominal wage $W_t = P_t w_t$. These firms do not need to borrow from financial intermediaries, and are able to finance themselves through retained earnings. Following Calvo (1983), we assume that these firms adjust their prices infrequently and that the opportunity to adjust prices follows an exogenous Poisson process. Each period there is a constant probability $1-\theta$ that the firm will be able to adjust its price.

The non-financial corporate sector contains also firms that have to borrow from financial intermediaries to develop a project. These firms only live for two periods and operate under perfect competition. In period *t* such a firm invests in a project in order to obtain a return in period *t+1*. The technology is such that

$$s_{t+1}(j) = \chi(j) s_t(j) . \tag{1}$$

where $s_t(j)$ is the initial investment made by firm *j* in the project and $\chi(j)$ is the firm-specific return of the project.

For simplicity, a constant fraction γ of the firms born in period *t* survive with probability one in period *t+1* and the surviving, "risk-free" firms are the least profitable ones. The remaining firms may die at the beginning of period *t+1* with probability δ_{t+1}, where δ_{t+1} is stochastic. A firm that does not survive obtains a zero return for its project. Finally, δ_{t+1} is realized only at the beginning of period *t+1*, after firms have applied for and received loans. The returns of innovative firms are nonstochastic, firm-specific, and distributed according to a log-normal distribution. The symbol γ is both the proportion of firms that survive with probability one next period and the most profitable non-risky firm.

The economy also contains a continuum of risk-neutral financial intermediaries that act as zero-profit go-betweens for households and innovative firms. These institutions receive deposits from households in period *t* and lend to innovative firms, charging for them a lending rate z_t. At time *t*+1 firms that have survived repay their loans and intermediaries pay to households the return r_{t+1} or zero if the firm fails. Intermediaries are able to monitor whether a firm exists or not without a cost, but cannot distinguish between firms and thus charge the same loan rate z_t to all firms. However, a firm *j* has an incentive to ask for a loan only if its expected project return is higher than the lending rate. In other words, there is no moral hazard problem in the model.

$$\chi(j) > z_t . \tag{2}$$

We assume that $z_t < \chi^{\max} \quad \forall t$. Therefore, the marginal firm ω_t to ask for a loan will be such that $\chi(\omega_t) = z_t$. The marginal-firm cutoff point ω_t can be interpreted as the proportion of innovative firms that have returns lower than z_t and, therefore, do not find it profitable to apply for a loan, ceasing to produce t+1. The proportion of firms asking for loans will be $1-\omega_t$.

In this economy riskiness and the lending rate are positively related. Given the technology of innovative firms, they have an infinite demand for loans, and since banks cannot distinguish among borrowers, they will divide their loanable resources into equal parts, providing the same amount of loans to each firm that asks for one: $l_t = \frac{d_t}{1-\omega_t}$. Thus, the riskiness of the whole loan portfolio is increasing (non-decreasing) in the lending rate. At higher rates fewer firms apply for a loan and the lending portfolio becomes more concentrated in the high-return and high-risk segment and thus more risky overall.[5]

Intermediaries' opportunity cost of a loan is a central bank bill that pays a nominal interest rate equal to i_t (policy rate), which is for all practical purposes equivalent to short-term treasury bill rate. Thus the return on lending to firms is equal to the return on investing in the central bank paper and the loan rate will be determined as the rate such that the expected returns from loans are equal to the interest rate i_t.

$$i_t d_t = E_t(z_t \tilde{l}_{t+1}), \qquad (3)$$

where $\tilde{l}_{t+1}$ are loans actually repaid in period *t+1*. Since banks do not know the probability of firm survival when they lend to them, they compute the loan rate based on their expectations of the δ_{t+1} shock. The *ex post* deposit rate will be thus $r_{t+1} = z_t \tilde{l}_{t+1} / d_t$. In other words, if a smaller proportion of loans are repaid in t+1, the (ex-post) deposit rate becomes smaller, which means an increase in the spread between the deposit rate on one hand and the policy rate and the lending rate on the other hand.

The economy-wide total technology a_t consists of two components. One component is exogenous and stochastic and follows an autoregressive process $\hat{a}_t^s = \rho^a \hat{a}_{t-1}^s + \varepsilon_t^a$, where ε_t^a is an independent and identically-distributed (i.i.d.) shock and $\hat{a}_t^s$ denotes log-deviations of a_t^s from steady state. The other, additional components of technology are the projects developed by

[5] Technically, it is possible for some combinations of parameters that the riskiness of the portfolio remains constant.

the innovative firms that asked for loans in period *t-1* and survived in period *t*. The production function for this type of technology is $a_t^i = \left[\int_{\omega_{t-1}}^{1} \left(s_t(j)\delta_t^*(j) \right)^{\frac{\tau-1}{\tau}} dj \right]^{\frac{\tau}{\tau-1}}$, where $\delta_t^*(j) = 1$ if the firm survived in period *t* and zero otherwise, and τ is the elasticity of substitution between any two projects *j* and *j'*. Substituting (1) into the last expression and rearranging, one obtains $a_t^i = \left[\int_{\omega_{t-1}}^{1} \left(\chi(j)\delta_t^*(j) \right)^{\frac{\tau-1}{\tau}} dj \right]^{\frac{\tau}{\tau-1}} \frac{d_{t-1}}{1-\omega_{t-1}}$. Finally, total technology combines both components according to a Cobb-Douglas function, $a_t = a_t^{i\,\alpha} a_t^{s\,1-\alpha}$, where α is the contribution of technology generated by innovative firms, a_t^i, to total technology.

The central bank seeks to stabilize the economy, which means that it responds to the productivity and survival shocks that hit the two types of firms (a_t^s and δ_t, respectively), however, it may or may not respond to the state of the financial system. First, the central bank sets its policy rate according to the simple Taylor rule,

$$\hat{i}_t = \phi_\pi \hat{\pi}_t + \phi_x x_t \tag{4}$$

where i_t is the policy rate, $\hat{\pi}_t$ is inflation in period *t* and x_t is the output gap, defined as the difference between actual output and natural output (that is, output in the flexible price allocation). While this is a backward-looking rule, it needs to be tested against a forward-looking rule that contains expected inflation (in *t*+1) instead of the current inflation (in *t*). While the latter rule is closer to the modeling practice in modern central banks, the resulting paths of inflation and output are similar.

Second, the central bank continually monitors financial intermediaries and their counterparts to infer the state of the economy and the impact of financial institutions' health on the real economy. This information is likely to be collected through prudential supervision of financial intermediaries (if the central bank has prudential powers), or through the central bank's role in the payment system. This information is confidential, that is, exclusive to the central bank on the systemic level. Empirical studies suggest that if central banks have recent supervisory information from on-site visits, they can achieve better predictions of financial stability than is possible based on publicly available data.[6] On the one hand, with no systemic risk, the usual

[6] Berger, Davies, and Flannery (2000) find that assessments based on freshly updated U.S. supervisory inspections tend to be more accurate than equity and bond market indicators in predicting performance of large bank holding companies. The predictive power of supervisory

(continued…)

Taylor rule would apply. On the other hand, with sizable systemic risk and low chances of survival for borrowing firms, the central bank would employ its private information on δ_t at the *beginning* of period *t*, possibly augmenting its rule-based decision with this information. The policy response function would look as follows:

$$\hat{i}_t = \begin{cases} \phi_\pi \hat{\pi}_t + \phi_x x_t & \text{if } (\delta_{t+1} - E_t \delta_{t+1}) < 0 \\ \phi_\pi \hat{\pi}_t + \phi_x x_t + (\phi_\delta + \nu^\delta)(\delta_{t+1} - E_t \delta_{t+1}) & \text{otherwise} \end{cases} \quad (5)$$

where $\phi_\delta < 0$ and ν^δ is a shock to the sensitivity of the rule to movements in δ_t, capturing both the reporting lags and the policymaker's nonlinear and asymmetric response to these movements. The term ν^δ also guarantees that private agents cannot infer δ_t from the interest rate set by the central bank, estimating ϕ_π, ϕ_x and ϕ_δ from the interest rate set by the central bank. In other words, we impose a limit on signal extraction by central bank observers.

The timing of events is as follows: at the beginning of every period, after δ_t and a_t^s are realized, total technology a_t is observed. Households make their decisions on consumption, saving, and labor allocations, forming their expectations based on the information they possess at the time. The central bank sets the policy rate according to the rule (4) in the benchmark scenario; while it employs the augmented rule (5) in the alternative scenarios, using also different values of this information in the rule (ϕ_δ).

Financial instability corresponds to a negative shock to the probability of survival (δ_t) of one standard deviation (ε^δ) and the policy response depends on the rule chosen. The negative default shock in period 0 results in a decline in output in period 1, translating into fewer firms surviving the next period and, consequently, less generation of endogenous technology in period 1. Inflation increases and aggregate demand decreases less than the fall in the natural level of output. The presence of the innovative shock alters significantly the responses in the first period from the ones in period 2 onwards. In period 1, the negative performance of current and future output impacts negatively on deposits. In addition to this, the higher default rate causes ω_1 to increase. These two elements depress further the creation of endogenous technology in period 2, causing labor (and, consequently, the output gap) to increase above its steady state level. When the central bank follows a simple Taylor rule, it fails to react in period 1 to the next-period shock to the probability of survival, δ_2, even though it possesses this information. The central bank reacts only from period 2 onwards, when the shock has already affected the economy, widening

---

data is even higher in economies with limited public availability of bank soundness data; see Bongini, Laeven, and Majnoni (2002).

the output gap and increasing inflation. At this point, the rule dictates that the central bank increase the policy rate, inducing a decline in aggregate demand and thus softening the effects of the shock.

The central bank may adjust its policy stance according to the augmented rule (5) before the shock affected total technology. Given that the central bank knows δ_2 in period 1, foreseeing the negative effects on the economy caused by a higher default rate, it can decrease the policy rate in period 1, in turn lowering the loan rate. The change in the expected deposit rate mimics the change in the policy rate, thus stimulating aggregate demand. Moreover, the decrease in the policy rate implies a lower cutoff point for the first-period marginal firm, ω_1, and it generates positive expectations over future activity and stimulates deposits. These two elements have a positive effect over endogenous technology in period 2, more than offsetting the negative effect of δ_2.

These simulations suggest that a central bank responding to financial sector instability is able to trade off higher initial inflation for more stable output and inflation later on. Under the traditional Taylor rule, the cost of ignoring information about δ is more pronounced, resulting in longer-lasting output decline and higher inflation. Of course, monetary policy is useful in reacting to financial stability shocks only to the extent private agents' signal extraction is limited—only the central bank has information on δ_{t+1} at the beginning of period *t*.

IV. Empirical Estimation

A. Estimation Strategy

The theoretical model leads to a testable prediction, namely that central banks faced with costly financial sector vulnerability may keep monetary policy more accommodative than they would do otherwise. In this section, we will test this prediction in a panel framework, using a Taylor rule augmented for measures of financial sector vulnerability.

To test the impact of financial sector vulnerability on stabilization policy, we estimate a Taylor-like policy rule in a broadly defined cross-country panel. The rule includes—in addition to the usual measures of country-specific output and inflation gaps and past interest rates—also control variables for external shocks and domestic financial sector vulnerability (ξ):

$$PV_{i,t} = f\left[(y-\bar{y})_{i,t}; y^G_{i,t}; \pi_{t-1}; i^G_{i,t}; debt_{i,t}; \xi_{i,t}; \lambda^G_{i,t}; \varepsilon_{i,t}\right], \tag{6}$$

where the policy variable (*PV*) are either domestic short-term nominal interest rates (*i*) or measures of domestic liquidity. Superscript *G* denotes world variables; *y* and $\bar{y}$ are actual and potential output, respectively; π is inflation; *debt* is the share of government debt on GDP; ξ measures the country specific financial sector vulnerability; λ^G measures financial contagion effects from the rest of the world; and ε are random shocks. We interpret the coefficient of ξ as a measure of policy importance of financial sector vulnerability in central bank policymaking.

This estimation needs to address three challenges. First, how to measure financial sector vulnerability, ξ. Second, how to distinguish the "supply" (AL) and "demand" (MP) lines in Figure 1. Third, how to account for differences in monetary policy frameworks and other differences in the policy setup (e.g., degree of central bank independence, exchange rate regime, central bank's involvement in banking supervision, and so on). We will now address these three challenges one by one.

Measuring financial sector stability (and vulnerability)

The exact meaning of financial sector stability has been subject to much debate during the 1990s, partly in relation to the series of financial sector crises. In response, central banks started publishing regular reports on financial sector stability, and some of them have put forward definitions of financial stability (for a survey of these reports, see Čihák, 2006). Also, a number of academic researchers tried to put forth their own measures of financial stability (see, e.g., Goodhart and others, 2006).

There are two broad approaches to defining financial sector stability. The first approach focuses on cases where vulnerability has developed into a full-fledged financial sector crisis (e.g, Mishkin, 1996; Caprio and Klingebiel, 2003). An important part of this literature tries to use the past crises to identify early warning indicators of future crises (see, e.g., Goldstein, Kaminsky, and Reinhart, 2000). These approaches are based on a 0/1 logic: either there is a (somewhat arbitrarily defined) crisis or there is no crisis. The advantage of this approach is that it is convenient for empirical work, since discrete realizations are easier to identify than continuous measures. However, an important limitation of this definition for our analysis is that situations of moderate financial sector vulnerability are excluded and that by focusing on actual realizations of crises it may overlook cases of increased vulnerability where a full-fledged crisis may have been averted by the monetary authorities' actions.

The second approach defines continuous measures of financial sector vulnerability. This includes various accounting ratios (such as capital adequacy, and various measures of profitability and asset quality), and a range of market-based measures (such as distance to default and credit default spreads). Many of these indicators, especially those in the first sub-group are a part of so-called financial soundness indicators (FSIs), a relatively new body of economic statistics that indicate the current financial health and soundness of the financial institutions in a country, and of their corporate and household counterparts. A substantial effort was undertaken in recent years to start producing comprehensive and cross-country comparable sets of FSIs. However, the available FSIs still suffer from methodological differences across countries and from short time series—most countries have started collecting low-frequency FSIs only from the mid-1990s.[7] Finally, individual FSIs by themselves do not provide a full picture of financial sector vulnerability. They therefore need to be combined; however, relatively little research is available on the links among these indicators.

The advantage of market-based variables, such as distance to default for a portfolio of banking sector shares or credit default swap spreads (see Appendix III), are based on publicly available data, are available in high frequency (sometimes daily) and can be forward looking. For these reasons, market-based indicators started to be used widely in central bank, IMF, and academic publications (see, e.g., Deutsche Bundesbank, 2005). The usefulness of these indicators depends on existence of deep financial markets.[8] Moreover, comparable data are available only for a shorter period (for distance to default, from 1990 for most countries).

Model-based proxies approximate vulnerability by using probability-of-crisis and time-to-crisis estimates derived from a separate logit and duration models, respectively (Appendix IV details these models). These estimates provide a comprehensive, model-based approach to measuring financial system vulnerability, based on actual realizations of crises. We employ model-based proxies from Schaeck, Čihák, and Wolfe (2006), who confirm that these estimates are robust to changes in the input data. A potential disadvantage of this approach is that given the limited number of crises in developed countries, the logit and duration models are largely driven by crises in low- and medium-income countries.

An increasingly popular measure of bank soundness is the Z-score (see, e.g., Boyd and Runkle (1993), Maechler, Mitra, and Worrell (2005), and Laeven and Levine (2006)). Its popularity stems from the fact that it is directly related to the probability of a bank's insolvency, i.e. the probability that the value of its assets becomes lower than the value of the debt. The z-score can be summarized as $z \equiv (k+\mu)/\sigma$, where k is equity capital as percent of assets, μ is average return as percent on assets, and σ is standard deviation of return on assets as a proxy for return volatility. The z-score measures the number of standard deviations a return realization has to fall in order to deplete equity, under the assumption of normality of banks' returns. A higher z-score

[7] It contains a discussion of the distinction between "Core Set" for which data are generally available and found highly relevant for analytic purposes in almost all countries, and "encouraged set" for which data are not as readily available and whose relevance could vary across countries (see also IMF and the World Bank, 2005).

[8] A separate form of market-based indicator are ratings issued by rating agencies. Rating is a lower frequency indicator than distance to default, however, it has similar advantages and disadvantages. Ratings are available only for a small sub-sample of financial institutions and thus, we did not include ratings in our analysis.

corresponds to a lower upper bound of insolvency risk—a higher z-score therefore implies a lower probability of insolvency risk.[9]

Considering that there are many various measures of vulnerability, but no agreement in the literature on which one is the best, we use a battery of possible measures, knowing that each of these have advantages and disadvantages. Table 2 provides an overview of the measures that we use in the paper, and their pros and cons.

Distinguishing demand and supply

The second empirical challenge is to separate the vulnerability-to-policy-rate nexus (the MP line) from the impact of high interest rate on financial firms balance sheets (AL line) and to this end, we use the method of instrumental variables (IV). The fact that changes in the AL and MP schedules are taking place simultaneously makes empirical estimation difficult. If we observe only real sector shocks, and thus only the MP schedule is shifting, we could directly estimate the AL line. Conversely, if we observe only financial sector shocks, and thus only the AL schedule is shifting, we could directly estimate the MP line. In reality, we are likely to observe both types of shocks, so we need to find variables that allow us to distinguish between these two types of shocks.[10]

The measurement issue of the two interest rates used for the AP and the MP lines can be challenging as well. On the one hand, to capture the monetary policy reaction function, we need the central bank's key policy rate or another policy-related variable. On the other hand, to measure the impact of market interest rates on the banking system, we need to capture nominal interest rates on deposits, loans, and debt instruments held by financial institutions. We use money market interest rate as a variable that is more correlated with the policy of the central bank than, for example, bank lending rates.

---

[9] The distance to default can be seen as a version of the z-score for banks uses the stock price data instead of accounting data to estimate the volatility in the economic capital of the bank. Distance to default is a superior alternative if the bank stocks are traded in liquid markets; otherwise, the z-score is superior.

[10] This modeling issues is similar to those related to measuring monetary policy's reaction to the stock market. Rigobon and Sack (2003) suggest using changes in volatility of stock prices to estimate the slope of the reaction function. Unlike the stock market literature, however, we do not have sufficiently rich high-frequency data on financial vulnerability that would enable us to use a similar approach.

Table 2. An Overview of Measures of Financial Vulnerability

Measure	**Advantages**	**Disadvantages**	**Included in this paper?**
Accounting measures			
Capitalization (equity to assets or capital to risk-weighted assets)	Relatively easy to collect and use. Used in previous papers, e.g. Ceccheti and Li (2005). Compared to some other accounting measures is available on higher (quarterly or monthly) frequency.	Dependent on the quality of the accounting and auditing profession. Available only in low frequency. Focuses on capital buffers, but not on sources of risks. High capitalization does not necessarily mean sound system if there are substantial risks.	No, because it can be a misleading indicator of stability when used alone.
Index of financial system soundness (IFSS), defined as IFSS = CAR/NPL, where CAR is the capital adequacy ratio and NPL are nonperforming loans to total loans.	Relatively easy to calculate. Used in previous papers, e.g. Das, Quintyn, and Chenard (2004).	Focuses only on credit risk. Ad hoc (in the absence of a well-specified underlying model, the same weights are applied to the two variables).	Yes.
Z-score (defined in text)	Has a clear link to probability of default.	Based on low frequency (annual) accounting data.	Yes.
Market-based measures			
Share price index	Available with a higher frequency and shorter lags.	Depend on the quality of the market. May be unreliable if the market is not liquid. May cover only a small part of the financial system.	No due to the superiority of the other market-based measures.
Distance to default	Generally available with a higher frequency and shorter lags.	Depend on the quality of the market. May be unreliable if the market is not liquid. May cover only a small part of the financial system.	Yes.
Credit default swaps	Generally available with a higher frequency and shorter lags.	Depend on the quality of the market. May be unreliable if the market is not liquid. May cover only a small part of the financial system.	Yes.
Ratings	Contains expert assessment of soundness.	Low coverage. Not available in a sufficiently high frequency.	No, due to the disadvantages.
Other			
Probability of crisis derived from a logit model (see Appendix IV).	Clear analytical link to systemic distress.	Most of crisis observations are from emerging markets and countries, not from advanced economies.	Yes.

Note: Except for the last indicator, all the indicators are derived from bank-by-bank data are therefore raise also complex issues of aggregation. Following most of the literature, we weight banks by total assets when aggregating.

Differences in policy frameworks

The third challenge is how to account for differences in policy frameworks, such as the exchange rate regime, central bank independence, or the role of the central bank in supervision. For example, for a given financial sector vulnerability shock, in economies with a flexible exchange rate we would expect a larger interest rate adjustment than in an economy with a peg. This is a testable proposition and we include a product of the financial sector vulnerability index and the degree of softness of the exchange rate peg (Reinhart and Rogoff, 2002) among control variables. Estimating Taylor rules in a panel data setting helps us address both the issue of short time series of financial sector vulnerability and policy frameworks.

The authorities' loss function can differ both across countries and across time.[11] To address this issue, first, we run the regressions for individual countries for those specifications of financial sector vulnerability for which we have long-enough series. Second, to control for cross-country differences in central banks' reactions to financial sector vulnerability we include a product of the financial sector vulnerability index with (i) an index of central bank independence and (ii) a dummy indicating whether the central bank has banking supervision responsibility or not, We expect to see relatively larger changes in policy rates in countries where central banks are less independent or that are involved in bank supervision. Finally, the creation of the Euro area introduced a break in most of the time series. We address the cessation of independent monetary policy in Euro area countries by including country-specific observations up to 1997 (with blanks after 1997), and by Euro area observations starting from 1997 (with blanks before 1997).

B. Estimation Results

We estimated a panel of quarterly macroeconomic and financial sector variables covering 28 countries for a period of 23 years (1980–2003). The main results of the empirical estimates are summarized in Table 3.[12] The underlying data, including data used in the logit and duration models that are used to estimate financial sector vulnerability, are described in more detail in Appendix II. The estimates of the duration model are summarized in Appendix IV.

The dependent variable is short-term money-market interest rate. These rates are closely correlated with policy rates and, unlike policy rates, are defined consistently across countries and are therefore more suitable for panel regressions than policy rates. Consistent with the Taylor-rule literature, we regress the interest rate on contemporaneous output growth and inflation, both

---

[11] See, e.g., the empirical estimates of Taylor rule coefficients under Fed chairmen in Judd and Rudebush (1998).

[12] Ex-post estimate of the financial sector vulnerability were estimated in logit and duration models using annual data for 49 countries for 1980–2003.

with an expected positive sign. We also include past interest rates, with an expected positive sign, to capture the persistence of monetary policy.

We focus on financial sector vulnerability variable, with an expected negative sign, using a number of specifications, as described earlier. In our regression the expected indirect relationship between vulnerability and short-term interest rate translates into an expected *positive* sign for distance to default, ISSF index and for time to crisis (higher values mean more stability), and an expected *negative* sign for the probability of crisis (higher values mean less stability).

Table 3 presents alternative specifications of the model, using the above definitions of financial sector vulnerability. The explanatory variables have the expected signs and generally are significant. The key explanatory variable investigated in this paper, financial sector vulnerability, has the expected signs across the model specifications, i.e., more vulnerability is found to be associated with lower policy rates. The point estimates for crisis probability, time to crisis, and the Z-score are statistically significant; the point estimates for distance to default and the IFSS have the expected sign, but are statistically insignificant.

Most experiments with interactive variables controlling for the difference in policy frameworks yield statistically insignificant results, although they have the expected signs. We include the products of the financial sector vulnerability variables with the indices of softness of peg, central bank independence, and a dummy for central bank supervision. The only weakly significant coefficient was that of the product of the softness of peg and probability of crisis (Table 3).

Time series regressions corroborate the panel results. To allow for country specific differences in Taylor rules, we run the regressions for probability of crisis, time to crisis, and distance to default for individual countries (there are insufficient observations to run country specific regressions for the IFSS index). We find that responsiveness of monetary policy to domestic financial sector vulnerability appears to be smaller in very open economies and in economies where banking supervision is outside the central bank (Table 4).

Table 3. Main Regression Results: Panel
(Dependent Variable: Money Market Interest Rate)

	I	II	III	IV	V	VI	VII
Crisis probability$_t$	-0.34	...	...	...	...	...	-0.01
	(0.18)*	...	...	...	...	...	(0.12)
Time to crisis$_t$	...	2.16	...	...	...	...	...
	...	(1.26)*	...	...	...	...	...
Z-score	...	...	0.18	...	...	...	...
	...	...	(0.08)*	...	...	...	...
Distance to default$_t$	...	...	...	0.11	...	...	...
	...	...	...	(0.09)	...	...	...
CDS	...	...	...	...	-0.09	...	...
	...	...	...	...	(0.07)	...	...
IFSS$_t$	...	...	...	...	...	0.43	...
	...	...	...	...	...	(0.81)	...
GDP gap$_t$	1.72	1.75	1.39	1.44	1.7411	1.39	1.89
	(0.24)***	(0.34)***	(0.17)***	(0.09)***	(0.1764)***	(0.10)***	(0.22)***
GDP gap$_{t-1}$	1.83	1.47	0.20	0.92	0.8356	0.21	1.76
	(1.20)	(0.37)**	(0.28)**	(0.24)**	(0.3109)**	(0.20)	(0.23)***
CPI change$_t$	1.03	0.94	0.73	0.90	0.8948	0.84	1.06
	(0.02)***	(0.15)***	(0.65)**	(0.58)**	(0.4894)**	(0.13)**	(0.03)***
CPI change$_{t-1}$	0.61	0.33	1.91	1.02	0.7654	2.49	0.61
	(0.42)	(0.67)	(0.72)*	(0.60)*	(0.8490)	(2.02)	(0.53)
Money market int. r. $_{t-1}$	0.74	0.82	0.91	0.71	0.8827	0.69	0.73
	(0.24)**	(0.15)***	(0.08)***	(0.09)***	(0.1351)***	(0.20)***	(0.27)*
Crisis probability times softness of peg$_t$	...	...	...	...	...	...	-0.19
	...	...	...	...	...	...	(0.07)**
R-squared	0.47	0.45	0.44	0.38	0.3351	0.33	0.48
Number of observations	1382	1382	758	773	763	375	1382

Source: Authors' calculations.
Notes: Standard errors in parentheses. Estimates use as instrumental variables lending rates and measures of corporate sector leverage (capital/assets) and profitability (earnings before tax and interest to interest expenses).
*** Significant at 1 percent level. ** Significant at 5 percent level. * Significant at 10 percent level.

Table 4. Regression Results for Selected Countries
(Shown is the slope coefficient of money market interest rate with respect to selected indicators of financial sector vulnerability in country-by-country regressions)

	Crisis probability	Z-score	Distance to default	IFSS
Australia	-0.40*	0.21	0.13	0.53
Canada	-0.36	0.19	0.12	0.47
Czech Republic	-0.45	0.23	0.15	0.59
Denmark	-0.50*	0.26*	0.17*	0.67*
ECB	-0.41	0.21	0.13	0.53
Hong Kong SAR	-0.05	0.01	-0.03	0.08
Hungary	-0.40	0.21	0.13	0.52
Korea	-0.53	0.27*	0.18*	0.71*
Japan	-0.40	0.21	0.13	0.52
Mexico	-0.49*	0.25*	0.16	0.65
Norway	-0.48*	0.25*	0.16*	0.64
Philippines	-0.36	0.19	0.12	0.46
Poland	-0.46*	0.24*	0.15	0.61
Russian Federation	-0.48*	0.25*	0.16*	0.64
South Africa	-0.40	0.21	0.13	0.51
Switzerland	-0.45*	0.24*	0.15	0.60
United Kingdom	-0.37	0.19	0.12	0.47
United States	-0.39	0.21	0.13	0.51

Source: Authors’ calculations.
Notes: Standard errors in parentheses. Estimates use as instrumental variables lending rates and measures of corporate sector leverage (capital/assets) and profitability (earnings before tax and interest to interest expenses).
*** Significant at 1 percent level. ** Significant at 5 percent level. * Significant at 10 percent level.
We report here only the slope coefficient of money market interest rate with respect to selected indicators of financial sector vulnerability in country-by-country time-series regressions.

V. Conclusions and Topics for Further Research

Monetary authorities, especially in countries where they supervises the banking system, seem to prefer to accommodate financial sector vulnerability by lower policy rates than what is optimal under the conventional Taylor rule with inflation, output gap, and interest rate inertia only. Thus, as predicted in the theoretical model, the authorities try to divide the expected cost of financial sector vulnerability between explicit fiscal spending and higher expected inflation.

We test this prediction empirically in a panel and time-series framework, using the Taylor rule augmented for alternative measures of financial sector vulnerability, and find some empirical support for this hypothesis. The point estimates of the financial sector vulnerability variables had consistently the expected signs, however, they are statistically significant in some specifications only. Our estimates contribute to the existing literature on monetary policy rules by highlighting the authorities' reaction to financial sector vulnerability. While previous empirical papers have found either a weakly positive relationship or no significant relationship between vulnerability and monetary stance, our findings suggest that these papers failed to distinguish between the "supply" of and "demand" for financial stability, and thus captured a combination of these two effects.

The empirical model can be extended in a number of ways. In this paper, we have followed a panel data approach, to exploit both the within-country and the cross-country variation. Nonetheless, as an alternative approach, it may be useful to perform a more detailed analysis of individual countries, accounting for structural breaks in their policies (following, in a broad sense, Judd and Rudebush, 1998). Also, as more observations will become available, we should be able to test whether the central banks' reportedly increased focus on financial stability in late 1990s and 2000s (as documented, e.g., in Čihák, 2006) was reflected in monetary policy actions.

APPENDIX I. DURATION MODEL OF THE AL LINE

The positive relationship between interest rates and financial sector vulnerability that makes the asset-liability (AL) line upward-sloping, follows (i) from a direct effect of nominal interest rate change on the interest payment flows and prices of interest-rate sensitive assets, and (ii) from an indirect effect, through changes in credit risk implied by interest rate changes.

The direct impact of higher nominal interest rates on capital and capital adequacy is typically negative, resulting from the fact that financial institutions operate with a duration gap between their assets and liabilities. Duration of assets (liabilities), D_A (D_L), is defined as the weighted average, term-to-maturity of an asset's (liability's) cash flow, the weights being the present value of each future cash flow as a percent of the asset's (liability's) full price.[13] Duration approximates the elasticity of the market values of assets and liabilities to the respective rates of return,

$$\frac{\Delta A(r_A)}{A(r_A)} \cong \frac{-D_A \Delta r_A}{(1+r_A)}, \quad \frac{\Delta L(r_L)}{L(r_L)} \cong \frac{-D_L \Delta r_L}{(1+r_L)}, \tag{1}$$

where $A(r_A)$ and $L(r_L)$ are market values of assets and liabilities of the financial system, and r_A and r_L are annual interest rates of assets and liabilities.[14] Differentiating the capital adequacy ratio with respect to the interest rate on assets and substituting from (1), we obtain:

$$\frac{\Delta[C(r_A, r_L)/A_{RW}(r_A)]}{\Delta r_A} \cong -\frac{(L/A_{RW})}{1+r_A}\left(D_A - D_L \frac{1+r_A}{1+r_L}\frac{\Delta r_L}{\Delta r_A}\right)\frac{1-\frac{\Delta A_{RW}}{A_{RW}}\frac{C}{\Delta C}}{1-\frac{\Delta A}{A}\frac{C}{\Delta C}}. \tag{2}$$

Assuming that the risk-weighted assets move proportionately to total assets, i.e., $\Delta A_{RW}/A_{RW}=\Delta A/A$, equation (2) can be simplified into

$$\frac{\Delta[C(r_A, r_L)/A_{RW}(r_A)]}{\Delta r_A} \cong -\frac{(L/A_{RW})}{1+r_A} GAP_D, \tag{3}$$

where GAP_D is the duration gap, defined as[15]

---

[13] See the draft Compilation Guide on FSIs (paragraph 3.52) for a formula. In practice, the calculation of duration of total assets and total liabilities of a financial system is a difficult computational task and various simplifications are used in practice (e.g., duration is computed for groups of assets and liabilities with common features and aggregated across such groups; or duration is replaced by residual maturity and time to repricing).

[14] See, e.g., Bierwag (1987). The results are first-order approximations; for large changes in interest rates, second derivative terms need to be included to account for convexity of portfolios.

[15] If the interest rates for assets and liabilities move simultaneously, the duration gap can be approximated as a difference of the two durations, D_A–D_L.

$$GAP_D = D_A - D_L \frac{1 + r_A}{1 + r_L} \frac{\Delta r_L}{\Delta r_A} . \qquad (4)$$

Most financial institutions, and banks in particular, operate by transforming short-term, low-interest rate liabilities into long-term, higher-interest rate assets. This means that $D_A >> D_L$, $r_A > r_L$, and $GAP_D > 0$. Thus, an increase in interest rates has a negative impact on the institutions' net worth and capitalization, leading to increased financial sector vulnerability.

The indirect effects, related to the interest-risk nexus work in the same direction. An increase in nominal interest rates—to the extent that it increases real interest rates and makes it more difficult for borrowers to repay their debts and to obtain new credit—is likely to have a negative effect on the credit risk of the financial institutions' borrowers. Other things equal, higher risk eventually translates into higher losses and a decline of the financial institutions' net worth. The exact impact depends on factors such as the borrowers' earnings in relation to interest and principal expenses, loan loss provisions, and the degree of collateralization of the loans. Country case studies find a positive relationship between higher interest rates and nonperforming loans or loan losses.[16]

[16] See, e.g., Peng and others (2003) for Hong Kong, Babouček and Jančar (2005) for the Czech Republic, and Pesola (2005) for the Nordic countries. For a cross-country study, see IMF (2003). The studies that have found no robust relationship between interest rates and credit risk (e.g., IMF, 2003) did not distinguish the AL line from the MP line.

APPENDIX II. ADDITIONAL DATA INFORMATION

The following list provides details on the data used in the empirical estimates in Section IV.

Variable	Definition	Source
NPL	Gross nonperforming loans as a share of total gross loans	Data from FSAPs, EDSS, and central banks' publications
CAR	Nonperforming loans net of provisions as a share of regulatory capital	Data from FSAPs, EDSS, and central banks' publications
GDP gap	Raw data from IFS. Smoothed with Hodrick-Prescott filter. Output gap in percent.	International Financial Statistics (IFS).
CPI	Annual consumer price inflation	IFS
EX	Annual change in the nominal exchange rate relative to the US$	IFS
REER	Annual change in the real effective exchange rate	IFS
PPP_GDP	Level of GDP per capita in purchasing power parity (US$)	WDI database
M2/GDP	Ratio of M2 (money and quasi money) to nominal GDP	IFS
Z-score	Defined as $z \equiv (k+\mu)/\sigma$, where k is equity capital as percent of assets, μ is average return as percent on assets, and σ is standard deviation of return on assets as a proxy for return volatility. Measures the number of standard deviations a return realization has to fall in order to deplete equity, under the assumption of normality of banks' returns. A higher z-score implies a lower risk of insolvency. Z-scores are calculated for each bank in a country in the BankScope database, and an average z-score is calculated, using total assets as weights.	Bankscope and authors calculations.
Distance to default	Distance to default of a portfolio of bank shares in the country. See Appendix III for details. Can be thought of as an implementation of the z-score using stock marked prices instead of accounting values to estimate the volatility of the economic value of the bank.	Datastream, Bankscope, and authors' calculations described in Appendix III.
CDS	Credit default swap spread values for obligations issued by banks, in percentage points. Daily data. A weighted average for the banks in the country for which CDS data are available, using banks' total assets as weights. See Appendix III for details.	Datastream, Bloomberg, and authors' calculations (see Appendix III).
Probability of crisis	See Appendix IV for details.	Authors' calculations described in Appendix IV.
Time to crisis	See Appendix IV for details.	Authors' calculations described in Appendix IV.
Crisis (1)	Dummy variable that takes on the value one if a systemic crisis is observed or zero otherwise	Demirgüç-Kunt and Detragiache (2005)
Crisis (2)	Dummy variable that takes on the value one if a systemic crisis is observed or zero otherwise	Honohan and Laeven (2005)
Money market interest rates	Short-term money market interest rates	International Financial Statistics, central banks' websites

Variable	Definition	Source
Nominal lending rates	Average rates on banks' lending	International Financial Statistics, central banks' websites
Corporate sector leverage	Capital to assets in the corporate sector.	WorldScope
Capital sector profitability	Earnings before tax and interest to interest expenses in the corporate sector	WorldScope
Banking supervision	Dummy variable taking on the value of one if the central bank carries out banking supervision; zero otherwise.	IMF and World Bank (2005)
Softness of peg	Measure of softness of the exchange rate peg (hard peg=0, float=3)	Reinhart and Rogoff (2002), adapted (original scale: peg=1, float=4)
CB independence	Index of central bank independence	Cukierman (1992)
H-Statistic	Variable that captures the competitiveness of the banking industry whereby $H \leq 0$ indicates monopoly equilibrium; $0 < H < 1$ indicates monopolistic competition and $H = 1$ indicates perfect competition	Claessens and Laeven (2004)
Concentration	Proportion of total assets held by the 3 largest institutions in a country, averaged over the period 1988–2003	Beck, Demirgüç-Kunt, and Levine (2006) and Bankscope
Real GDP growth	Rate of growth of the gross domestic product	World Bank Development Indicators
Real interest rate	Nominal interest rate minus the rate of inflation	International Financial Statistics
GDP deflator	Rate of change of the GDP deflator	World Bank Development Indicators
Terms of trade	Change in the net barter terms of trade	World Bank Development Indicators
Depreciation	Change in the foreign exchange rate	International Financial Statistics
M2/Reserves	Ratio of M2 to gross foreign reserves	World Bank Development Indicators
Credit growth	Rate of growth of domestic credit to the private sector, adjusted for inflation with GDP deflator	International Financial Statistics
Moral hazard index	Indicator that measures generosity of design features of deposit insurance schemes calculated as the first principal component of the following design features: co-insurance, coverage of foreign currency and interbank deposits, membership, management, type and source of funding, level of explicit coverage and augmented for additional features regarding the presence of risk based premiums, deposit insurer's power to revoke the bank licence and its ability to intervene a bank.	Demirgüç-Kunt and Detragiache (2002) and authors' calculations
British, French, German, and Scandinavian legal origin	A set of dummy variables that take on the value one if the country's legal system is of British/French/German/Scandinavian origin and zero otherwise	La Porta, Lopez-de-Silanes, and Shleifer (1998)

Variable	Definition	Source
Activity restrictions	Activity restrictions index for securities, insurance, real estate and ownership of non-financial firms that takes on values between 4 and 16, whereby greater values indicate more restrictions.	Barth, Caprio, and Levine (2004)
Capital regulatory index	Summary index for overall capital stringency calculated as the sum of initial capital stringency and overall capital stringency.	Barth, Caprio, and Levine (2004)
Foreign ownership	Proportion of bank assets owned by foreign entities.	Barth, Caprio, and Levine (2004)
Government ownership	Proportion of bank assets owned by government	La Porta, Lopez-de-Silanes, and Shleifer (2000)

The main model presented in Table 3 was estimated on quarterly data on this sample of 28 economies: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong SAR, Hungary, Italy, Korea, Japan, Luxembourg, Mexico, Netherlands, Norway, Philippines, Poland, Portugal, Russian Federation, South Africa, Spain, Switzerland, United Kingdom, United States.

The satellite model presented in Appendix IV was estimated on annual data on a wider sample of 52 economies: Australia, Austria, Bangladesh, Belgium, Brazil, Canada, Chile, Colombia, Costa Rica, Croatia, Czech Republic, Denmark, Dominican Republic, Ecuador, Finland, France, Germany, Greece, Honduras, Hong Kong SAR, China, Hungary, India, Indonesia, Italy, Japan, Kenya, Korea, Latvia, Lebanon, Luxembourg, Malaysia, Mexico, Netherlands, Nigeria, Norway, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Russian Federation, South Africa, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, United States, Venezuela.

APPENDIX III: DISTANCE TO DEFAULT AND CREDIT DEFAULT SWAP SPREADS

This appendix explains two market-based measures of bank soundness that are used in the paper, namely distance to default and credit default swap spreads. These indicators have become increasingly popular in the literature because they are based on high-frequency data that are available with minimum lags. Their main drawbacks include their dependence on the liquidity of the underlying market: if an important part of financial institutions in the country does not have securities traded in liquid markets, these indicators have limited informational contents or cannot even be construed..

Distance to default (DD) is derived from information contained in bank equity prices. In a standard valuation model, the DD is determined by: (i) the market value of a firm's assets, V_A, a measure of the present value of the future cash flows produced by the firm's assets; (ii) the uncertainty or volatility of the asset value (risk), σ_A; and (iii) the degree of leverage or the extent of the firm's contractual liabilities, measured as the book value of liabilities at time t, D_t (with maturity T), relative to the market value of assets.

Distance to default is computed as the sum of the ratio of the estimated current value of assets to debt and the return on the market value of assets, divided by the volatility of assets. The formula is given by:

$$DD_t = \frac{\ln(V_{A,t} / D_t) + (\mu - \frac{1}{2}\sigma_A^2)T}{\sigma_A \sqrt{T}}$$

where μ measures the mean growth of V_A.

Using market data of equity and annual accounting data, the market value V_A and the volatility of assets σ_A are typically estimated using Black and Scholes (1973) and Merton (1974) options pricing model. A higher DD indicates an improvement in financial soundness, although the measure is sensitive to underlying assumptions. In this exercise, the value of assets is estimated to be equal to the sum of the market value of equity and the book value of debt.

Distance to default has originally been developed in the context of individual institutions. However, with the increased focused on macroprudential surveillance in recent years, the concept of distance to default has been increasingly used also in the context of the banking (or financial) sector. In this paper, we use the DD measures both at the level of individual banks and at the level of the sector. The DD measures at the banking sector level are calculated for a *portfolio* of systemically important banks, making up for the majority of the country's banking system equity.

The DD is calculated on a daily basis. The values are then indexed, with the first day of year 2000 as the base. For use in the regressions, quarterly and annual averages of the DD are calculated from the daily data.

If financial institutions issue debt that is publicly traded in liquid markets, credit spreads on those instruments could be used as an alternative measure of soundness of these institutions. We use the **credit default swap premium** (CDS) as a direct measure of credit spreads. CDS is the most popular instrument in the rapidly growing credit derivatives markets. Under a CDS contract the protection seller promises to buy the reference bond at its par value when a pre-defined default event occurs. In return, the protection buyer makes periodic payments to the seller until the maturity date of the contract or until a credit event occurs. This periodic payment, which is usually expressed as a percentage (in basis points) of its notional value, is called CDS spread. By definition, credit spread provides a pure measure of the default risk of the reference entity.

Our CDS data are provided by Bloomberg. We include all CDS quotes written on a given country (sovereign entities excluded) and denominated in the country’s currency. We eliminate the subordinated class of contracts because of their small relevance in the database and unappealing implication in credit risk pricing. We focus on 5-year CDS contracts with modified restructuring (MR) clauses as they are the most popularly traded. We match the CDS data with other information such as equity prices and balance sheet information. We aggregate CDS data for individual institutions in a country weighting the individual observation by the total assets of the institution.

APPENDIX V. REGRESSIONS FOR PROBABILITY OF CRISIS AND TIME TO CRISIS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Duration models				**Logit probability models**			
Constant	4.6274	0.8507	0.0802	6.5739	-5.4307	-1.1953	-0.6020	-2.8211
	(0.6236)***	(1.5846)	(1.9978)	(5.2874)	(0.7062)***	(1.4726)	(1.8109)	(4.3279)
GDP growth (real)	-0.0691	-0.0214	-0.0184	-0.0141	0.1315	0.0787	0.0719	0.0709
	(0.0803)	(0.0904)	(0.0909)	(0.0880)	(0.0817)	(0.0922)	(0.0935)	(0.0920)
Real interest rate	-0.0084	-0.0103	-0.0085	-0.0067	0.0219	0.0253	0.0235	0.0231
	(0.0118)	(0.0139)	(0.0126)	(0.0131)	(0.0100)**	(0.0130)*	(0.0130)*	(0.0130)*
GDP deflator	-0.0021	-0.0018	-0.0010	0.0002	0.0053	0.0043	0.0036	0.0033
	(0.0018)	(0.0017)	(0.0018)	(0.0022)	(0.0031)*	(0.0037)	(0.0039)	(0.0038)
Terms of trade change	-0.0024	-0.0029	-0.0026	-0.0025	0.0002	0.0001	-0.0000	-0.0001
	(0.0017)	(0.0017)*	(0.0017)	(0.0018)	(0.0027)	(0.0035)	(0.0032)	(0.0033)
Depreciation	-0.0039	-0.0025	-0.0027	-0.0030	0.0002	-0.0010	-0.0008	-0.0007
	(0.0015)***	(0.0017)	(0.0015)*	(0.0014)**	(0.0023)	(0.0020)	(0.0019)	(0.0018)
M2/international reserves	0.0138	0.0187	0.0293	0.0266	0.0057	-0.0020	-0.0110	-0.0080
	(0.0296)	(0.0305)	(0.0324)	(0.0319)	(0.0239)	(0.0262)	(0.0326)	(0.0320)
Credit growth (real)	-0.0014	-0.0019	-0.0020	-0.0022	0.0010	0.0016	0.0017	0.0018
	(0.0004)***	(0.0005)***	(0.0005)***	(0.0006)***	(0.0008)	(0.0008)**	(0.0008)**	(0.0008)**
Moral hazard index	-0.0372	0.2685	0.2602	0.0527	0.3375	0.0299	0.0601	0.1363
	(0.2190)	(0.2772)	(0.2933)	(0.3306)	(0.3417)	(0.3690)	(0.3683)	(0.3984)
British legal origin	-0.5227	-0.3812	-0.1951	-0.6531	1.1127	1.1103	1.0450	1.2049
	(0.6629)	(0.7934)	(0.8777)	(0.9105)	(0.8397)	(0.9437)	(0.9338)	(0.9193)
French legal origin	-1.1209	-1.5525	-1.3319	-1.2832	1.6562	2.2597	2.1015	2.1036
	(0.6180)*	(0.5790)***	(0.5518)**	(0.6086)**	(0.6230)***	(0.6465)***	(0.5998)***	(0.6185)***
Scandinavian legal origin	-1.1441	-1.0797	-1.5069	-1.2270	1.2795	1.2279	1.5485	1.4447
	(0.5604)**	(0.5249)**	(0.7134)**	(0.7192)*	(1.1575)	(1.1414)	(1.2624)	(1.2846)
H-Statistic		5.0854	4.2562	-6.3020		-5.8513	-5.2130	-1.7627
		(1.7922)***	(1.9919)**	(8.2633)		(1.7523)***	(1.8819)***	(6.2430)
Concentration			2.3486	-11.8460			-1.8366	2.9196
			(2.4725)	(11.2600)			(2.4980)	(8.6863)
H-Statistic * Concentration				23.9997				-7.8430
				(18.7818)				(13.1666)
Observations	619	619	619	619	567	567	567	567
Number of crises	22	22	22	22	28	28	28	28
Type I Error	n/a	n/a	n/a	n/a	25.00%	28.57%	25.00%	25.00%
Type II Error	n/a	n/a	n/a	n/a	41.37%	33.95%	33.58%	33.21%
Akaike Info. Criterion	0.1610	0.1555	0.1571	0.1578	0.400	0.387	0.390	0.393
Pseudo R^2	n/a	n/a	n/a	n/a	0.091	0.132	0.135	0.136

The above estimates are used to provide two of the specifications of financial sector vulnerability used in the main regression estimates in Table 3, namely probability of crisis and time to crisis. The estimates are based on the data and calculations in Schack, Čihák, and Wolfe (2006).

Exponential duration models with time varying covariates are estimated in columns (1)-(4) and logit probability models in column (5)-(8). All estimates use annual data for 1980–2003 for the following 49 economies: Australia, Austria, Bangladesh, Belgium, Brazil, Canada, Chile, Colombia, Costa Rica, Croatia, Czech Republic, Denmark, Dominican Republic, Ecuador, France, Germany, Greece, Honduras, Hong Kong SAR, China, Hungary, India, Indonesia, Italy, Japan, Kenya, Latvia, Lebanon, Luxembourg, Malaysia, Mexico, Netherlands, Nigeria, Norway, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Russian Federation, South Africa, Spain, Switzerland, Turkey, Ukraine, United Kingdom, United States, Venezuela.

The dependent variable is the log of time to crisis in the exponential duration models. The observations are right-hand censored if no crisis surfaced during the observation period. The number of observations in the duration models is greater than in the logit models since the dataset has to be set up differently for analyzing duration data with multiple crises. If a crisis runs over multiple years, the years following the onset of a crisis are deleted from the duration-model dataset. If a country experiences multiple crises, subsequent systemic episodes are included in the sample. However, the number of crises in the duration-model database is smaller than in the logit database, since the former focuses on time spans for each country and exploits information in the data at the end of each span. Therefore, values of the first observation for each country recorded in the initial dataset are discarded in the duration-model database.

The dependent variable in the logit probability models is a dummy variable that equals one if a crisis is observed and zero otherwise. All explanatory variables are lagged in the models by one period to avoid simultaneity problems. If a crisis runs over multiple years, the years following the onset of a crisis are deleted from the dataset. If a country experienced multiple crises, subsequent systemic episodes are included in the sample.

Specifications (1) and (5) are our baseline models that include covariates used in previous studies, whereby we update the Moral Hazard Index by Demirgüç-Kunt and Detragiache (2002). We also incorporate three dummies for origin of the legal system, whereby we capture German legal origin in the intercept. Specifications (2) and (6) include the *H-Statistic* as measure for the competitiveness of the industry and Specification (3) and (7) incorporate the level of concentration as measured by the three-bank concentration ratio, averaged over the sampling period. To control for nonlinear relationships between the degree of competitiveness and the level of concentration, we include an interaction term of these two variables in Specification (4) and (8). White's heteroskedasticity consistent standard errors are given in parentheses. Type I and Type II Error are calculated as the total number of crisis observations (28) divided by the number of observations in the sample (567); this yields a cut-off point of 0.0494. Significance levels of 1, 5 and 10 percent are indicated by ***, ** and *.

References

Anderson, Ronald W. and Chantal Kegels, 1998, *Transition Banking. Financial Development of Central and Eastern Europe* (Oxford: Clarendon Press).

Babouček, Ivan, and Martin Jančar, 2005, "A VAR Analysis of the Effects of Macroeconomic Shocks to the Quality of the Aggregate Loan Portfolio of the Czech Banking Sector," CNB Working Paper No. 2005/01 (Prague: Czech National Bank).

Barro, Robert J., and David B. Gordon, 1983, "Rules, Discretion and Reputation in a Model of Monetary Policy," *Journal of Monetary Economics*, Vol. 12 (July), pp. 101–122.

Barth, James R., Gerard Caprio Jr. and Ross Levine, 2004, "Bank regulation and supervision: What works best?" *Journal of Financial Intermediation*, Vol. 13, pp. 205–48.

Batini, Nicoletta, Richard Harrison, and Stephen P. Millard, 2003, "Monetary policy rules for an open economy," *Journal of Economic Dynamics and Control*, Vol. 27, (September), pp. 2059–94.

Beck, Thorsten, Asli Demirgüç-Kunt and Ross Levine, 2006, "Bank concentration, competition, and crises: First results." *Journal of Banking and Finance*, forthcoming.

Begg, David, 2000, "Beyond the Design of Monetary Policy Alone: Fiscal Commitment, Macro Coordination, and Structural Adjustment," CEPR Discussion Paper, No. 2637 (London: Centre for Economic Policy Research).

Bernanke, B. and M. Gertler, 1999, "Monetary policy and asset price volatility", (Kansas City: Fed of Kansas City Economic Review), 4th quarter, pp. 17-51.

Bierwag, Gerald, 1987, *Duration Analysis* (Cambridge, MA: Harper & Row).

Borghijs, Alain, and Louis Kuijs, 2004, "Exchange Rates in Central Europe: A Blessing or a Curse?" IMF Working Paper No. 04/2 (Washington: International Monetary Fund). Available at

Borio, Claudio and Philip Lowe, 2002, "Asset Prices, Financial and Monetary stability: Exploring the Nexus," BIS Working Papers, No 114 (Basel: Bank for International Settlements). Available at http://www.bis.org/publ/work114.pdf.

Borio, Claudio and Philip Lowe, 2004, "Securing Sustainable Price Stability: Should Credit Come back from the Wilderness?" BIS Working Papers, No 157 (Basel: Bank for International Settlements). Available at http://www.bis.org/publ/work157.pdf.

Boyd, John H., and David E. Runkle, 1993, "Size and Performance of Banking Firms," *Journal of Monetary Economics*, Vol. 31, pp. 47–67.

Brousseau, Vincent and Carsten Detken, 2001, Monetary Policy and Fears of Financial Instability, *European Central Bank Working Paper*, No. 89, November.

Bauducco, Sofia, Aleš Bulíř, and Martin Čihák, 2008, "Taylor Rule Under Financial Instability" IMF Working Paper No. 08/18 (Washington: International Monetary Fund). Available at http://www.imf.org/external/pubs/ft/wp/2008/wp0818.pdf

Caprio, G. and D. Klingebiel, 1997, "Bank Insolvencies: Cross-Country Experience," Policy Research Working Paper No. 1620, Dataset mimeo (Washington: The World Bank).

Crockett, Andrew, 1997, "The Theory and Practice of Financial Stability," Essays in International Finance No. 203 (Princeton: Princeton University).

Cecchetti, Stephen, Genberg, H., Lipsky, John and S. Wadhwani, 2000, "Asset Prices and Central Bank Policy" ICMB/CEPR Report, No. 2 (London: Centre for Economic Policy Research).

Cecchetti, Stephen and Lianfa Li, 2005, "Do Capital Adequacy Requirements Matter for Monetary Policy?" National Bureau of Economic Research Working Paper 11830, Available at http://www.nber.org/papers/w11830.

Čihák, Martin, 2006, "How Do Central Banks Write on Financial Stability? IMF Working Paper No. 06/163 (Washington: International Monetary Fund),. Available at

Claessens, Stijn and Luc Laeven, 2004, "What drives bank competition? Some international evidence,“ *Journal of Money, Credit and Banking*, Vol. 36 (3), pp. 563–583.

Cukierman, A., Webb, S. B., and Neyapti, B., 1992, "Measuring the Independence of Central Banks and its Effects on Policy Outcomes,“ *World Bank Economic Review* (Washington: World Bank), VI, 353–398.

Das, Udaibir S., Marc Quintyn, and Kina Chenard, 2004, "Does Regulatory Governance Matter for Financial System Stability? An Empirical Analysis," IMF Working Paper 04/89 (Washington: International Monetary Fund). Available at

Demirgüç-Kunt, Asli and Enrica Detragiache, 2005, "Cross-Country Empirical Studies of Systemic Bank Distress: A Survey," IMF Working Paper 05/96 (Washington: International Monetary Fund). Available at http://www.imf.org/external/pubs/ft/wp/2005/wp0596.pdf.

Deutsche Bundesbank, 2005, *Financial Stability Review* (Frankfurt: Deutsche Bundesbank).

Diamond, Douglas W, Dybvig, Philip H, 1983, "Bank Runs, Deposit Insurance, and Liquidity," *Journal of Political Economy*, vol. 91(3), pages 401-19.

Driffill, John, Zeno Rotondi, Paolo Savona, and Cristiano Zazzara, 2006, "Monetary Policy and Financial Stability: What Role for the Futures Market?" *Journal of Financial Stability*, Vol. 2 (April), pp. 95–112.

Evjen, Snorre, Arild J Lund, Kjersti Haare Morka, Kjell B Nordal, and Ingvild Svendsen, 2005, "Monetary and Financial Stability in Norway: What Can We Learn from Macroeconomic Stress Tests?, In: "Investigating the relationship between the financial and real economy, BIS paper No. 22 (Basel: Bank for International Settlements). Available at http://www.bis.org/publ/bppdf/bispap22u.pdf.

Ghosh, Atish R., Timothy D. Lane, Marianne Schulze-Ghattas, Aleš Bulíř, Javier Hamann, Alexandros T. Mourmouras, 2002, "IMF-Supported Programs in Capital Account Crises," IMF *Occasional Paper* No. 210 (Washington: International Monetary Fund). Available at

Goldstein, Morris, Graciela L. Kaminsky, and Carmen M. Reinhart, 2000, *Assessing Financial Vulnerability: An Early Warning System for Emerging Markets* (Washington: Institute for International Economics).

Goodhart, C.A.E., Sunirand, P., Tsomocos, D.P., 2006. "A Model to Analyse Financial Fragility." *Economic Theory* 27, pp. 107–142.

Hilbers, Paul, Inci Otker-Robe, Ceyla Pazarbasioglu, and Gudrun Johnsen, 2005, "Assessing and Managing Rapid Credit Growth and the Role of Supervisory and Prudential Policies," IMF Working Paper 05/151 (Washington: International Monetary Fund). Available at

Honohan, Patrick and Luc Laeven (eds.), 2005, *Systemic financial crises: Containment and resolution* (Cambridge: University Press).

International Monetary Fund, 2003, Financial Soundness Indicators—Background Paper, May. (Washington: International Monetary Fund) Available at http://www.imf.org/external/np/sta/fsi/eng/2003/051403bp.pdf.

________________, 2004, *Compilation Guide on Financial Soundness Indicators*, (Washington DC, IMF). Available at http://www.imf.org/external/np/sta/fsi/eng/2004/guide/appendx.pdf

________________, and the World Bank, 2005, *Financial Sector Assessment: A Handbook* (Washington: IMF and the World Bank). Available at http://www.imf.org/external/pubs/ft/fsa/eng/index.htm.

Judd, John P., and Glenn D. Rudebusch, 1998, "Taylor's Rule and the Fed: 1970–1997," *FRBSF Economic Review* No. 3 (San Francisco: Federal Reserve Bank of San Francisco). Available at

Kashyap, Anil, and Jeremy Stein, 2000, "What Do a Million Observations on Banks Say about the Transmission of Monetary Policy," *American Economic Review*, Vol. 90(3), pp. 407–428.

Kumhof, Michael, Ricardo Nunes, and Irina Yakadina, 2006, "Simple Monetary Rules under Fiscal Dominance," mimeo, International Monetary Fund. Available at

La Porta, Rafael, Florencio Lopez-de-Silanes, and Andrei Shleifer, 1998, "Law and Finance." *Journal of Political Economy*, Vol. 106, pp. 1113–1155.

Laeven, Luc, and Ross Levine, 2006, "Corporate Governance, Regulation, and Bank Risk Taking," World Bank Mimeo.

Lindgren, Carl-Johan, Tomás J.T. Baliño, Charles Enoch, Anne-Marie Gulde, Marc Quintyn, and Leslie Teo, 1999, "Financial Sector Crisis and Restructuring: Lessons from Asia." IMF *Occasional Paper* No. 188 (Washington: International Monetary Fund).

Maechler, Andrea, Srobona Mitra, and DeLisle Worrell, 2005, "*Exploring Financial Risks and Vulnerabilities in New and Potential EU Member States*," Second Annual DG ECFIN Research Conference: "Financial Stability and the Convergence Process in Europe," October 6–7, 2005.

Mishkin, F. S., 1996, "Understanding financial crises: a developing country's perspective," NBER Working Paper No. 5600 (Cambridge, MA: National Bureau of Economic Research). Available at

Peng, Wensheng, Kitty Lai, Frank Leung, and Chang Shu, 2003, "The Impact of Interest Rate Shocks on the Performance of the Banking Sector," Hong Kong Monetary Authority Research Memorandum, May 2003. Available at http://www.info.gov.hk/hkma/eng/research/RM07-2003.pdf.

Pesola, Jarmo, 2005, "Banking fragility and distress: An econometric study of macroeconomic determinants," Bank of Finland Research Discussion Papers No. 13 (Helsinki: Bank of Finland). Available at

Poole, William, 2006, "The Fed's Monetary Policy Rule," The Federal Reserve Bank of St. Louis *Review*, Vol. 88 (January/February), pp. 1–12. Available at

Rajan, Raghuram, and Luigi Zingales, 1998, Financial Dependence and Growth, *American Economic Review*, Vol. 88, No.3, pp. 559–586.

Reinhart, Carmen M., and Kenneth S. Rogoff, 2002, "The Modern History of Exchange Rate Arrangements: A Reinterpretation," NBER Working Paper No. 8963 (May). Available at

Rigobon, Roberto and Brian Sack, 2003, "Measuring the Reaction of Monetary Policy to the Stock Market," *The Quarterly Journal of Economics*, Vol. 118, No. 2, pp. 639–669.

Schaeck, Klaus, Čihák, Martin, and Simon Wolfe, 2006, "Are More Competitive Banking Systems More Stable?" (Washington: International Monetary Fund), IMF Working Paper No. 06/143. Available at

Schinasi, Garry, 2006, *Safeguarding Financial Stability: Theory and Practice* (Washington: International Monetary Fund).

Schwartz, Anna, 1995, "Why Financial Stability Depends on Price Stability", *Economic Affairs*, 21–25.

Shu, Chang, 2002, “The Impact Of Macroeconomic Environment On The Asset Quality Of Hong Kong’s Banking Sector,” Hong Kong Monetary Authority. Available at http://www.info.gov.hk/hkma/eng/research/RM20-2002.pdf.

Stiglitz, Joseph E., and Andrew Weiss, 1981, "Credit Rationing in Markets with Imperfect Information," *American Economic Review*, Vol.71 (June), pp.393–410.

Steigum, Erling, 2003, “Financial Deregulation with a Fixed Exchange Rate: Lessons from Norway’s Boom-Bust Cycle and Banking Crisis.” *Norges Bank’s Occasional Papers* No. 33 (Oslo: Norges Bank). Available at

Taylor, John B., 1993, “Discretion versus Policy Rules in Practice,” *Carnegie-Rochester Conference Series on Public Policy*, Vol. 39 (December), pp. 195–220.